# Electrophysiological Correlates of Memory Intrusions

Hellerstedt, Robin; Johansson, Mikael; Anderson, Michael

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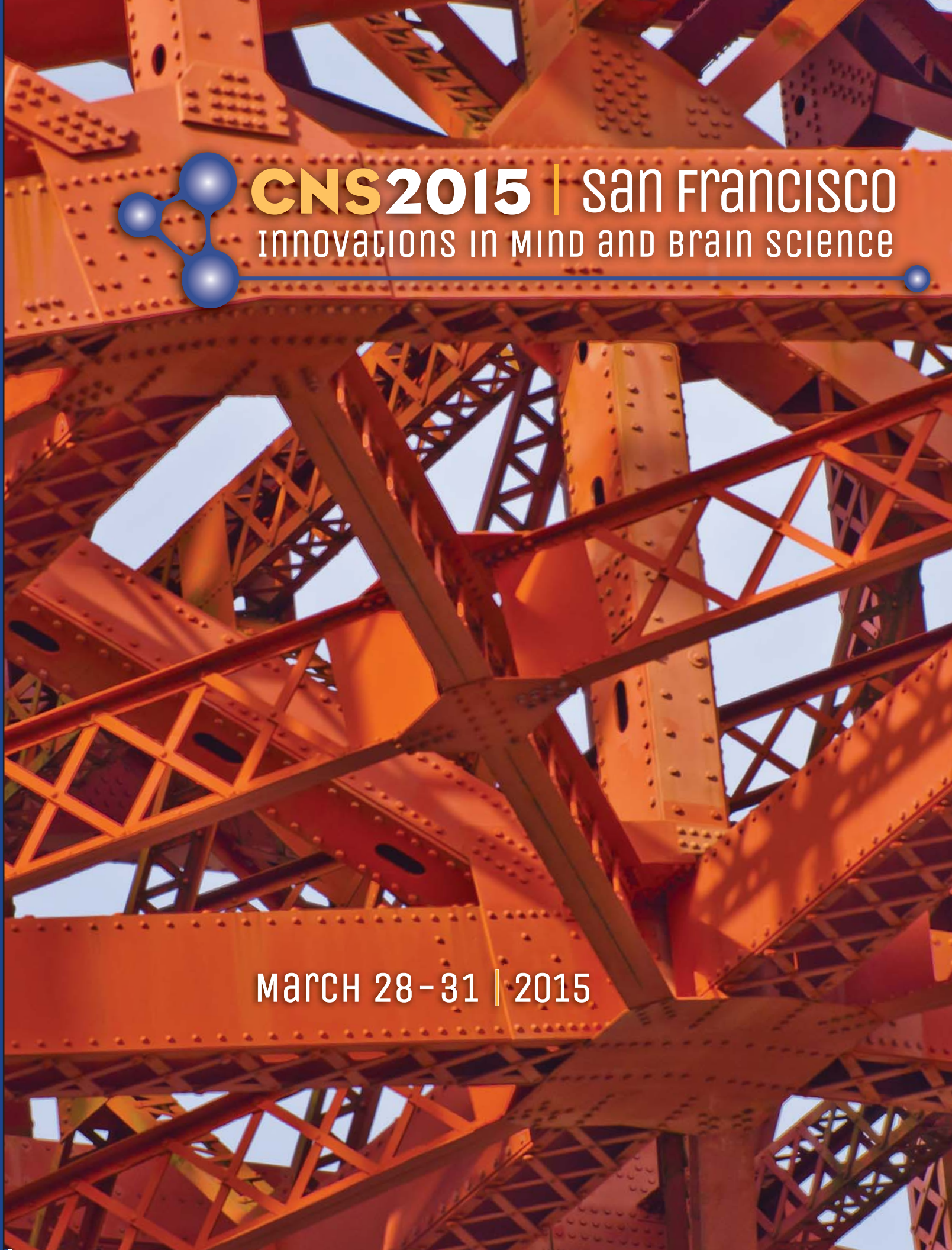
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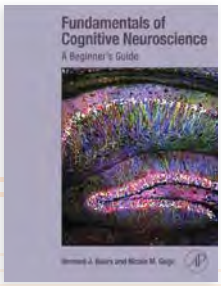


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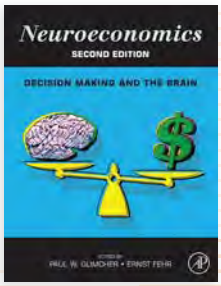


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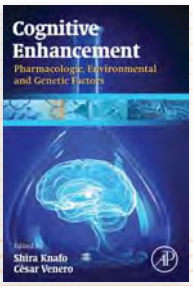


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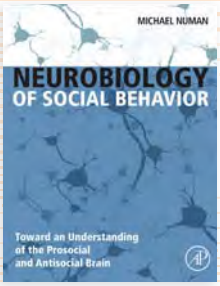


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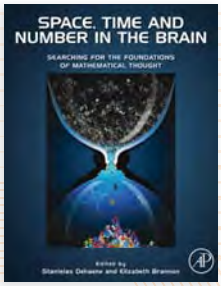


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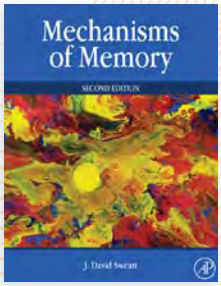


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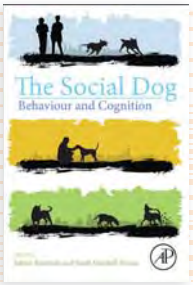


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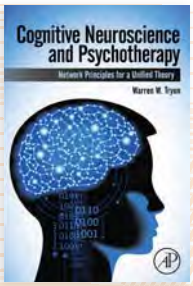


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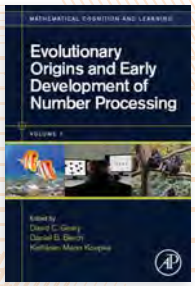


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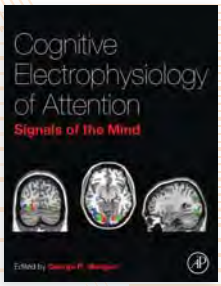


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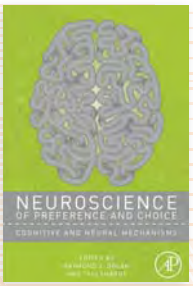


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# Cognitive Neuroscience Society

22nd Annual Meeting, March 28-31, 2015
Hyatt Regency Hotel, San Francisco, California

# 2015 Annual Meeting Program

## Contents




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# Schedule Overview

## Saturday, March 28

| | |
|---|---|
| 11:00 am – 3:00 pm | Exhibitor Check-In, *Exhibit Hall* |
| 11:00 am – 7:00 pm | Onsite Registration & Pre-Registration Check-In, *Grand Ballroom Foyer* |
| 2:00 – 3:30 pm | Keynote Address, **Anjan Chatterjee, "The neuroscience of aesthetics and art"** OPEN TO THE PUBLIC (Q&A to follow), *Grand Ballroom* |
| 3:30 – 4:00 pm | Coffee Service, *Exhibit Hall* |
| 3:30 – 5:30 pm | Exhibits on Display, *Exhibit Hall* |
| 3:30 – 5:30 pm | Poster Session A, *Exhibit Hall* |
| 5:30 – 6:30 pm | **4th Annual Distinguished Career Contributions in Cognitive Neuroscience Lecture – Marta Kutas**, "45 years of Cognitive Electrophysiology: Neither just psychology nor just the brain but the visible electrical interface between the twain", *Grand Ballroom* |
| 6:30 – 7:30 pm | Welcome Reception, *Atrium* |

## Sunday, March 29

| | |
|---|---|
| 7:30 am – 6:30 pm | Onsite Registration & Pre-Registration Check-In, *Grand Ballroom Foyer* |
| 8:00 – 8:30 am | Continental Breakfast, *Exhibit Hall* |
| 8:00 – 10:00 am | Poster Session B, *Exhibit Hall* |
| 8:00 am – 5:30 pm | Exhibits on Display, *Exhibit Hall* |
| 10:00 am – 12:00 pm | Mini-Symposium 1 – "**What can be, or should be, the relationship between language and neuroscience?**" Hanna Gauvin, Chair, *Grand Ballroom A* |
| | Mini-Symposium 2 – "**Zooming-in on the hippocampus: Advances in high-resolution imaging in the context of cognitive aging and dementia**" Naftali Raz, Chair, *Grand Ballroom B/C* |
| | Mini-Symposium 3 – "**Reasoning: Origins and development**" Kathy Mann Koepke, Chair, *Bay View Room* |
| 12:00 – 1:30 pm | Exhibit Expo, *Exhibit Hall* |
| 12:00 – 1:30 pm | Lunch Break |
| 1:30 – 2:30 pm | **YIA Special Lectures**, "Constructive Episodic Simulation of Future Events" **Donna Rose Addis** and "Do humans make good decisions?" **Christopher Summerfield**, *Grand Ballroom A* |
| 1:30 – 3:30 pm | **Data Blitz 1**, *Grand Ballroom B/C* |
| 2:30 – 3:30 pm | **NIH Funding Workshop**, Kathy Mann Koepke and Lisa Freund, NICHD/CDBB, *Grand Ballroom A* |
| 3:30 – 4:00 pm | Coffee Service, *Exhibit Hall* |
| 3:30 – 5:30 pm | Poster Session C, *Exhibit Hall* |
| 5:30 – 6:30 pm | **21st Annual George A. Miller Prize in Cognitive Neuroscience Lecture – Patricia Kuhl**, "The Neurogenetics of Language", *Grand Ballroom* |
| 7:00 pm | CNS Student Association Student Social Night, *Hyatt Regency Reception Area* |

## Monday, March 30

| | |
|---|---|
| 8:00 – 8:30 am | Continental Breakfast, *Exhibit Hall* |
| 8:00 am – 7:30 pm | Onsite Registration & Pre-Registration Check-In, *Grand Ballroom Foyer* |
| 8:00 – 10:00 am | Poster Session D, *Exhibit Hall* |
| 8:00 am – 7:30 pm | Exhibits on Display, *Exhibit Hall (Exhibit Booths closed 10:00 am – 1:30 pm)* |
| 10:00 am – 12:00 pm | Mini-Symposium 4 – "**Cerebellar contributions to learning and cognition**" Rich Ivry, Chair, Arseny Sokolov, Co-Chair, *Grand Ballroom A* |
| | Mini-Symposium 5 – "**Disrupting the face perception network**" David Pitcher, Chair, *Grand Ballroom B/C* |
| | Mini-Symposium 6 – "**Approaches to identify network connectivity in neuroimaging**" Vaughn Steele, Chair, *Bay View Room* |
| 10:00 am – 1:30 pm | Exhibit Booths Closed, *Exhibit Hall* |
| 12:00 – 1:00 pm | **NSF Funding Workshop**, Alumit Ishai, Director, NSF Cognitive Neuroscience Program, *Grand Ballroom B/C* |
| 12:00 – 1:30 pm | Lunch Break, *(Exhibit Booths Closed)* |
| 1:30 – 3:30 pm | Poster Session E, *Exhibit Hall* |
| 3:00 – 3:30-pm | Coffee Service, *Exhibit Hall* |
| 3:30 – 5:30 pm | Mini-Symposium 7 – "**Interactions between the prefrontal cortex and the medial temporal lobes supporting the control of memory retrieval**" Michael Anderson, Chair, Grand *Ballroom A* |
| | Invited Symposium 1 – "**The renaissance of EEG: An old dog teaching us new tricks**" Micah Murray, Chair, *Grand Ballroom B/C* |
| 5:30 – 7:30 pm | Poster Session F, *Exhibit Hall* |

## Tuesday, March 31

| | |
|---|---|
| 8:00 – 8:30 am | Continental Breakfast, *Exhibit Hall* |
| 8:00 – 10:00 am | Poster Session G, *Exhibit Hall* |
| 8:00 am – 12:00 pm | Exhibits on Display, *Exhibit Hall* |
| 8:00 am – 3:30 pm | Onsite Registration & Pre-Registration Check-In, *Grand Ballroom Foyer* |
| 10:00 am – 12:00 pm | Mini-Symposium 8 – "**Temporal coordination of neuronal processes by cross-frequency interactions**" Ole Jensen, Chair, *Grand Ballroom A* |
| | Mini-Symposium 9 – "**Fresh perspectives on social perception: From functional specialization to connectivity**" Emily Cross, Chair, *Grand Ballroom B/C* |
| | **Data Blitz 2**, *Bay View Room* |
| 12:00 – 1:00 pm | **Journal Reviewers Workshop**, Toby Charkin, (Elsevier), Chair, *Grand Ballroom B/C* |
| 12:00 – 1:30 pm | Lunch Break |
| 1:30 – 3:30 pm | Invited Symposium 2 – "**The Changing Brain—Insights from Lifespan Cognitive Neuroscience**" Patricia A. Reuter-Lorenz and Michael D. Rugg, Co-Chairs, *Grand Ballroom A* |
| | Invited Symposium 3 – "**Decisions, emotion, the self, and medial prefrontal cortex**" Scott Huettel, Chair, *Grand Ballroom B/C* |

# Keynote

## Anjan Chatterjee, M.D.

Elliott Professor and Chief of Neurology at Pennsylvania Hospital

## Keynote Address, Open to the Public

Saturday, March 28, 2:00-3:30 pm, Grand Ballroom

### The neuroscience of aesthetics and art

What can neuroscience possibly tell us about aesthetics and art? In this talk, I will offer a framework from which a neuroscientist might decompose aesthetic experiences. I will discuss findings from neurology and cognitive neuroscience that reveal neural structures and networks engaged when we respond to beauty and react to art. I will consider the uneasy relationship between scientific aesthetics and the humanities, dispel some critiques, and acknowledge specific limitations of neuroaesthetics. Finally, informed by our understanding of the neural underpinnings of art, I will speculate about its evolution. Previous debates about whether art-making and appreciation represent an instinct or an epiphenomenon of other evolved capacities are probably not well-framed. I offer a third way to think about why we are now – and perhaps have always been – surrounded by these mysterious objects that we call art.

### Biography

Anjan Chatterjee, MD, is the Elliott Professor and Chief of Neurology at Pennsylvania Hospital. He is a member of the Center for Cognitive Neuroscience and the Center for Neuroscience and Society at the University of Pennsylvania. He is or has served on the editorial boards of: Empirical Studies of the Arts, Cognitive and Behavioral Neurology, Behavioural Neurology, Neuropsychology, Journal of Cognitive Neuroscience, European Neurology, The Journal of the International Neuropsychological Society, American Journal of Bioethics: Neuroscience, Brain Science, and Policy Studies in Ethics, Law and Technology. In 2002, he was awarded the Norman Geschwind Prize in Behavioral and Cognitive Neurology by the American Academy of Neurology. He is a past-President of the International Association of Empirical Aesthetics and the President of the Behavioral and Cognitive Neurology Society. His neurology practice focuses on patients with cognitive disorders. His research focuses on spatial cognition, language, ethics, and aesthetics. He is author of The Aesthetic Brain: How we Evolved to Desire Beauty and enjoy Art (Oxford, 2014), has published over 150 peer-reviewed papers and co-edited Neuroethics in Practice: Medicine, Mind, and Society and The Roots of Cognitive Neuroscience: Behavioral Neurology and Neuropsychology.

# George A. Miller Prize

## Congratulations to Dr. Patricia Kuhl for being awarded this honor!

Dr. Kuhl will accept this prestigious award and deliver her lecture on Sunday, March 29, 2015, 5:30-6:30 pm, in the Grand Ballroom.

## The Neurogenetics of Language

### Patricia Kuhl

**Co-Director, Institute for Learning & Brain Sciences**
**Director, NSF Science of Learning Center (The LIFE Center)**
**University of Washington, Seattle, Washington**

In neuroimaging studies using structural (diffusion weighted magnetic resonance imaging or DW-MRI) and functional (magnetoencephalography or MEG) imaging, my laboratory has produced data on the neural connectivity that underlies language processing, as well as electrophysiological measures of language functioning during various levels of language processing (e.g., phonemic, lexical, or sentential). Taken early in development, electrophysiological measures or "biomarkers" have been shown to predict future language performance in neurotypical children as well as children with autism spectrum disorders (ASD). Work in my laboratory is now combining these neuroimaging approaches with genetic sequencing, allowing us to understand the genetic contributions to language learning. In this talk, I will describe ongoing work in which we use neuroimaging and genetic sequencing to account for individuals' ability to learn a second language. This work lends support to a theoretical model whose main tenet is that language learning involves domain general cognitive and social skills. This model is advancing as new data contribute to our understanding of the neurogenetics of language.

## About the George A. Miller Prize in Cognitive Neuroscience

The George A. Miller Prize in Cognitive Neuroscience was established in 1995 by the Cognitive Neuroscience Society to honor the innovative scholarship of George A. Miller, whose many theoretical advances has so greatly influenced the discipline of cognitive neuroscience. The first ten years of the prize were funded by generous support from the James S. McDonnell Foundation.

The Prize is awarded to the nominee whose career is characterized by distinguished and sustained scholarship and research at the cutting-edge of their discipline and that has in the past, or has the potential in the future, to revolutionize cognitive neuroscience.

Extraordinary innovation and high impact on international scientific thinking should be a hallmark of the recipient's work.

Each year a call for nominations for the George A. Miller Prize is made to the membership of the society. The recipient of the prize attends the annual meeting of the Cognitive Neuroscience Society and delivers the George A. Miller lecture.

## Previous Winners of the George A. Miller Lectureship

| | |
|---|---|
| 2014 | Jon Kaas, Ph.D., Vanderbilt University |
| 2013 | Fred H. Gage, The Salk Institute |
| 2012 | Eve Marder, Ph.D., Brandeis University |
| 2011 | Mortimer Mishkin, Ph.D., NIMH |
| 2010 | Steven Pinker, Ph.D., Harvard University |
| 2009 | Marcus Raichle, Ph.D., Washington University School of Medicine |
| 2008 | Anne Treisman, Ph.D., Princeton University |
| 2007 | Joaquin M. Fuster, Ph.D., University of California Los Angeles |
| 2006 | Steven A. Hillyard, Ph.D., University of California San Diego |
| 2005 | Leslie Ungerleider, Ph.D., National Institute of Mental Health |
| 2004 | Michael Posner, Ph.D., University of Oregon |
| 2003 | Michael Gazzaniga, Ph.D., Dartmouth College |
| 2002 | Daniel Kahneman, Ph.D., Princeton University |
| 2001 | William Newsome, Ph.D., Stanford University |
| 2000 | Patricia Churchland, Ph.D., University of California, San Diego |
| 1999 | Giacommo Rizzolatti, Ph.D., University of Parma, Italy |
| 1998 | Susan Carey, Ph.D., New York University |
| 1997 | Roger Shepard, Ph.D., Stanford University |
| 1996 | David Premack, Ph.D., CNRS, France |
| 1995 | David H. Hubel, Ph.D., Harvard Medical School |

# Distinguished Career Contributions Award

## Congratulations to Dr. Marta Kutas for being awarded this honor!

Dr. Kutas, will accept this prestigious award and deliver her lecture on Saturday, March 28, 2015, 5:30 – 6:30 pm, in the Grand Ballroom.

## 45 years of Cognitive Electrophysiology: Neither just psychology nor just the brain but the visible electrical interface between the twain


### Marta Kutas, MD

**Distinguished Professor and Chair, Cognitive Science and Distinguished Adjunct Professor of Neurosciences, and Director of the Center for Research in Language, University of California, San Diego**


I've spent my scientific life demonstrating that event related brain potentials (ERPs) – warts and all - are temporally exquisite instruments for investigating what the brain does – loosely, the mind. ERPs are effective instruments because they are continuous and instantaneous reflections of brain activity (neuronal communication) which have been proven systematically sensitive to sensory, motor, and psychological variables. Moreover, after careful study in their own right, ERPs in known paradigms, can offer opportunities for looking at what the brain considers qualitatively similar or just quantitatively different and by when, at brain activity that may or may not lead to overt behavior, as well as at hypothetical psychological processes that may not otherwise be readily accessible. I was smitten with ERPs from the beginning; others have warmed up more slowly, if at all. I plan to share aspects of my scientific journey: P3 latency and mental chronometry, RP and specific movement preparation, N400, meaning and modularity, the nogo N200 and seriality of language production, and what ERP data say about the functional role of the visual system in accessing knowledge about an object from its name.

#### A scientific refrain

Brain brain please don't go away
And do come again each and every day
Please help me find the right connection
That missing link to my mind to help instruct me
On how I think (for I think I do), upon reflection.
Nu? How it is my neural and body cells construct
What I see, what I hear
What I think, and what I fear
but dare not or care not to reveal in utterances aloud.
yet have routinely allowed to be read
from sensors bound to my head
Electrical and magnetic
-- empirically prophetic.

## About the Distinguished Career Contributions Award

The Distinguished Career Contributions (DCC) award honors senior cognitive neuroscientists for their distinguished career, leadership and mentoring in the field of cognitive neuroscience. The recipient of this prize gives a lecture at our annual meeting.

## Previous Winners of the Distinguished Career Contributions Award

| | |
|---|---|
| 2014 | Marsel Mesulam, M.D., Northwestern University |
| 2013 | Robert T. Knight, University of California, Berkeley |
| 2012 | Morris Moscovitch, University of Toronto |

# Young Investigator Award

## Congratulations to the 2015 Young Investigator Award Winners

**Donna Rose Addis, Ph.D., University of Auckland, New Zealand**

**Christopher Summerfield, Ph.D., University of Oxford**

YIA special lectures take place on Sunday, March 29, 1:30 –2:30 pm, in Grand Ballroom A.

The purpose of the awards is to recognize outstanding contributions by scientists early in their careers. Two awardees, one male and one female, are named by the Awards Committee, and are honored at the CNS annual meeting. Each award includes $500 US to be used by the winners toward travel costs to the meeting, or for any other purpose.

## Constructive Episodic Simulation of Future Events

### Donna Rose Addis, Ph.D.

University of Auckland, New Zealand

Humans spend a great deal of their time thinking about their future activities. In particular, we can draw upon information stored in episodic memory to construct detailed simulations about upcoming events. Future simulations have adaptive value, enhancing wellbeing, problem solving and decision making. However, if these simulations are to guide and enhance our future behaviour, it is critical that future events are not only sufficiently detailed but also successfully encoded into memory. In this talk, I will discuss recent behavioural and neuroimaging studies from my laboratory examining how constructive episodic memory processes (supported by the hippocampus and associated networks) support the simulation of detailed future events, as well as the factors that influence the encoding of simulations.

## Do humans make good decisions?

### Christopher Summerfield, Ph.D.

University of Oxford

Human performance on perceptual classification tasks approaches that of an ideal observer, but economic decisions are often inconsistent and intransitive, with preferences reversing according to the local context. I will discuss the view that suboptimal choices may result from the "efficient" coding of decision-relevant information, a strategy that allows expected inputs to be processed with higher gain than unexpected inputs. Efficient coding leads to 'robust' decisions that depart from optimality but maximise the information transmitted by a limited-capacity system in a rapidly-changing world. I will consider recent work from my lab and elsewhere showing that when perceptual environments are variable or volatile, perceptual decisions exhibit the same suboptimal context-dependence as economic choices, and we propose a general computational framework that accounts for findings across the two domains.

# Special Events

## NIH Funding: Training and Research Grant Opportunities

**Sunday, March 29, 2:30-3:30 pm, Grand Ballroom A**

This presentation will highlight current federal training, career development, and research funding opportunities available to CNS investigators. Program Directors representing the NIH will present an overview of relevant funding opportunities, as well as a brief overview of the grant application, review, and funding processes, providing hints for successful grant writing along the way. Come learn how to advance your research with federal support!

Speakers: Kathy Mann Koepke, NICHD/NIH, Lisa Freund, NICHD/NIH

Panelists: Kathy Mann Koepke (NICHD), Lisa Freund (NICHD), Steve Grant (NICHD), Aleksandra Vicentic (NIMH), Molly Wagster (NIA)

## Cognitive Neuroscience Society Student Association Student Social Night

**Sunday, March 29, 7:00 pm, Meet in Hyatt Regency Reception Area**

Come and join us for the annual CNSSA Student Social Night, Sunday, March 29th, after the George A. Miller Prize Lecture. We will meet at 7:00 in the conference hotel reception area (look for signs), and walk out to a nearby bar/restaurant around 7:15. There will be no cover charge and light snacks will be provided at the restaurant (cash bar). This event is open to all students and post docs of the Cognitive Neuroscience Society.

More information will be posted on the Cognitive Neuroscience Society Student Association Facebook page (http://www.facebook.com/CNSStudentAssociation). We look forward to meeting you!

## Federal Funding Opportunities at the National Science Foundation

**Monday, March 30, 12:00-1:00 pm, Grand Ballroom B/C**

Dr. Alumit Ishai, Director of the Cognitive Neuroscience Program, will present an overview of current federal funding opportunities for Cognitive Neuroscientists at NSF, the grant application, review and funding processes, and provide hints for successful grant writing along the way. Come learn how to advance your research with federal support!

Speaker: Alumit Ishai, Director, NSF Cognitive Neuroscience Program

## Journal Publishing Workshop: How to peer review a paper

**Tuesday, March 31, 12:00 – 1:00 pm, Grand Ballroom B/C**

This workshop will cover the purpose of peer review, the steps in the peer review process, why you should review, tips on how to review a paper, tips on how to write comments to Editors and authors, what oversight a reviewer provides, and what criteria a reviewer needs for assessment. There will be a couple of short presentations followed by Q&A and a panel discussion.

Speakers: Michael Rugg (Editor-in-Chief of Neuropsychologia), Toby Charkin (Elsevier)

Panelists: Marie Banich (Editor-in-Chief of Cognitive, Affective, and Behavioral Neuroscience), Sarah-Jayne Blakemore (Editor-in-Chief of Developmental Cognitive Neuroscience), Mark D'Esposito (Editor-in-Chief of Journal of Cognitive Neuroscience), Cindy Lustig (Editor-in-Chief of Current Opinion in Behavioral Sciences), Patti Reuter-Lorenz (Section Editor of Neuropsychologia), Michael Rugg (Editor-in-Chief of Neuropsychologia)

# Data Blitz

## Data Blitz Sessions

A Data Blitz is a series of 5-minute talks, each covering just a bite-sized bit of research. It will offer a fast-paced overview of some of the most exciting research presented at this year's poster sessions.

## Data Blitz Session 1

Sunday, March 29, 1:30 - 3:30 pm, Grand Ballroom B/C

**Talk 1: DEVELOPMENTAL PROSOPAGNOSIA (DP) IS BEST EXPLAINED AS A DEFICIT IN DETECTING FACIAL DISTINCTIVENESS: THE DISTINCTIVENESS HYPOTHESIS OF DP.** Edwin Burns[1], Jeremy Tree[1], Christoph Weidemann[1]; [1]Swansea University

**Talk 2: THE MODULATION OF CLASSICALLY CONDITIONED FEAR GENERALIZATION WITH D-CYCLOSERINE: AN FMRI STUDY** Tori Espensen-Sturges[1], Alicia Kielbasa[1], Philip Burton[1], Kathryn Cullen[1], Shmuel Lissek[1]; [1]University of Minnesota

**Talk 3: FOOD-CUE INHIBITORY TRAINING REDUCES REWARD REACTIVITY AND EATING URGES** Pin-Hao A. Chen[1], Richard B. Lopez[1], William M. Kelley[1], Mary DiGeronimo[1], Todd F. Heatherton[1]; [1]Dartmouth College

**Talk 4: HIGH ROAD OR LOW ROAD? DISSECTING THE CONTRIBUTION OF CORTICAL AND SUBCORTICAL VISUAL PATHWAYS TO THREAT ENCODING IN AN AVERSIVE CONDITIONING STUDY** Yuqi You[1], Wen Li[1]; [1]University of Wisconsin-Madison

**Talk 5: PRESERVED SYNTACTIC PROCESSING AND ITS RELATIONSHIP TO GREY MATTER INTEGRITY IN THE CAM-CAN COHORT** Karen L. Campbell[1], . Cam-CAN[2], Lorraine K. Tyler[1]; [1]University of Cambridge, [2]Cambridge Centre for Ageing and Neuroscience (Cam-CAN), University of Cambridge and MRC Cognition and Brain Sciences Unit, Cambridge

**Talk 6: PANTOMIMING OBJECT USE DECOUPLES FUNCTIONAL CONNECTIVITY BETWEEN TEMPORAL AND PARIETAL TOOL-SELECTIVE AREAS** Frank E. Garcea[1,2], Bradford Z. Mahon[1,2,3]; [1]Department of Brain and Cognitive Sciences, University of Rochester, [2]Center for Visual Science, University of Rochester, [3]Department of Neurosurgery, University of Rochester Medical Center

**Talk 7: LINKING GENES, BRAIN, AND BEHAVIOR IN A STUDY OF SECOND LANGUAGE LEARNING** Ping Mamiya[1], Todd Richard[1], Jeff Stevenson[1], Evan Eichler[1], Patricia Kuhl[1]; [1]University of Washington

**Talk 8: COMPARING SEMANTIC REPRESENTATIONS OF ANIMALS AS INFERRED FROM BRAIN READING STUDIES VERSUS BEHAVIORAL STUDIES: THEMATIC AND TAXONOMIC ORGANIZATION** Andrew Bauer[1], Charles Kemp[1], Marcel Just[1]; [1]Carnegie Mellon University

**Talk 9: PREDICTING COGNITIVE DECLINE IN THE ELDERLY FROM 500+ HETEROGENEOUS BIOMARKERS USING MACHINE LEARNING** Sarah K. Madsen[1], Greg Ver Steeg[2], Adam Mezher[1], Neda Neda Jahanshad[1], Talia N. Nir[1], Xue Hua[1], Boris A. Gutman[1], Aram Galstyan[2], Paul M. Thompson[1]; [1]Imaging Genetics Center, USC, [2]USC Information Sciences Institute

**Talk 10: LOCAL AND DISTRIBUTED EFFECTS OF TARGETED NONINVASIVE STIMULATION OF THE HIPPOCAMPAL SYSTEM ON RESTING-STATE FUNCTIONAL NETWORKS** Jane Wang[1], Joel Voss[1]; [1]Northwestern University Feinberg School of Medicine

**Talk 11: BLOCKING GAP JUNCTIONS DURING SLEEP IMPAIRS DECLARATIVE MEMORY CONSOLIDATION IN HUMANS** Gordon B. Feld[1], Andreas Fritsche[1], Jan Born[1], Manfred Hallschmid[1]; [1]University of Tuebingen, Germany

**Talk 12: THE UPS AND DOWNS OF REPEATED STUDY: AN FMRI INVESTIGATION OF COMPETITIVE MEMORY INTERFERENCE** Zachariah Reagh[4], Elizabeth Murray[4], Michael Yassa[4]; [1]Department of Neurobiology and Behavior, [2]Institute for Memory Impairments and Neurological Disorders, [3]Center for the Neurobiology of Learning and Memory, [4]University of California, Irvine

**Talk 13: THE RELATIONSHIP BETWEEN HIPPOCAMPAL VISCOELASTICITY AND RELATIONAL MEMORY PERFORMANCE IN HEALTHY YOUNG ADULTS: A MAGNETIC RESONANCE ELASTOGRAPHY STUDY** Hillary Schwarb[1], Curtis L. Johnson[1], Matthew D. J. McGarry[2], Neal J. Cohen[1]; [1]Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, [2]Thayer School of Engineering, Dartmouth College

**Talk 14: ELECTRICAL STIMULATION OF DORSOLATERAL PREFRONTAL CORTEX AT RETRIEVAL INCREASES EPISODIC RECOLLECTION ACCURACY** Stephen Gray[1], Geoffrey Brookshire[1], Daniel Casasanto[1], David Gallo[1]; [1]The University of Chicago

**Talk 15: MEMORY AS DECISION-MAKING: THE SUCCESSFUL RETRIEVAL EFFECT TELLS US ALMOST NOTHING ABOUT MEMORY ACCURACY** Tyler Santander[1], Brian A. Lopez[2], Misty Schubert[2], Craig Bennett[2], Michael B. Miller[2]; [1]University of Virginia, [2]University of California, Santa Barbara

## Data Blitz Session 2

Tuesday, March 31, 10:00 am - 12:00 pm, Bay View Room

**Talk 1: QEEG OF PASSIVE MUSICAL PARADIGMS ASSAYS INTEGRATIVE CEREBRAL FUNCTION IN THE MINIMALLY CONSCIOUS STATE** Brian C. Fidali[1], Mary M. Conte[1], Daniel J. Thengone[1], Tanya J. Nauvel[1], Nicholas D. Schiff[1]; [1]Weill Cornell Medical College

**Talk 2: ON THE FATE OF IRRELEVANT MENTAL REPRESENTATIONS IN VISUO-SPATIAL WORKING MEMORY: EVIDENCE BY A RETRO-CUING PARADIGM** Daniel Schneider[1], Edmund Wascher[1]; [1]Leibniz Research Centre for Working Environment and Human Factors

**Talk 3: THE REPRESENTATIONAL CAPACITY OF THE HUMAN PREFRONTAL CORTEX: A HIGH-RESOLUTION FMRI STUDY** Patricia Shih[1], David Badre[1]; [1]Brown University

**Talk 4: LOAD-DEPENDENT NEURAL PATTERNS WITHIN SUPERIOR INTRAPARIETAL CORTEX REFLECT THE DETERIORATION OF PRECISION IN VISUAL WORKING MEMORY** Elena Galeano Weber[1,2], Benjamin Peters[3], Tim Hahn[1], Christoph Bledowski[3], Christian J. Fiebach[1,2]; [1]Department of Psychology, Goethe University Frankfurt, Germany, [2]IDeA Center for Individual Development and Adaptive Education, Frankfurt, Germany, [3]Institute of Medical Psychology, Goethe University Frankfurt, Germany

**Talk 5: TYPICALITY SHARPENS OBJECT REPRESENTATIONS IN OBJECT-SELECTIVE CORTEX** Marius Cătălin Iordan[1], Michelle R. Greene[1], Diane M. Beck[2], Fei-Fei Li[1]; [1]Stanford University, [2]University of Illinois at Urbana-Champaign

**Talk 6: PROBING BINOCULAR RIVALRY: PRE-STIMULUS ALPHA DETERMINES WHETHER SUPPRESSED-EYE PROBES ELICIT A SWITCH IN PERCEPTUAL DOMINANCE** Brian A. Metzger[1,2], Kyle M. Mathewson[3], Monica Fabiani[1,2], Gabriele Gratton[1,2], Diane M. Beck[1,2]; [1]University of Illinois at Urbana-Champaign, [2]Beckman Institute for Advanced Science and Technology, [3]University of Alberta

**Talk 7: HIPPOCAMPAL INVOLVEMENT IN THE PERCEPTUAL JUDGEMENT OF ESCHER-LIKE IMPOSSIBLE SCENES.** Danielle M. Douglas[1], Sathesan Thavabalasingam[1], Zahraa Chorghay[1], Andy C. H. Lee[1,2]; [1]University of Toronto, [2]Rotman Research Institute

**Talk 8: A MULTIMODAL STUDY OF DISGUST IN THE ULTIMATUM GAME** Filippo Rossi[1], Veerle van Son[2], Ian Fasel[3], Marian Bartlett[1,3], Alan Sanfey[2]; [1]Institute for Neural Computation, University of California, San Diego, [2]Donders Institute for Brain, Cognition and Behavior, Radboud University, [3]Emotient, Inc., San Diego

**Talk 9: SHIFTS IN CONNECTIVITY DURING PROCEDURAL LEARNING AFTER MOTOR CORTEX INHIBITION** Leonora Wilkinson[1], Adam Steel[1], Sunbin Song[2], Devin Bageac[1], Kris Knutson[1], Ziad S. Saad[3], Steven J. Gotts[4], Eric M. Wassermann[1]; [1]Behavioral Neurology Unit, National Institute of Neurological Disorders and Stroke, [2]Human Cortical Physiology Section, National Institute of Neurological Disorders and Stroke, [3]Scientific and Statistical Computing Core, National Institute of Mental Health, National Institutes of Health, [4]Laboratory of Brain and Cognition, National Institute of Mental Health, National Institutes of Health

**Talk 10: PREDICTIVE VISUAL MOTION FACILITATES SPEECH PERCEPTION** David Brang[1,2], Satoru Suzuki[1], Vernon L Towle[2], Sasha Wu[2], James X Tao[2], Marcia Grabowecky[1]; [1]Northwestern University, [2]University of Chicago

**Talk 11: SPATIO-TEMPORAL DYNAMICS OF THE LEXICAL SELECTION NETWORK IN SPEECH PRODUCTION: INSIGHTS FROM ELECTROCORTICOGRAPHY** Stephanie Ries[1], Rummit Dhillon[1], Alex Clarke[2], Kenneth Laxer[3,4], Peter Weber[3], Rachel Kuperman[5], Kurtis Auguste[4,5], Gerwin Schalk[6], Josef Parvizi[7], Nathan Crone[8], Nina Dronkers[9], Robert Knight[1]; [1]University of California, [2]Centre for Speech, Language and the Brain, Department of Experimental Psychology, University of Cambridge, [3]California Pacific Medical Center, San Francisco, [4]University of California San Francisco, [5]Children's Hospital and Research Center, Oakland, CA, [6]New York State Department of Health, Wadsworth Center, and Department of Neurology, Albany Medical College, [7]Stanford Human Intracranial Cognitive Electrophysiology Program (SHICEP), Stanford University, [8]Department of Neurology, The Johns Hopkins University School of Medicine, [9]VA Northern California Health Care System and University of California, Davis

**Talk 12: INVESTIGATING BODY PERCEPTION IN HEALTHY AND EATING DISORDERED FEMALES.** Katie Groves[1], Steffan Kennett[1], Helge Gillmeister[1]; [1]University of Essex

**Talk 13: TASK-EVOKED BRAIN ACTIVITY AFTER NEGATIVE INDUCTION PREDICTS ENHANCEMENT OF MEMORY FOR NEUTRAL MATERIAL** Morenikeji Adebayo[1,2], Joseph Andreano[1,2], Alexandra Touroutoglou[1,2], Bradford Dickerson[1,2], Lisa Feldman Barrett[1,2,3]; [1]Harvard Medical School, [2]Massachusetts General Hospital, [3]Northeastern University

**Talk 14: THE EFFECTS OF OXYTOCIN ON PREFERRED INTERPERSONAL SPACE: A PHARMACOLOGICAL NEUROIMAGING STUDY** Daniela Cohen[1], Anat Perry[1], Gadi Gilam[2,3], Naama Mayseless[1], Talma Hendler[2,3], Simone Shamay-Tsoory[1]; [1]University of Haifa, [2]Sagol School Neuroscience, Tel Aviv University, [3]Functional Brain Center, Wohl Institute for Advanced Imaging, Tel Aviv Sourasky MedicalCenter

**Talk 15: SPECIFIC HYPOACTIVATION OF RIGHT TEMPORO-PARIETAL JUNCTION IN AUTISM AT THE SOCIALLY AWKWARD MOMENTS OF A SITCOM** Peter C. Pantelis[1], Lisa Byrge[1], J. Michael Tyszka[2], Ralph Adolphs[2], Daniel P. Kennedy[1]; [1]Indiana University-Bloomington, [2]California Institute of Technology

# General Information

## Abstracts

Poster abstracts can be found in the printed program and in the PDF version which is downloadable from www.cogneurosociety.org.

## ATM

An ATM is located on the Atrium level of the hotel for your convenience.

## Audiovisual Equipment for Talks

LCD projectors (e.g., for PowerPoint presentations) will be provided in all rooms where spoken sessions are scheduled; however, computers will NOT be provided. Presenters must bring their own computers and set them up BEFORE the start of the session in which they are presenting. Speakers are requested to bring their own dongle. Facilities will be provided to allow several computers to be connected to the LCD projector in a room. Presenters are strongly encouraged to arrive in their scheduled symposium room a minimum of 30 minutes before their talks so that they know how to set up their equipment.

## Baggage Check

The Bell Desk - Assistance with luggage, packages and other carry-on's, is located with the Concierge, next to the front desk on the Atrium level.

## Business Center

The Business Center is located on the Bay Level adjacent to the Drumm Street windows. The following services are available: Copy Services, Facsimile Services, On-Site Computers, Internet Access, Typing Services, and Shipping Services (UPS and FedEx). After staffed hours, the business center can be accessed with your room key to access computers with Internet and printing capabilities

## Catering

Catering will be available during the conference and is included in the registration fee. Please refer to the table below for the catering times.

**Saturday, March 28**

Coffee Break, 3:30 – 4:00 pm, *Exhibit Hall*

Welcome Reception, 6:30 – 7:30 pm, *Atrium*

**Sunday, March 29**

Continental Breakfast, 8:00 – 8:30 am, *Exhibit Hall*

Coffee Break, 3:30 – 4:00 pm, *Exhibit Hall*

**Monday, March 30**

Continental Breakfast, 8:00 – 8:30 am, *Exhibit Hall*

Coffee Break, 3:00 – 3:30 pm, *Exhibit Hall*

**Tuesday, March 31**

Continental Breakfast, 8:00 – 8:30 am, *Exhibit Hall*

## Certificate of Attendance

To receive a Certificate of Attendance please visit the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel. If you require any changes, we will be happy to email/mail a copy after the meeting. See also Receipts.

## Chair People

Please ensure that you are available in your presentation room at least thirty minutes before the start of the session. Persons chairing sessions are asked to keep the talks on time.

## Contact Us

To contact us onsite, visit the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel or send an email to meeting@cogneurosociety.org We will respond to your email at our soonest opportunity.

## Code of Conduct

The Cognitive Neuroscience Society is committed to providing a safe and professional environment during our annual meeting. All CNS members are expected to conduct themselves in a business-like and professional manner. It is unlawful to harass a person or employee because of that person's sex or race. Harassment is defined by hostile or offensive behavior towards another.

## Disclaimer

The Program Committee reserves the right to change the meeting program at any time without notice. Please note this program is correct at time of print.

## Drink Tickets

Each Attendee will receive one drink ticket; it can be redeemed for an alcoholic or non-alcoholic beverage at the Welcome Reception on Saturday. Lost drink tickets will not be replaced.

## Exhibits

The conference exhibits are located in Pacific Concourse of the San Francisco Hyatt Regency Hotel. Also located in

this room are posters and catering. Exhibits are open to all attendees at the following times:

| | |
|---|---|
| Saturday, March 28 | 3:30 – 5:30 pm |
| Sunday, March 29 | 8:00 am – 5:30 pm |
| Monday, March 30 | 8:00 – 10:00 am* |
| | 1:30 - 7:30 pm |
| Tuesday, March 31 | 8:00 am – 12:00 pm |

*Exhbit booths are closed Monday, 10:00 am to 1:30 pm, but the Exhibit Hall is open all day.

## Facebook

Find us on Facebook search for "Cognitive Neuroscience Society" and like us!

## Hotel

The San Francisco Hyatt Regency Hotel is our exclusive Hotel for the CNS 2015 Annual Meeting and where all CNS 2015 meeting events will be held. Hyatt Regency San Francisco, 5 Embarcadero Center, San Francisco CA 94111.

## Hotel Restaurants

Eclipse Restaurant & Lounge. Whether you are in the mood for quick refreshment or a full meal, the culinary offerings at Eclipse will satiate you with an unforgettable interpretation of global dining.

## Internet Access

CNS attendees will receive complimentary wireless Internet in their guest room, when reserved within the CNS block and before March 4, 2015.

Free Internet terminals are located in the Ballroom Foyer near the CNS Registration Desk. Internet terminals are available during the meeting registration hours on Saturday, Sunday, Monday, and Tuesday when not needed for onsite registration. See Onsite Meeting Registration.

## LinkedIn

Join our group on LinkedIn search "Cognitive Neuroscience Society (CNS)".

## Lost & Found

The meeting Lost and Found is located at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel.

## Member Services

The member services desk is located at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel. The member services desk will be open at the following times:

| | |
|---|---|
| Saturday, March 28 | 11:00 am – 5:00 pm |
| Sunday, March 29 | 7:30 am – 4:30 pm |
| Monday, March 30 | 8:00 am – 7:30 pm |
| Tuesday, March 31 | 8:00 am – 12:30 pm |

## Message Center

Messages for meeting registrants can be left and retrieved at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel. A bulletin board will be available for announcements and job postings.

## Mobile Phones

Attendees are asked to silence their mobile phones when in sessions.

## Name Badges

The San Francisco Hyatt Regency Hotel and Convention Center is open to public access. For security purposes, attendees, speakers and exhibitors are asked to wear their name badges to all sessions and social functions.

Entrance into sessions is restricted to registered attendees only. Entrance to the Exhibition will be limited to badge holders only. If you misplace your name badge, please go to the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel for a replacement.

## Parking

The San Francisco Hyatt Regency Hotel offers secured and covered Valet parking. Parking rates are currently $66.00/24 hour for hotel guests with in and out privileges or $70.00/24 hour for non-guests. (Please note this information was correct at time of print.)

## Phone Charging Station

There will be a small phone charging station located at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel.

## Photo Disclaimer

Registration and attendance at, or participation in, the Cognitive Neuroscience Society meetings and other activities constitute an agreement by the registrant/attendee to CNS's use and distribution (both now and in the future) of the registrant's or attendee's image in photographs of such events and activities.

## Poster Sessions

Poster sessions are scheduled on Saturday, March 28, Sunday, March 29, Monday, March 30, and Tuesday, March 31. The presenting author must be present during the assigned session and other authors may be present to answer questions. The poster sessions are in the Pacific Concourse Exhibit Hall of the San Francisco Hyatt Regency

Hotel. Badges are required at all times. Do not leave personal items in the poster room.

## Printed Program

One copy of the printed program is available to each attendee. If you would like a second copy please check in at the Registration Counter on the Ballroom floor of the San Francisco Hyatt Regency Hotel on the last day of the event. Every effort has been made to produce an accurate program. If you are presenting at the conference, please confirm your presentation times as listed in this program. Attendees also have the option to view the program by downloading it from our website.

## Receipts

You received two receipts via email, one at the time of purchase and a second with your registration confirmation. Please email the registration desk if you require an additional copy. See also Certificate of Attendance.

## Receptions

The Welcome Reception will be held in the Atrium, from 6:30-7:30 pm on Saturday, March 28, directly following the Distinguished Career Contributions in Cognitive Neuroscience Lecture.

## Registration

The Registration Counter is located on the Ballroom floor of the San Francisco Hyatt Regency Hotel. The Registration Counter will be open at the following times:

| | |
|---|---|
| Saturday, March 28 | 11:00 am – 7:00 pm |
| Sunday, March 29 | 7:30 am – 6:30 pm |
| Monday, March 30 | 8:00 am – 7:30 pm |
| Tuesday, March 31 | 8:00 am – 3:30 pm |

## Smoking

Smoking is not permitted in or outside any of the meeting rooms or the exhibition hall.

## Speakers

All speakers must register and wear name badge to present. Please ensure that you are available in your presentation room at least thirty minutes before the start of the session. See also Audiovisual equipment for Talks.

## Transportation

Taxis - There is a taxis stand at the front of the Hotel. A Taxi to or from SFO is about 20-30 minutes and is approximately $50-55.

BART (Bay Area Rapid Transit) -Please visit www.bart.gov for fares and schedules. Station is located within steps of the hotel's front entrance. Approximate one-way fare from San Francisco International Airport $8.65 each way.

Lorrie's Shuttle - Offers service to the Hyatt Regency San Francisco. Shuttles depart every 20 minutes. Board shuttles just outside of the luggage carousels on the lower level of SFO. Fare is $17 from the airport to the hotel.

*Fares subject to change without notice.

## Twitter

Follow CNS Annual Meeting (@CNSmtg). Our Hashtag this year is #CNS2015

## Website

http://www.cogneurosociety.org/annual-meeting/

## GSA/PFA Awards

Congratulations to the 2015 winners of the Graduate Student Awards and the Post-Doctoral Fellow Awards. Each winner receives a monetary stipend to cover conference travel expenses.

### Graduate Student Award Winners

Shirpa Kanjlia, Johns Hopkins University

David W. Sutterer, University of Oregon

Atsushi Kikumoto, University of Oregon

Marius Cătălin Iordan, Stanford University

Andrew Bauer, Carnegie Mellon University

Sean O'Bryan, Texas Tech University

Tori Espensen-Sturges, University of Minnesota

### Post-Doctoral Fellow Award Winners

Fanny Lachat, Aalto University, Finland

Daniel Schneider, Leibniz Research Centre for Working Environment and Human Factors

Filippo Rossi, University of California, San Diego

Thackery I. Brown, Stanford University

Lindsay Nagamatsu, University of Illinois at Urbana-Champaign

Ping Mamiya, University of Washington

Carina de Klerk, University of London

# Exhibits

## Exhibitors

Visit our exhibitors in the Exhibit Hall located in the Pacific Concourse, one floor down from the CNS Registration Desk. Take the stairs outside the Market Street Foyer on the ground floor.

**ANT North America**
**BIOPAC Systems, Inc.**
**Brain Vision LLC**
**Cambridge Cognition**
**Cedrus Corporation**
**Compumedics Neuroscan**
**Cortech Solutions, Inc.**
**Current Designs, Inc.**
**Electrical Geodesics, Inc.**
**Lumos Labs**
**Neuralynx, Inc.**
**NITRC: Neuroimaging Informatics Tools and Resources Clearinghouse**
**Psychology Press**
**Psychology Software Tools**
**Rogue Research, Inc**
**Rogue Resolutions Ltd.**
**Royal Society Publishing**
**Sinauer Associates, Inc.**
**Smart Eye AB**
**SR Research, Ltd.**
**The Black Box Toolkit**
**The MIT Press**
**TMS International**

## Exhibit Hours

Exhibits are open to all attendees during these hours:

| | |
|---|---|
| Saturday | 3:30 – 5:30 pm |
| Sunday | 8:00 am – 5:30 pm* |
| Monday | 8:00 am – 10:00 am, 1:30 – 7:30 pm** |
| Tuesday | 8:00 am – 12:00 pm |

** Exhibits are closed from 10:00 am - 1:30 pm on Monday.

## *Join Us at the Exhibit Expo

Join us Sunday for a special Exhibit Expo from 12:00 – 1:30 pm. Explore all that CNS's exhibitors have to offer during this exclusive event dedicated to providing attendees new ideas, innovative technologies, and useful products. No other meeting events or sessions are scheduled during this exhibits-only period.

**SAVE THE DATE**

**CNS 2016 Annual Meeting**

**April 2-5, 2016**
**Hilton New York Hotel**
**New York City**

# Invited-Symposium Sessions

| # | Title | Date | Time | Location |
|---|---|---|---|---|
| 1 | The renaissance of EEG: An old dog teaching us new tricks | Monday March 30 | 3:30 - 5:30 pm | Grand Ballroom B/C |
| 2 | The Changing Brain—Insights from Lifespan Cognitive Neuroscience | Tuesday March 31 | 1:30 - 3:30 pm | Grand Ballroom A |
| 3 | Decisions, Emotion, the Self, and Medial Prefrontal Cortex | Tuesday March 31 | 1:30 - 3:30 pm | Grand Ballroom B/C |

## Invited Symposium Session 1

### THE RENAISSANCE OF EEG: AN OLD DOG TEACHING US NEW TRICKS

**Monday, March 30, 3:30 - 5:30 pm, Grand Ballroom B/C**

**Chair: Micah Murray, University Hospital Center and University of Lausanne, Center for Biomedical Imaging, Vanderbilt University**

**Speakers: Christoph Michel, Micah Murray, Charles Schroeder, José del Millán**

This symposium highlights how the humble EEG has proven itself a remarkably information-rich, versatile, accessible, and cost-effective neuroimaging method. However, many researchers using EEG fail to capitalize on the breadth of the technique's full capabilities. The goal of this symposium is therefore to present a selection of key and avant-garde uses of EEG in cognitive, clinical, and trans-species neuroscience presented in a tutorial style. The first two talks will provide evidence for EEG being a true neuroimaging method. The other two talks will show the richness of information available from EEG that comes with applications of advances in signal processing. Christoph Michel will explain the basics of spatio-temporal analysis of multichannel EEG and will demonstrate the spatial precision of EEG source imaging. Micah Murray will detail how many of the long-assumed shortcomings of event-related potential (ERP) analysis can be overcome by combining high-density recordings with data-driven, multivariate analyses that provide direct neurophysiologic interpretability. Charles Schroeder will demonstrate how oscillatory brain dynamics provide critical insights into quintessential mechanisms of signal transmission within and between brain regions that in turn reveal the fundamental principles of attentional control over sensation and action. Finally, José Millán will demonstrate the critical insights provided by advanced EEG signal analysis in the continued development of neurotechnologies and neuroprostheses.

#### TALK 1: TEMPORAL DYNAMICS OF LARGE-SCALE NEURONAL NETWORKS STUDIED WITH EEG

**Christoph Michel[1]; [1]University of Geneva, Switzerland**

This lecture will provide an overview on how to use the EEG as a modern functional imaging method. It is based on the recording of the electric potential field at the scalp surface with multichannel recording devices. By properly sampling and correctly analyzing this electric field, EEG can provide reliable information about the neuronal activity in the brain and the temporal dynamics of this activity in the millisecond range. Source localization based on high-density EEG and individual head models reveal very high precision as demonstrated in many clinical validation studies. Connectivity analyses in the source space reveal the dynamics of information exchange within and between large-scale networks in the sub-second time range. The versatility of EEG allows simultaneous recordings with other imaging methods (fMRI, TMS, NIRS, iEEG, MEG) and therefore allows for a comprehensive understanding of the spatio-temporal dynamics of brain networks on different time scales.

#### TALK 2: ELECTRICAL NEUROIMAGING OF EVENT-RELATED POTENTIALS

**Micah Murray[1,2,3]; [1]University Hospital Center and University of Lausanne, Switzerland, [2]EEG Brain Mapping Core of the Center for Biomedical Imaging, Switzerland, [3]Vanderbilt University, Nashville, TN, USA**

This talk will provide a tutorial on the analyses of ERPs within an electrical neuroimaging framework. Both the rationale for as well as the implementation of this analysis framework are based on the reference-free information available from high-density electrode montages that in turn render statistical information concerning modulations in response strength, latency, and topography both between and within experimental conditions as well as across groups. The electrical neuroimaging framework allows experimenters to glean additional information and neurophysiologic interpretability beyond what is available from canonical waveform analyses, while also surmounting many caveats that often go overlooked. I will provide both a conceptual and mathematical description of how each step of the analysis is carried out, what it yields, and how to interpret its statistical outcome. The electrical neuroimaging framework is intuitive, mathematically straightforward and can remove much of the guesswork often confronting ERP researchers, prompting a renaissance in the use of EEG in basic, clinical, and translational research.

### TALK 3: WHY DO OSCILLATIONS MATTER?

Charles Schroeder[1,2]; [1]The Nathan Kline Institute, Orangeburg, NY, USA, [2]Columbia University, New York, NY, USA

Neuroelectric oscillations reflect rhythmic fluctuations of excitability in neuron ensembles distributed throughout the brain. For many scientists, the question of whether they matter is already moot. It is clear, for example, that: 1) the ability of a sensory structure to transmit information from a receptor surface to a central target is dramatically affected by the oscillatory phase under which the peripheral input arrives, 2) at a perceptual level, the ability to even "notice" an event has a similar stimulus-phase dependence in key brain regions, and 3) generation of a behavioral response such as a button press, likewise depends on local oscillatory phase in motor regions of the brain. I will begin by briefly reviewing recent evidence along the above lines and then discuss recent evidence on the cellular and circuit mechanisms that induce oscillatory synchrony within and between brain regions. I will end with speculations about how we can put this developing understanding to use in neuroprosthesis.

### TALK 4: THE RISE OF NEUROPROSTHETICS: THE PERCEPTION-ACTION CLOSED LOOP

José del Millán[1]; [1]Ecole Polytechnique Fédérale de Lausanne, Switzerland

Future neuroprosthetics will be tightly coupled with the user in such a way that the resulting system can replace and restore impaired upper limb functions because they are controlled by the same neural signals as their natural counterparts. However, robust and natural interaction of subjects with sophisticated prostheses over long periods of time remains a major challenge. To tackle this challenge we can get inspiration from natural motor control, where goal-directed behavior is dynamically modulated by perceptual feedback resulting from executed actions. Current brain-machine interfaces (BMI) partly emulate human motor control as they decode cortical correlates of movement parameters —from onset of a movement to directions to instantaneous velocity— in order to generate the sequence of movements for the neuroprosthesis. A closer look, though, shows that motor control results from the combined activity of the cerebral cortex, subcortical areas and spinal cord. This hierarchical organization supports the hypothesis that complex behaviors can be controlled using the low-dimensional output of a BMI in conjunction with intelligent devices in charge to perform low-level commands. A further component that will facilitate intuitive and natural control of motor neuroprosthetics is the incorporation of rich multimodal feedback and neural correlates of perceptual processes resulting from this feedback. As in natural motor control, these sources of information can dynamically modulate interaction.

## Invited Symposium Session 2

## THE CHANGING BRAIN—INSIGHTS FROM LIFESPAN COGNITIVE NEUROSCIENCE

**Tuesday, March 31, 1:30 - 3:30 pm, Grand Ballroom A**

**Chair: Patricia A. Reuter-Lorenz, University of Michigan**

**Co-Chair: Michael D. Rugg, University of Texas at Dallas**

**Speakers: Patricia A. Reuter-Lorenz, Lorraine K. Tyler, Michael D. Rugg, Ulman Lindenberger**

Over the last 25 years, cognitive neuroscience research has greatly advanced our understanding of the aging mind and brain, and provided important insights into neurocognitive function in young adults, and across the lifespan. The speakers in this symposium will discuss their research on executive function, language, memory, and plasticity, highlighting how research on the older brain can improve understanding of brain function more generally.

### TALK 1: AGE-RELATED DECLINE AND COMPENSATION: IMPLICATIONS FOR A LIFE SPAN APPROACH

Patricia A. Reuter-Lorenz[1]; [1]Department of Psychology, University of Michigan

Brain imaging has led to significant advances in identifying age-related neural alterations that underlie aspects of cognitive decline in healthy older age. These methods have also revealed age differences in brain function, especially in the domain of executive control that may provide some forms of compensation to maintain effective performance in some cognitive domains. This talk will review key evidence indicating aspects of decline related to the dedifferentiation of representations, dysregulation of the default network, dysfunction of medial temporal regions and prefrontal connectivity. Evidence for these potentially adverse effects of aging will be considered in light of other findings of greater bilateral activity and prefrontal recruitment that characterizes brain imaging results from at least some populations of older adults and may suggest potential for compensation, plasticity and capacity for neural reorganization into older age. A new conceptual model is presented, the Scaffolding Theory of Aging Cognition- Revised (Reuter-Lorenz & Park, 2014), which takes a lifespan approach to integrate evidence for decline and compensation within a longitudinal framework that recognizes lifelong influences that can enrich or diminish neural resources thereby shaping the likelihood of successful cognitive aging.

### TALK 2: LANGUAGE FUNCTION AND THE AGING BRAIN

Lorraine K. Tyler[1]; [1]Centre for Speech, Language and the Brain

Normal healthy aging involves widespread brain changes that are thought to lead to increasingly severe problems with many everyday cognitive functions. However, despite changes in brain structure, some cognitive functions – such as language comprehension – are preserved across the adult lifespan, raising the important question of what mechanisms enable preserved cognitive functions? Are they examples of particularly effective compensation? We address

this question in the context of language comprehension, a complex system that involves the rapid transformation of speech input into a various different types of representation. In spite of the multiple rapid computations involved, there is little evidence that aging significantly impairs normal language comprehension. Focusing on syntactic processing during natural listening, we find no evidence for functional compensation of the left hemisphere specialized syntax network. While age-related decreases in grey matter are associated with weakened connectivity within the syntax network and increased interhemispheric connectivity elsewhere, these changes are related to poorer performance and therefore are not evidence for successful compensation. Where we do see functional compensation is during experimental paradigms that place additional cognitive demands on the listener. Under these conditions, older listeners show increased activation of domain-general (but not domain specific) networks, which are associated with improved performance. Overall, this research suggests that in the context of widespread age-related grey matter changes, preserved syntactic comprehension depends on the residue of the domain-specific language system and that this system does not functionally reorganize. I will discuss these findings in relation to current neurocognitive models of aging.

## TALK 3: DISSOCIATING THE EFFECTS OF AGE AND PERFORMANCE ON FUNCTIONAL BRAIN ACTIVITY: AN INDIVIDUAL DIFFERENCES APPROACH

Michael D. Rugg[1]; [1]Center for Vital Longevity, University of Texas at Dallas

Performance in numerous cognitive domains declines with increasing age. At all ages, however, there are marked individual differences in levels of performance, and there is considerable overlap in the performance of people at different ages. In this presentation I will discuss how an individual differences approach can be used to distinguish between age effects on functional brain activity that reflect a direct influence of age on brain function or organization, and effects that are a consequence of differences in mean performance across age groups. This is an important distinction: while the second of these classes of age differences sheds light on the neural bases of individual differences in cognitive performance that generalize across the adult lifespan, the first class provides insight into how brain function is impacted by increasing age. Drawing on a large data set in which fMRI was employed to identify neural correlates of successful associative encoding and recollection in groups of young (18-30yrs), middle-aged (45-55yrs) and older (65-75yrs) individuals, I will present evidence that both encoding- and retrieval-related neural activity are robustly associated with individual differences in memory performance. Most of these neural measures demonstrated no age-related differences after across-participant differences in performance were accounted for, although they remained correlated with performance. Only a few measures - notably, encoding-related 'deactivation' - demonstrated age-related differences that could not be accounted for by performance differences. The implications of these findings for an understanding of why episodic memory declines with age will be discussed.

## TALK 4: EXPERIENCE-DEPENDENT PLASTICITY IN ADULTHOOD: INDIVIDUAL DIFFERENCES, MECHANISMS, AND FUTURE PERSPECTIVES

Ulman Lindenberger[1]; [1]Center for Lifespan Psychology, Max Planck Institute for Human Development

Human cognitive aging differs between and is malleable within individuals. In the absence of a strong genetic program, it is open to a host of hazards, such as vascular conditions, metabolic syndrome, and chronic stress, but also open to protective and enhancing factors, such as experience-dependent cognitive plasticity. Across the entire human lifespan, stability and plasticity form a dynamic equilibrium, with age-graded changes in set points. Longitudinal studies suggest that leading an intellectually challenging, physically active, and socially engaged life may mitigate losses and consolidate gains, but need to be interpreted with caution, as individuals are not randomly assigned to lifestyles. Interventions help to identify contexts and mechanisms of successful cognitive aging and give science and society a hint about what would be possible if conditions were different. Recent research on mechanisms regulating the onset and termination of critical periods shows that plasticity itself is plastic, and hence opens new avenues for cognitive interventions in adulthood.

# Invited Symposium Session 3

## DECISIONS, EMOTION, THE SELF, AND MEDIAL PREFRONTAL CORTEX

Tuesday, March 31, 1:30 - 3:30 pm, Grand Ballroom B/C

Chair: Scott Huettel, Duke University

Speakers: Scott Huettel, Lesley Fellows, Sarah-Jayne Blakemore, Mauricio Delgado

Many sub-areas of cognitive neuroscience claim the medial prefrontal cortex for their own. This large and cytoarchitectonically diverse region has been linked to a broad range of functions: behavioral control, experience and regulation of emotions, social cognition and the sense of self, and computing the value of actions. This symposium will examine the medial prefrontal cortex from each of these perspectives to identify common processes and organizational properties that shed light on its function.

### TALK 1: PARSING THE MEDIAL PREFRONTAL CORTEX: VALUE AND CONTROL

Scott Huettel[1]; [1]Duke University

Over the past decade, research on the brain mechanisms underlying reward-based decision making has proceeded rapidly – and often apace from new findings in cognitive neuroscience. Yet, new insights about the computation of value in the medial prefrontal cortex have broad relevance for other areas of cognition, including emotion regulation, memory, and social perception. I will review how medial prefrontal cortex shapes decision making, describe recent work connecting value-guided decision making to other domains of cognition, and discuss key challenges for an integrated perspective on medial prefrontal cortex function.

### TALK 2: MEDIAL PREFRONTAL CONTRIBUTIONS TO DECISIONS, ERRORS, AND SELF-MONITORING: EVIDENCE FROM HUMAN LESION STUDIES

Lesley Fellows[1]; [1]Montreal Neurological Institute

Regions along the medial wall of the frontal lobe have been linked to a dizzying array of behaviours, from basic aspects of action monitoring and cognitive control, to complex social and emotional responses. Studies of people with damage to the medial frontal lobe can help to define the component behavioural processes that rely critically on this region. I will review lesion studies that argue for specific contributions of dorsal and ventromedial frontal regions to error processing, learning to assign value to stimuli or actions, and mediating the effects of attention on value updating in decision-making. Finally, these findings will be related to classical descriptions of "frontal" symptoms, such as apathy and utilization behaviour.

### TALK 3: DEVELOPMENT OF DORSOMEDIAL PREFRONTAL CORTEX IN ADOLESCENCE

Sarah-Jayne Blakemore[1]; [1]University College London

Dorsomedial prefrontal cortex is a key region of the social brain, that is, the network of brain regions involved in understanding one's own and other people's mental states. Several structural and functional MRI studies have shown that dorsomedial prefrontal cortex develops in terms of grey matter volume, and activity and functional connectivity during social cognition tasks, during the period of adolescence. Behavioural studies have also shown that social decision-making and perspective taking are still developing in adolescence. These findings are considered in relation to the proposal that adolescence is a formative period for the development of self identity and a sensitive period for social processing.

### TALK 4: THE FLEXIBLE CONTROL OF EMOTIONS BY THE VENTROMEDIAL PREFRONTAL CORTEX

Mauricio Delgado[1]; [1]Rutgers University, Newark

Emotion regulation is an adaptive process that allows for the flexible control of emotional responses to promote better decisions. Central to this process is the role of the ventromedial prefrontal cortex (vmPFC) in interpreting the emotional meaning of events. Specifically, the vmPFC has been involved in a) facilitating changes in the emotional meaning of stimuli that predict negative outcomes and b) flexibly interpreting negative outcomes that influence behavior maladaptively. This talk will focus on the putative role of the vmPFC in emotion-focused coping. Further, this will be contrasted with an alternative mechanism for coping that depends on neural structures such as the striatum to correct behavior and avoid further negative outcomes.

# Mini-Symposium Sessions

| # | Title | Date | Time | Location |
|---|---|---|---|---|
| 1 | What can be, or should be, the relationship between language and neuroscience? | Sunday, March 29 | 10:00 am - Noon | Grand Ballroom A |
| 2 | Zooming-in on the hippocampus: Advances in high-resolution imaging in the context of cognitive aging and dementia | Sunday, March 29 | 10:00 am - Noon | Grand Ballroom B/C |
| 3 | Reasoning: Origins and Development | Sunday, March 29 | 10:00 am - Noon | Bay View Room |
| 4 | Cerebellar Contributions to Learning and Cognition | Monday, March 30 | 10:00 am - Noon | Grand Ballroom A |
| 5 | Disrupting the face perception network | Monday, March 30 | 10:00 am - Noon | Grand Ballroom B/C |
| 6 | Approaches to identify network connectivity in neuroimaging | Monday, March 30 | 10:00 am - Noon | Bay View Room |
| 7 | Interactions Between the Prefrontal Cortex and the Medial-Temporal Lobes Supporting the Control of Memory Retrieval | Monday, March 30 | 3:30 - 5:30 pm | Grand Ballroom A |
| 8 | Temporal coordination of neuronal processes by cross-frequency interactions | Tuesday March 31 | 10:00 am - Noon | Grand Ballroom A |
| 9 | Fresh perspectives on social perception: From functional specialization to connectivity | Tuesday March 31 | 10:00 am - Noon | Grand Ballroom B/C |

## Mini-Symposium Session 1

### WHAT CAN BE, OR SHOULD BE, THE RELATIONSHIP BETWEEN LANGUAGE AND NEUROSCIENCE?

**Sunday, March 29, 10:00 am - Noon, Grand Ballroom A**

**Chair: Hanna Gauvin, Gent University**

**Speakers: David Poeppel, Sophie Scott, Fred Dick**

The voluminous and fast-growing literature on language in the brain suggests that our understanding of how linguistic processes are computed by the brain is progressing by leaps and bounds. However, many if not most such studies come to the conclusion that 'area x is involved in/responsible for linguistic process y'. This situation is hardly unique to the cognitive neuroscience of language, but clearly one we need to progress from. The aim of this mini-symposium is to stimulate debate - and potentially even generate some answers - about how we can leverage exciting new developments in natural language processing, linguistic typology, speech recognition, and other fields of linguistics to understand how our brain allows us to develop and master this most extraordinary, unique, yet ubiquitous human skill.

#### TALK 1: CORRELATIONAL, INTEGRATED, AND EXPLANATORY NEUROSCIENCE OF LANGUAGE

**David Poeppel[1,2]; [1]New York University, [2]Max Planck Institute**

What would an integrated approach to language research look like that connects theoretical, psycholinguistic, and neurobiological domains of inquiry? To what extent is 'unification' (e.g. in the sense of Marr) possible across domains? I discuss the outlines of a program of research at the center of which lies the idea that computational/representational (CR) theories of language must be used to investigate the neurobiological (NB) foundations of language. Unlike most approaches to the neuroscience of language - and borrowing from arguments advanced by Gallistel for the case of spatial navigation - I argue for a more 'muscular' cognitive science/linguistics that takes a leading role (in epistemological terms) in motivating neurobiological questions. Different ways are considered in which CR and NB might be connected. These are (1) a correlational way, in which NB computation is correlated with the CR theory (i.e. business as usual); (2) an integrated way, in which NB data provide crucial evidence for choosing among CR theories (this happens, but rarely…); and (3) an explanatory way, in which properties of the neurobiology explain in a causal, mechanistic sense why a computational-representational theory is the way it is (the aspirational goal). I examine various questions concerning the prospects for explanatory connections, in particular, including to what extent it makes sense to say that NB could be specialized for particular linguistic computations.

#### TALK 2: THE BRAIN DOESN'T CARE ABOUT YOUR EXPERIMENT.

**Sophie Scott[1]; [1]University College London**

Functional imaging has made tremendous leaps in our understanding of the functional anatomy of the intact human brain. Is this of importance to our understanding of human language? Some have been skeptical, and others more confident of the insights. In my talk, I will address

some of the strengths and limitations of functional imaging and neuroscientific perspectives. Great strengths of this general approach is the ability to move beyond an uncritical dependence and interpretation on Wernicke's area and Broca's area as explanatory constructs, and the possibilities of using other neurobiological frameworks and theories to inform linguistic perspectives. More problematic can be the ways that we exploit this, with a very heavy reliance on the kinds of experimental paradigms that are typically essential when performing behavioural studies, but which can lead to spurious patterns of activation, which are not essential to the linguistic phenomena being studied, but which are associated with the task itself. I also would suggest that we have been historically fixated on more abstract aspects of language processing in a way which may have significantly underplayed the social and emotional significance of the spoken or signed word, and I will use the example of speech and voice as a way of demonstrating the effects of this.

### TALK 3: LINGUISTICS AND COGNITIVE NEUROSCIENCE: IT'S TIME TO TAKE DIVERSITY SERIOUSLY.

Fred Dick[1]; [1]Birkbeck College, University of London

The marriage of cognitive neuroscience and linguistics has been a long and productive one. But as with all relationships, it's easy to end up rehashing the same old routines and conversations if you don't make new friends and try out new approaches to old problems. In this regard, cognitive neuroscience can benefit from a more pluralistic and up-to-date view of linguistic research. I'll highlight some recent studies that have successfully used computational approaches to natural language processing as a way to characterize underlying neural representations, and will suggest some ways we can move forward using such approaches. Such detailed models can also give us a way to think about how 'a language brain' might have evolved, and what it means for neuroscientific theories of language when different brains seem to accomplish very basic language tasks in quite different ways. Here, thinking developmentally will be crucial to understand this 'diversity of neural organization', as well as in testing the predictions of linguistic theories. I will highlight some studies on the slow and rather dramatic developmental changes of very basic language skills that suggest that what seems 'easy' according to most linguistic theories is actually something that takes the brain a very long time to sort out to its own satisfaction. Finally, I will discuss how recent work in learning and language evolution bear on a fairly common assumption about language and the brain, namely that the regularities and 'rules' that we can observe in language are actually represented in the brain.

## Mini-Symposium Session 2

### ZOOMING-IN ON THE HIPPOCAMPUS: ADVANCES IN HIGH-RESOLUTION IMAGING IN THE CONTEXT OF COGNITIVE AGING AND DEMENTIA

**Sunday, March 29, 10:00 am - Noon, Grand Ballroom B/C**

**Chair: Naftali Raz, Wayne State University**

**Speakers: Susanne Mueller, Craig Stark, Geoffrey Kirchner, Michael Yassa**

Medial temporal lobe circuits play pivotal roles in fundamental cognitive processes and the hippocampal formation is arguably the most researched constituent of the mammalian brain. However, the hippocampus is not a uniform structure and its components or subfields differ dramatically in their cytoarchitectonic, vascular and electrophysiological properties and exhibit differential vulnerability to multiple pathophysiological and neurotoxic factors. The cumulative record of studies in rodents reveals intricate mapping of diverse cognitive operations on specific hippocampal regions, but until recently investigations of similar brain-behavior associations in humans have been rare. Latest advancements in non-invasive magnetic resonance imaging (MRI) techniques allowed progressively finer resolution of hippocampal regional structure and function thus providing cognitive neuroscientists with intriguing opportunities to delve deeper into the neural basis of cognitive differences and changes that accompany aging, development and neurological disease. In this symposium, we will survey the latest developments in MR imaging of the hippocampal subfields, which include four compartments of Cornu ammonis (CA1-CA4), the dentate gyrus, and the subiculum complex. We will present findings pertaining to the role of distinct subfields in specific aspects of episodic memory of healthy adults and persons with cognitive deficits that are linked to multiple pathophysiological and genetic causes.

### TALK 1: INSIGHTS INTO NEUROANATOMICAL CORRELATES OF EPISODIC MEMORY FROM LOCALIZED EFFECTS OF CEREBROVASCULAR DISEASE

Susanne Mueller[1]; [1]University of California at San Francisco

Vascular risk and cerebrovascular disease increase dramatically with age and are associated with differential decline the hippocampus and its subfields. Thus, cerebrovascular disease presents a useful model for studying episodic memory through investigation of memory deficits arising from disease-related changes in hippocampal structure and function in elderly subjects. In 150 subjects (range: 66-92 years) with and without mild cognitive impairment due to cerebrovascular disease, we obtain high resolution PD-weighted images of the hippocampus that we manual parcellated to obtain subfield volumes from the anterior third of the hippocampal body and entorhinal cortex. We observed smaller CA1 volumes were smaller cognitively impaired participants and were negatively associated with

Framingham coronary risk score. Larger CA1-2 transition zone volumes were associated with lower vascular risk. Larger volume of CA1 was associated with better performance on verbal and non-verbal memory tasks but not with an index of global cognition. Thus, vascular disease and vascular risk factors that have been shown to target areas CA1 and CA1-2 are linked to episodic memory performance and may constitute a common substrate for physiological and pathological memory impairment in the elderly.

### TALK 2: DIFFERENTIAL ROLE OF HIPPOCAMPAL SUBFIELDS AND HIPPOCAMPAL CONNECTIVITY IN MEMORY

Craig Stark[1]; [1]University of California at Irvine

The hippocampus has long been linked to declarative or explicit forms of memory, but only recently computational models and electrophysiological studies in rodents have associated different memory functions with distinct hippocampal subregions. One particular function, ascribed to the dentate gyrus, is a pattern separation. By transforming similar representations of similar events into discrete representations (pattern separation or orthogonalization), memories can be formed rapidly without suffering high levels of interference. Our understanding of the hippocampus and its role in various forms of memory (e.g., episodic memory, recollection, etc.) would be greatly enhanced if we could translate these computational and rodent studies and provide experimental validation of these findings in humans. Here, I will present data from high-resolution BOLD fMRI studies that are consistent with differential computations across hippocampal subfields. I will further show how healthy aging is associated with a disruption in hippocampal connectivity that is, in turn, associated with alteration of subfield-level activity and memory behavior tied to pattern separation and the dentate gyrus.

### TALK 3: LAMINAR ATROPHY IN THE HIPPOCAMPUS AND MEMORY DEFICITS

Geoffrey Kirchner[1]; [1]Stanford University School of Medicine

Hippocampal subregions exhibit selective vulnerability to age and neurodegeneration. This selectivity is apparent not only between subfields, but also between laminae, as post-mortem tissue analysis reveals that the neurites in the CA1 stratum radiatum / stratum lacunosum-moleculare (SRLM) are among the first structures in the hippocampus to exhibit neurofibrillary tau pathology in Alzheimer's disease (AD). Using ultra-high field 7-Tesla MRI and 0.22 mm in-plane resolution, we observed differential SRLM atrophy among patients with AD dementia relative to age-matched controls; among older versus younger cognitively-healthy controls; and among carriers of the ApoE4 allele relative to non-carriers. In patients with AD and amnestic mild cognitive impairment (a prodromal stage of AD), there is a robust and specific correlation between the degree of SRLM atrophy and episodic memory performance, consistent with the notion that loss of synaptic structures in this neuropil region of the hippocampus relates to a core cognitive feature of AD. SRLM atrophy reflects the burden of tau-related neuropathology, as measured by cerebrospinal fluid tau and phospho-tau levels. In summary, quantitative evaluation of hippocampal laminar structure yields important insights into the selective vulnerability SRLM to aging and AD-related neurodegeneration, and its close association with molecular biomarkers and behavioral performance.

### TALK 4: DISSECTING HIPPOCAMPAL COMPUTATIONS AND PROCESSES: A TRANSLATIONAL PERSPECTIVE USING HIGH-RESOLUTION FMRI

Michael Yassa[1], Zachariah Reagh[1]; [1]University of California at Irvine

There has been widespread interest recently in distinguishing the roles that particular hippocampal subfields play in service of episodic memory storage. This is compounded with the fact that subfield-specific patterns of pathology are expressed in the context of various mental disorders including, aging, AD, and depression. I will discuss our recent work in (1) delineating the computational roles various hippocampal subfields play with a particular emphasis on the dentate gyrus and CA3 regions, (2) the interactions of these subfields with other medial temporal lobe regions in the context of specific types of memory, (3) differential vulnerability of hippocampal subfields to aging, AD, and depression, and (4) using subfield-level MRI to derive novel biomarkers for early prediction of disease and treatment outcomes.

## Mini-Symposium Session 3

### REASONING: ORIGINS AND DEVELOPMENT

**Sunday, March 29, 10:00 am - Noon, Bay View Room**

**Chair: Kathy Mann Koepke, Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD)/NIH**

**Speakers: Aaron Blaisdell, Silvia Bunge, Ben Rottman, Daniel Krawczyk**

Despite great neuroscience advances, pursuit of the mechanisms underlying reasoning abilities has stalled. Without clear models, universal definitions, or normative data on which to build rich, heuristic theoretical models of reasoning, the search for clear neurobiological and genetic underpinnings has been slow. Understanding how reasoning skills develop; identifying developmental challenges, sensitive periods, risks and key prevention, maintenance, and remedial interventions have emerged as critical priorities. Refining nomenclature, developing homologous cross-species measurements, identifying sophisticated analytic methods that incorporate developmental, neurobiological, social and environmental factors, and building predictive theories of real-world reasoning are urgently needed. To this end, NICHD has called together a multidisciplinary work group of leading scientists to identify current knowledge and advancement gaps in reasoning research. Speakers will present current research and focus attention on issues identified by the work group that can be addressed in both

the short and longer term before the field can significantly advance. Aaron Blaisdell will introduce evidence of pigeon spatial- and rat causal-inferences, the value and utility of animal models of reasoning. Silvia Bunge will explore brain changes associated with developing reasoning ability and how brain plasticity might be manipulated to improve reasoning. Ben Rottman will examine how people make sophisticated causal inferences with incomplete information. Daniel Krawczyk will introduce the disordered reasoning witnessed in Autism Spectrum Disorder and Traumatic Brain Injury, the underlying neural perturbations, and the clinical implications of disordered reasoning. In each case, the speakers' own research will both highlight new understanding and important gaps in reasoning research.

## TALK 1: COMPARATIVE BEHAVIORAL NEUROSCIENCE OF REASONING PROCESSES.

Aaron Blaisdell[1]; [1]UCLA

Reasoning has long been thought to be a uniquely human capacity, but it did not appear de novo in our species. Rather, reasoning is found in a wide spectrum of primate and non-primate species. In this talk, I will review just some of the many elements of reasoning that are found in nonhumans, focusing on experiments in rats and pigeons. I will discuss my own work on spatial inferences in pigeons and causal inferences and imagery in rats, including the neural circuitry that is involved in reasoning about absent events. Despite this increased sophistication in our understanding, the neural basis of reasoning in animals has received inadequate attention. Further, very recent discoveries of deep homologies at the cell-molecular level for many of the brain/cognitive phenotypes seen in humans will be discussed, linking their ancestry far back in evolutionary time. These new cell-molecular mechanisms provide a window to study ontogeny of cognition and an opportunity to fill knowledge gaps. Animal models, such as the rat and the pigeon, can provide valuable tools to investigate the role of neurodevelopmental processes and life-history experience in the establishment of the adult form of reasoning. Animal models can be interrogated at the cell-molecular, neural circuit, behavioral, and computation levels of analysis. Thus, with the advent of more sophisticated neuroimaging and neuromanipulation techniques and assessment of neurogenetics during development, the field of development of reasoning is poised to enter a renaissance and dramatically improve our understanding of human cognitive development and dysfunction.

## TALK 2: NEURAL MECHANISMS, DEVELOPMENT, AND PLASTICITY OF REASONING

Silvia Bunge[1]; [1]University of California at Berkeley

Reasoning, the ability to think logically and solve novel problems, is a prerequisite for scholastic achievement. Despite – or because of – its central role in theories of human intelligence, reasoning has in recent years fallen out of research favor. As the United States slips behind other industrialized nations in mathematics and science achievement, it is time to revisit reasoning research with a fresh perspective. First I will briefly review evidence that various forms of deductive reasoning recruit overlapping regions within the lateral frontoparietal network (LFPN). Specifically, the inferior parietal lobule and rostrolateral prefrontal cortex play key roles in relational reasoning; I will suggest that their contributions may be domain-general. I will then report on longitudinal brain imaging in children ages 6-21, identifying structural and functional changes within the LFPN that best predict the growth of reasoning ability over childhood and adolescence. Next, I will show that 3 months of intensive practice of reasoning skills leads to structural and functional changes in the LFPN in young adults. Finally, I will describe how we are using eyetracking methodology and lateralized stimulus presentation techniques to gain novel insights into how people reason. These studies point to the need for further exploration of: (1) domain-general and domain-specific brain mechanisms that support reasoning, (2) changes in brain structure and function that support optimal reasoning development over childhood and adolescence, (3) the extent to which reasoning skills can be improved via experience-dependent brain plasticity, and (4) approaches for monitoring and predicting the growth of reasoning.

## TALK 3: CAUSAL REASONING: THE ROLE OF TEMPORAL HEURISTICS FOR SOPHISTICATED INFERENCES

Ben Rottman[1]; [1]University of Pittsburgh

When learning and reasoning about causal relationships, people are faced with an extremely challenging and underdetermined problem. For example, people often do not know how the data were generated or have misconceptions about the data, and different beliefs and assumptions can lead to different inferences. In the last 15 years, Bayesian models of causal learning originally developed by computer scientists and philosophers have been applied and extended as models of human causal reasoning. Bayesian models are extremely flexible and explain how a rational agent should incorporate knowledge and beliefs when learning in a new situation. However, much of this research has ignored the process or algorithmic-level description of human causal reasoning, focusing exclusively on the computational level. I will discuss research showing that people often make highly sophisticated and flexible causal inferences that go beyond the typical assumptions of most learning algorithms. Yet, these inferences are intuitive and amenable to simple heuristics. Many of these inferences rely upon subtle temporal cues to causality. Furthermore because they unfold over time, these inferences are easily interpretable with algorithmic explanations. At the same time, these inferences often provide insight into pre-existing assumptions and beliefs people have when engaging in causal reasoning, and can inform a Bayesian or computational-level analysis. New models of probabilistic reasoning are reshaping the field of reasoning in dramatic and important ways. To develop a thorough understanding of causal reasoning and probabilistic reasoning more generally, future research will need to

integrate heuristic and algorithmic-level explanations with computational-level explanations of reasoning.

### TALK 4: CLINICAL IMPLICATIONS FOR DEFICITS OF REASONING: EVIDENCE FROM AUTISM SPECTRUM DISORDERS AND TRAUMATIC BRAIN INJURY

Daniel Krawczyk[1]; [1]University of Texas at Dallas and the University of Texas-Southwestern Medical Center

Reasoning depends on multiple factors including perceiving the relevant context, recall of appropriate knowledge to a given situation, and inference processes. Neuroscience studies have begun to contribute to several of these processes by specifying the conditions when they are engaged and mapping cognition to neural systems. I will discuss examples from three lines of research that illustrate important correspondences between cognitive processes and neural function. First, neuroimaging studies provide converging evidence for the importance of the prefrontal cortex and its functional connections in governing relational perception, the verification of rules, and generating inferences. Second, evidence from adolescents demonstrates that perceiving similarity at multiple levels is needed for abstract reasoning. Such abilities are disrupted in clinical conditions such as traumatic brain injury, and conditions affecting social perception such as autism and schizophrenia. Lastly, neuroimaging studies of expertise highlight the importance of our knowledge of previous successes. Together these approaches provide a more complete picture of the abilities important for reasoning as well as the multiple brain regions and interconnectivity that supports reasoning. Despite our progress to date, there has not been adequate agreement within the field about the key sub-processes that contribute to reasoning. Neuroscience evidence can help to achieve greater clarity on these sub-processes. To achieve this end the research community will need to seek methods that will provide both experimental control and the ability to scale research to simulate the complexity faced in real world reasoning, including social factors, multi-tasking, and the limits of human expertise.

## Mini-Symposium Session 4

### CEREBELLAR CONTRIBUTIONS TO LEARNING AND COGNITION

**Monday, March 30, 10:00 am - Noon, Grand Ballroom A**

**Chair: Rich Ivry, University of California, Berkeley**

**Co-Chair: Arseny Sokolov, Centre Hospitalier Universitaire Vaudoi**

**Speakers: Rich Ivry, Aparna Suvrathan, Arseny Sokolov, Julie Fiez**

This symposium will provide an overview of current ideas concerning the contribution of the cerebellum to learning and cognitive processing. Recent findings from neurophysiology, neuropsychology and brain imaging have led to significant changes in our understanding of the mapping and function of the cerebellum. The symposium will feature an interdisciplinary panel of speakers who will present state-of-the-art research, diverse views and approaches employed to understand cerebellar contributions to learning and cognition. Ivry will discuss the role of the cerebellum in motor learning, and ask how computational principles derived from this work may help explain non-motor functions of this structure. Suvrathan will describe physiological work that addresses how synaptic learning rules are implemented by the cerebellar circuit. Sokolov will present lesion and imaging evidence on the interaction between the cerebellum and temporal cortex during the visual perception of action. Fiez will address the role of the cerebellum in the development of skilled reading, also drawing on lesion and neuroimaging data. The speakers will integrate their talks to consider general principles of intracerebellar processing and cerebellar-cortical communication. The symposium should be of substantial interest to the cognitive neuroscience community, providing fresh ideas on the interaction between the cerebellum and cortex, one that has attracted considerable interest in literatures as diverse as motor control, cognition, psychiatry and development.

### TALK 1: THE PREDICTIVE BRAIN: CEREBELLAR CONTRIBUTIONS TO ACTION AND COGNITION

Rich Ivry[1]; [1]University of California, Berkeley

Sensorimotor learning can be studied by asking participants to move in novel workspaces in which they encounter novel forces or systematic distortions of visual feedback (e.g., where the visual feedback is translated or rotated in space). In such tasks, people adapt a sensorimotor map to implicitly compensate for the perturbation. Patients with cerebellar degeneration exhibit a pronounced impairment on such tasks. This learning impairment does not appear to be directly related to problems in motor control per se, but rather in generating expectancies of the sensory consequences of the movements. These expectancies are compared with the actual feedback to generate sensory prediction errors, a signal used to adapt an internal model of the workspace. Recent work has highlighted the obligatory and modular nature of this cerebellar learning system; for example, error-based learning from sensory prediction errors continues to occur even under conditions in which this process is maladaptive. A failure to generate and utilize sensory predictions has also been observed in people with psychiatric disorders such as autism and schizophrenia, conditions in which there is consistent evidence of cerebellar pathology. This work suggests a computational hypothesis concerning how cerebellar dysfunction might contribute to the cognitive deficits observed in these psychiatric populations, as well as a more general view of cerebellar function in healthy individuals.

### TALK 2: TUNING OF SYNAPTIC PLASTICITY FOR CEREBELLAR LEARNING

Aparna Suvrathan[1], Jennifer Raymond[1]; [1]Stanford University

A broad goal in neuroscience is to understand how the features of behavior and cognition are shaped by the properties of neurons and synapses. Our lab is studying how the neural learning algorithms emerge from, and are shaped by

local rules controlling the induction of plasticity at different synapses within the circuit. It has been widely assumed that the plasticity rules are uniform across a given brain structure. For example, the cerebellum is composed of clearly distinct functional zones, with different behavioral roles and hence computational requirements, yet models linking synaptic plasticity mechanisms to cerebellar learning have been based largely on the synaptic properties reported in one small, physiologically accessible region of the cerebellum. We directly compared the synaptic learning rules at equivalent synapses in different functional zones of the cerebellum, and found striking differences. These differences seem to reflect tuning of the plasticity mechanisms for the computational requirements of the specific kinds of learning implemented by each zone.

### TALK 3: INTERACTIONS BETWEEN THE CEREBELLUM AND TEMPORAL CORTEX DURING ACTION PERCEPTION

Arseny Sokolov[1]; [1]Centre Hospitalier Universitaire Vaudois, Lausanne, Switzerland

Visual perception of human actions is indispensable in our everyday life. Observation of biological motion subserves motor learning, car driving and non-verbal social communication. While the cortical system for action observation has been studied in great detail, subcortical contributions to action understanding have received minimal attention. Our data from neurosurgical patients with tumors to the cerebellum indicate that the integrity of left lateral cerebellar structures is essential for the veridical perception of body motion. Several lines of neuroimaging evidence provide converging evidence in support of this hypothesis. 1) Activity in the left lateral cerebellar lobules Crus I and VIIB in healthy adults is related to action observation. 2) Dynamic causal modelling reveals reciprocal communication between the left lateral cerebellum and the right superior temporal sulcus, a key structure of the cortical networks for action observation and social cognition. 3) A direct structural pathway between these regions can be identified with diffusion tensor imaging. 4) Recovery of biological motion processing after cerebellar tumor removal is paralleled by topographical reorganization in the corresponding cerebro-cerebellar network. In summary, lesion and multimodal imaging evidence illustrate the role of the cerebellum in the circuitry for visual processing of body motion. The findings open a window for further research on interactions between the cerebellum and temporal cortex in social cognition, multimodal integration, language processing, and in neuropsychiatric conditions, such as multiple sclerosis, epilepsy, schizophrenia or autistic spectrum disorders.

### TALK 4: CONTRIBUTIONS OF THE CEREBELLUM TO READING DEVELOPMENT

Julie Fiez[1]; [1]University of Pittsburgh

Neurobiological studies of developmental dyslexia have focused predominantly on regions in a dorsal temporo-frontal pathway associated with phonological analysis and speech production, and its interconnections with a putative visual word form area in the mid-fusiform gyrus. However, recent work has provided renewed support for a cerebellar deficit hypothesis of developmental dyslexia proposed 20 years ago. Despite increased evidence in support of this hypothesis, the functional role of the cerebellum in normal and disordered reading remains poorly understood. To gain traction on this issue, a task overlap approach was used to identify cerebellar regions that are active in normal readers learning new visual word forms, and also in two tasks in which normal performance correlates with reading skill (rhyme judgment, immediate serial recall). Based upon the results of this analysis, it is suggested that orthographic learning makes use of a decoding scaffold that involves speech motor planning, with the cerebellum contributing a phonological error-monitoring component to this scaffold. This interpretation is explored through convergent work involving participants with focal lesions to the cerebellum. Phonological analysis and orthographic learning deficits in this population provide support for a phonological monitoring account of cerebellar contributions to orthographic-phonological mapping. Together, the imaging and lesion results provide a neuroanatomical basis for the self-teaching hypothesis of reading (Share, 1995) and a theoretical framework for understanding the role of the cerebellum in the development of skilled reading.

## Mini-Symposium Session 5

### DISRUPTING THE FACE PERCEPTION NETWORK

**Monday, March 30, 10:00 am - Noon, Grand Ballroom B/C**

**Chair: David Pitcher, NIMH**

**Speakers: Arash Afraz, Marlene Behrmann, David Pitcher, Kevin Weiner**

Faces are rich sources of social information that simultaneously convey someones identity, attentional focus, and emotional state. Our visual system is so efficient that, to us, processing this information appears to happen effortlessly. Yet the simplest functions, like recognizing your mother or judging her mood, depend on interactions across a network of specialized brain regions. Despite many years of study our understanding of the unique functions performed by each region and how these regions interact to facilitate face perception remains limited. The speakers in this symposium use novel combinations of experimental techniques to study the behavioural effects of disruption in the face perception network. Our aims are to update the fundamental understanding of how faces are cortically represented and to establish common theoretical ground among researchers. To achieve this we will present studies using a range of subject populations (healthy-humans, brain-damaged patients, pre-operative epileptic patients and non-human primates) and experimental methods (optogenetics, fMRI, microstimulation, physiology, TMS, diffusion weighted imaging and neuropsychology). We believe this symposium will be of great interest to CNS attendees for two reasons. Firstly,

understanding the neural processes underlying face perception has proven to be a testing ground in which key disputes concerning anatomical specificity and computational modularity take place and which therefore generates great interest amongst all cognitive neuroscientists. Secondly, studying the face network serves as a proxy for studying the whole brain as a network and we believe attendees will be eager to apply the experimental techniques discussed to address their own questions.

## TALK 1: THE CAUSAL ROLE OF FACE-SELECTIVE NEURONS IN FACE PERCEPTION.

Arash Afraz[1]; [1]Massachusetts Institute of Technology

Many neurons in the inferior temporal cortex (IT) of non-human primates respond more strongly to images of faces than to images of non-face objects. Such so-called "face neurons" are thought to be involved in face recognition behaviors such as face detection and face discrimination. While this view implies a causal role for face neurons in such behaviors, the main body of neurophysiological evidence to support it is only correlational. Here, I bring together evidence from electrical microstimulation, optogenetic and pharmacological intervention in macaques to bridge the gap between the neural spiking of IT face selective neurons and face perception.

## TALK 2: REVERSE ENGINEERING THE FACE PERCEPTION SYSTEM: INSIGHTS FROM CONGENITAL PROSOPAGNOSIA

Marlene Behrmann[1]; [1]Department of Psychology, Carnegie Mellon University, USA

Reverse engineering involves disassembling a complex device and analyzing its components and workings in detail with the goal of understanding how the device works in its intact state. To elucidate the neural components implicated in normal face perception, we investigate the disrupted components in individuals with congenital prosopagnosia, an apparently lifelong impairment in face processing, despite normal vision and other cognitive skills. Structural and functional MRI data reveal compromised connectivity between more posterior face-selective cortical patches and more anterior regions that respond to face stimuli. Computational descriptions of the topology of this connectivity, using measures from graph theory that permit the construction of the network at the level of the whole brain, uncover atypical organization of the face network in CP. Moreover, this network disorganization is increasingly pronounced as a function of severity of the face recognition disorder. Last, we reconstruct the face images viewed by normal and prosopagnosic observers from the neural data and demonstrate the altered underlying representations in key cortical regions in the prosopagnosic individuals. This multipronged approach uncovers in fine-grained detail the alteration in information discrimination in the prosopagnosic individuals as well as the pertubations in the neural network that gives rise to normal face perception.

## TALK 3: TRANSIENT DISRUPTION IN THE FACE PERCEPTION NETWORK: COMBINING TMS AND FMRI

David Pitcher[1]; [1]National Institute of Mental Health

Faces contain structural information, for identifying individuals, as well as changeable information, that can convey emotion and direct attention. Neuroimaging studies reveal brain regions that exhibit preferential responses to invariant or changeable facial aspects but the functional connections between these regions are unknown. This issue was addressed by causally disrupting two face-selective regions with thetaburst transcranial magnetic stimulation (TBS) and measuring the effects of this disruption in local and remote face-selective regions with functional magnetic resonance imaging (fMRI). Participants were scanned, over two sessions, while viewing dynamic or static faces and objects. During these sessions, TBS was delivered over the right occipital face area (rOFA) or right posterior superior temporal sulcus (rpSTS). Disruption of the rOFA reduced the neural response to both static and dynamic faces in the downstream face-selective region in the fusiform gyrus. In contrast, the response to dynamic and static faces was doubly dissociated in the rpSTS. Namely, disruption of the rOFA reduced the response to static but not dynamic faces, while disruption of the rpSTS itself, reduced the response to dynamic but not static faces. These results suggest that dynamic and static facial aspects are processed via dissociable cortical pathways that begin in early visual cortex, a conclusion inconsistent with current models of face perception.

## TALK 4: THE HUMAN FACE PROCESSING NETWORK IS RESILIENT AFTER RESECTION OF SPECIALIZED CORTICAL INPUTS

Kevin Weiner[1]; [1]Department of Psychology, Stanford University

Functional hierarchies are a prevalent feature of brain organization. In high-level visual cortex, the "occipital face area" (OFA/IOG-faces) is thought to be the input to a specialized processing hierarchy subserving human face perception. However, evidence supporting or refuting the causal role of IOG-faces as a necessary input to the face network evades researchers because it necessitates a patient with a focal lesion of the right inferior occipital cortex, as well as functional measurements both before and after surgical removal of this region. Here, in a rare patient fulfilling both of these requirements, we show that the face network is surprisingly resilient in two ways following surgical removal of IOG-faces. First, the large-scale cortical layout and selectivity of the face network are stable after removal of IOG-faces. Second, following resection, face-selective responses in ventral temporal cortex surprisingly become more reliable in the resected hemisphere, but not in the intact hemisphere. Further investigations of the anatomical underpinnings of this resiliency using diffusion tensor imaging suggest the existence of additional white matter pathways connecting early visual cortex to downstream face-selective regions independent of IOG-faces. Thus, after resection, neural signals can still reach downstream regions via these pathways

that are largely unconsidered by present neurofunctional models of face processing. Altogether, these measurements indicate that IOG-faces is not the key input to the face network. Furthermore, our results pose important constraints on hierarchical models in high-level sensory cortices and provide powerful insight into the resiliency of such networks after damage or cortical trauma.

# Mini-Symposium Session 6

## APPROACHES TO IDENTIFY NETWORK CONNECTIVITY IN NEUROIMAGING

Monday, March 30, 10:00 am - Noon, Bay View Room

Chair: Vaughn Steele, The Mind Research Network

Co-Chair: Vince Calhoun, The Mind Research Network

Speakers: Vaughn R. Steele, Edward M. Bernat, Selin Aviyente, Vince D. Calhoun

Connectivity measures are widely used to identify neural correlates of cognitive functions, however many approaches ignore the possibility of time-varying connectivity. We present a series of talks which provide approaches that move beyond such static measures and capture transient or recurring patterns of connectivity. Whole brain connectivity analyses of cognitive control tasks will be presented for electroencephalogram (EEG), event-related potential (ERP), and functional magnetic resonance imaging (fMRI) data. First, we will review steps to ensure reliable cognitive control related signal in both ERP and fMRI. We replicate and extend previous reports by including both ERP and fMRI analysis with stabilization techniques such as bootstrapping and subsampling. Two of the talks are based on a recently proposed complex Cohen's class time-frequency distribution (Aviyente et al., 2011) to calculate phase-locking values (PLV) providing improved time-frequency resolution. The first utilizes bivariate PLV measures, demonstrating sensitivity to cognitive and motor processes in several active task paradigms. The next talk introduces a multivariate tensor-based dynamic functional connectivity tracking framework to provide a data-driven approach to characterizing changes in network connectivity across time and to determine the different network states during cognitive control based on EEG data. Finally, we will discuss methods related to dynamic functional connectivity of fMRI data using independent component analysis. This includes approaches to both estimation and characterization of recurring patterns of connectivity 'states' which may overlap as well as global measures of state behavior 'meta-states'. Taken together, we summarize practical steps for characterizing intrinsic networks measured using EEG, ERP, and fMRI.

### TALK 1: NEUROIMAGING MEASURES OF COGNITIVE CONTROL: EXTRACTING RELIABLE SIGNALS

Vaughn R. Steele[1], Edward M. Bernat[2], Vince D. Calhoun[1], Kent A. Kiehl[1]; [1]The Mind Research Network, [2]University of Maryland

Reliability of measured signal has long been a concern for researchers using event-related potential (ERP) and functional magnetic resonance imaging (fMRI). Using ERP data, reliability measures have been explored in neural correlates of cognitive control (i.e., response inhibition and error-monitoring) suggesting the necessity of 6 to 8 trials. However, identifying the number of trials needed for reliable cognitive control signal measured in fMRI and number of participant needed in each modality has yet to be fully examined. Datasets of healthy participants (ERP n=137; fMRI n=102) who performed a Go/NoGo task were analyzed to replicate and extend previous reports. Specifically, we sought to identify the necessary number of trials and participants needed to achieve reliable cognitive control signal in each neuroimaging modality. Measures related to a false alarm (error-monitoring) were extracted for analysis from ERP (error-related negativity [ERN] and error positivity [Pe]) and fMRI (anterior-cingulate cortex activation) data. For each modality, Cronbach's alpha became consistent at a similar number of trials (6-8) and number of participants (30-50). Stabilization techniques (i.e., bootstrapping and subsampling) were also used to extract subject-level data for comparison. In addition to these extracted values, simulations were included to highlight advantages when applied to analysis of network connectivity (i.e., characterizing complex patterns of activation among interconnected brain regions). Therefore, we outline best-practices in measuring reliable error-monitoring signals in both ERP and fMRI with respect to the necessary number of trials and participants. Also, we review advantages of using stabilization techniques specifically for analysis of network connectivity.

### TALK 2: INDEXING DYNAMIC FUNCTIONAL INTEGRATION USING BIVARIATE TIME-FREQUENCY PHASE-SYNCHRONY WITH EVENT-RELATED POTENTIAL DATA

Edward M. Bernat[1], Selin Aviyente,[2], Andrey Anokhin[2], Jason Moser[3], N. B. Schmidt[4]; [1]University of Maryland, [2]Washington University School of Medicine, [3]Michigan State University, [4]Florida State University

Dynamic functional integration of brain regions during task performance is an important emerging topic of study. Recent work with ERPs has begun to demonstrate the utility of time-frequency (TF) phase-synchrony (PS) approaches for indexing functional integration. Based on a recently developed TF-PS distribution (Aviyente et al., 2011), the work to be presented provides evidence that this TF-PS measure can successfully index dynamic functional integration associated with relevant cognitive and affective processing involving medial-prefrontal (mPFC), lateral-prefrontal (lPFC), motor, and occipital regions. Findings from four studies will be detailed. The first is a longitudinal study of adolescents (at ages: 12, 14, 16; N=214) engaged in a gambling task. Findings indicate that dynamic mPFC-lPFC and lPFC-motor functional integration increases significantly during this period of development. The second study (N=95) investigates functional integration during a common go/no-go task. Here greater mPFC-lPFC integration is observed for no-go trials, and greater mPFC integration with contralateral motor areas during response execution (go) and inhibition (no-go). The

final two studies involve clinically-relevant individual differences. In the first (N=94), increases in worry (Penn State Worry Questionnaire, PSWQ) are independently associated with increased error-related negativity (ERN) amplitude and a decrease in mPFC-lPFC functional integration. The fourth study (N=85, collection ongoing) involves gambling feedback ERP data from anxiety patients who have varying levels of suicidal thoughts and urges. Results indicate that both amplitude and mPFC-lPFC TF-PS are related to level of suicidal presentation. Broadly, findings validate the bivariate PLV measure, and provide motivation for the development of multivariate approaches.

### TALK 3: A TENSOR-BASED APPROACH TO TRACKING DYNAMICS OF FUNCTIONAL CONNECTIVITY IN THE BRAIN

Selin Aviyente[1], David Zoltowski[1], Arash Mahyari[1], Edward M. Bernat[2]; [1]Michigan State University, [2]University of Maryland

With the advances in neuroimaging technology, it is now possible to collect multi-channel neurophysiological signals such as electroencephalogram (EEG) data across different experimental conditions and subject groups. In this talk, we propose tensor tracking and compression algorithms to identify change points in network topography and to summarize the quasi-stationary network states. Tucker decomposition of the functional connectivity networks across frequency bands, subjects and time allows us to capture the variation of these higher order datasets using a few orthogonal factors. Using lower rank approximations to the tensor at each time point and subspace distance metrics to quantify the change in the network across time, we identify the change points. Once the change points are detected, each time interval is compressed to a single network state representation through tensor-matrix projection and sparsity optimization. The proposed dynamic functional connectivity network tracking methods are applied to EEG data collected during a study of cognitive control in the brain. The results indicate that during error processing, the brain's network organization across time and subjects can be efficiently described using 5 distinct network states in the theta (2-5Hz) frequency band, where the network states closely align with the subject's response time, onset of error-related negativity (ERN) and onset of the error positivity (P3e). Moreover, the topographic summarization of these network states indicates activation of broader brain regions before the response and more specialized and sparse activation patterns during ERN in particular between the medial prefrontal cortex (mPFC) and lateral prefrontal cortex (lPFC).

### TALK 4: THE CHRONNECTOME: TIME-VARYING CONNECTIVITY NETWORKS AS THE NEXT FRONTIER IN FMRI DATA DISCOVERY

Vince D. Calhoun[1], Vaughn R. Steele[1]; [1]The Mind Research Network

Recent years have witnessed a rapid growth of interest in moving functional magnetic resonance imaging (fMRI) functional connectivity investigations beyond simple scan-length averages and into approaches that capture time-varying properties of connectivity. In this perspective we use the term "chronnectome" to describe such metrics that allow a dynamic view of coupling. In the chronnectome, coupling refers to possibly time-varying levels of correlated or mutually informed activity between brain regions whose spatial properties may also be temporally evolving. We primarily focus on multivariate approaches developed in our group, and review a number of such approaches with an emphasis on matrix decompositions such as principle component analysis and independent component analysis. We also discuss the potential these approaches offer to improve characterization and understanding of brain function, which is inherently dynamic, not-well understood, and thus poorly suited to conventional scan-averaged connectivity measurements. We show examples of how dynamic connectivity can provide important information for both resting fMRI and task-based fMRI (e.g. go/nogo task) data. There are a number of methodological directions which need to be developed further, but chronnectome approaches already show great promise for the study of both the healthy and diseased brain.

## Mini-Symposium Session 7

### INTERACTIONS BETWEEN THE PREFRONTAL CORTEX AND THE MEDIAL-TEMPORAL LOBES SUPPORTING THE CONTROL OF MEMORY RETRIEVAL

**Monday, March 30, 3:30 - 5:30 pm, Grand Ballroom A**

**Chair: Michael Anderson, University of Cambridge**

**Co-Chair: David Badre, Brown University**

**Speakers: Helen Barbas, Michael Anderson, David Badre, Howard Eichenbaum**

Although memory retrieval often occurs automatically, adaptive behavior frequently recruits cognitive control processes that guide retrieval in a goal directed manner. Sometimes this control demand arises because memories may be difficult to retrieve, due to interference or other factors; other times, the retrieval process itself may need to be suppressed to support cognitive or emotional goals. Moreover, the products of retrieval need to be monitored for adaptive outcomes. Whereas episodic retrieval depends on medial temporal lobe (MTL) systems, the cognitive control of memory retrieval is known to require the prefrontal cortex (PFC), and it is widely believed that cognitive control over memory is achieved by PFC-MTL interactions. Despite this, relatively little is known about the nature of these interactions or the pathways that support them. In this symposium, we examine the nature of PFC-MTL interactions, the pathways mediating them, computations performed, and the mnemonic functions they serve. To address this issue, we bring together research with diverse methods and perspectives, ranging from work with functional and structural imaging with humans, to anatomical studies in non-human primates, and single unit electrophysiology studies of fron-

to-hippocampal interactions in rodents. We further examine both excitatory and inhibitory modulations of MTL function, in support of the controlled use of memory.

## TALK 1: PRIMATE PREFRONTAL PATHWAYS TO RHINAL AREAS AFFECT THE INPUT AND OUTPUT OF THE HIPPOCAMPUS AND MEMORY

Helen Barbas[1]; [1]Boston University

How does information from prefrontal cortices influence memory-related medial temporal cortices? Robust pathways from the anterior cingulate cortex (ACC), associated with the contextual significance of stimuli, innervate the entorhinal cortex, the gateway to the hippocampus. On the other hand, the posterior orbitofrontal cortex (pOFC), associated with the affective value of stimuli, innervates mostly adjacent perirhinal area 36. Both pathways innervate all layers of the respective cortices, suggesting direct or indirect influence on the upper (input) and deep (output) layers of the hippocampus. Both pathways innervate mostly excitatory neurons and smaller though significant proportions innervate inhibitory neurons in the respective rhinal cortices. Among the latter, in the upper layers of the entorhinal cortex the ACC pathway innervates the neurochemical class of calretinin inhibitory neurons, which have disinhibitory influence on nearby excitatory pyramidal neurons, suggesting facilitated passage to the hippocampus. On the other hand, in the upper layers of area 36 the pOFC pathway innervates preferentially calbindin inhibitory neurons, which are synaptically suited to reduce noise and enhance signal, suggesting facilitated focus on relevant stimuli and filtering out noise. In the deep rhinal layers, which receive the output of the hippocampus, both ACC and pOFC pathways innervate preferentially the powerful parvalbumin inhibitory neurons which provide strong perisomatic inhibition of nearby excitatory neurons. These findings suggest that ACC and pOFC pathways facilitate access of stimuli with contextual and affective significance to the hippocampus, but gate hippocampal output to the cortex and may determine which memories endure.

## TALK 2: A RIGHT DORSOLATERAL PREFRONTAL PATHWAY SUPPORTS THE SUPPRESSION OF MNEMONIC FUNCTIONS IN THE HIPPOCAMPUS

Michael Anderson[1], Taylor Schmitz[1], Catarina Ferreira[2]; [1]University of Cambridge, [2]University of Granada

Although memory for the past is usually viewed as desirable, our cognitive and affective goals often require us to limit the accessibility of unwanted memories. For example, people clearly limit the time they spend thinking about unpleasant experiences, a process that begins during encoding, but that continues when cues later remind someone of the unwelcome memory. In this talk, I will review the emerging behavioral and neuroimaging evidence that stopping the episodic retrieval process to suppress awareness of an unwelcome memory is achieved by a supramodal inhibitory control mechanism mediated by the right dorsolateral prefrontal cortex. This mechanism overlaps with mechanisms involved in motor response suppression. Functional and effective connectivity analyses indicate that this top-down control mechanism interacts with medial-temporal lobe structures, disrupting traces that support retention. This mnemonic stopping mechanism acts to globally suppress neural activity in the hippocampus, likely via GABA-ergic interneurons, disrupting both retrieval and encoding processes in non-specific fashion. These findings indicate that the fundamental mnemonic functions of the hippocampus are subject to strategic regulation, and that such regulation introduces lasting biases in which life events remain accessible

## TALK 3: SEPARABLE VENTRAL AND DORSAL FRONTAL PATHWAYS SUPPORTING COGNITIVE CONTROL DURING RETRIEVAL.

David Badre[1]; [1]Brown University

It has been well established that memory retrieval performance can be improved through strategic processes. These strategic processes are supported by executive or cognitive control systems that depend, in part, on the frontal lobes. However, the pathways by which frontal cortex can influence memory retrieval, such as in the medial temporal lobe system, remains under specified. In this talk, I will discuss a line of recent studies using human imaging that investigate the pathways linking prefrontal cortex with MTL during the cognitive control of memory. First, I will describe a set of fMRI and functional connectivity experiments demonstrating a functional dissociation between ventral versus dorsal pathways related to control over access to memory versus control over responding. Then, I will provide evidence from high angular resolution diffusion tractography that elaborates the organization of these pathways in the human brain.

## TALK 4: AN ANIMAL MODEL SYSTEM FOR UNDERSTANDING PREFRONTAL-HIPPOCAMPAL INTERACTIONS IN MEMORY RETRIEVAL

Howard Eichenbaum[1]; [1]Boston University

In humans, in interactions between the prefrontal cortex (PFC) and hippocampus support the retrieval of memories that are relevant to the current context. Here I will outline a rodent model system in which prefrontal-hippocampal interactions can be explored at the level of information coding by neuronal ensembles and local field potentials within these brain areas. Similar to neuropsychological findings in humans, damage to the hippocampus in rats increases forgetting whereas damage to PFC results in failure to suppress context-inappropriate memories. Consistent with these findings, representational similarity analysis reveals that the dorsal (posterior in humans) hippocampus creates a systematic organization of highly specific memories within a context, whereas the ventral (anterior) hippocampus generalizes across memories within a context and strongly distinguishes between memories from different contexts. Furthermore, PFC inactivation reduces the ability of the dorsal hippocampus to suppress inappropriate memory representations, consistent with the behavioral findings on PFC damage. Finally, analysis of the flow of information

through the system reveals how bidirectional communication between PFC and the hippocampus supports memory. This analysis showed that, during context-cued memory retrieval, contextual cues initially processed by the ventral hippocampus are sent to PFC, likely via well-known monosynaptic projections; then PFC controls retrieval of memory representations in the dorsal hippocampus by suppressing the activation of context-inappropriate neural and behavioral responses. These findings converge on an understanding, at the cellular level, of fundamental prefrontal-hippocampal interactions that are common across species and domains of declarative memory.

# Mini-Symposium Session 8

## TEMPORAL COORDINATION OF NEURONAL PROCESSES BY CROSS-FREQUENCY INTERACTIONS

**Tuesday, March 31, 10:00 am - Noon, Grand Ballroom A**

**Chair: Ole Jensen, Donders Centre for Cognitive Neuroimaging**

**Speakers: Sara Szczepanski, Peter Lakatos, Hyojin Park, Ole Jensen**

Electrophysiological brain activity is dominated by oscillatory activity during cognitive tasks. The oscillations have been reported in various brain regions and covers a wide range of frequencies. These oscillations are believed to orchestrate neuronal processing and the functional connectivity between brain regions. While oscillations in different bands have been well-characterized over the years, it remains less clear how they interact. Typically robust phase-to-power interactions between slower and faster oscillations have been reported in various kinds of task and species. Examples are delta-to-gamma coupling in auditory cortex, alpha-to-gamma couplings in visual regions and theta-to-gamma couplings in the hippocampus. Most likely the slower oscillations serve to coordinate neuronal processing reflected in higher frequencies bands. The goal of this symposium is to undercover the state-to-the-art of cross-frequency couplings identified in various cognitive states and tasks. This will be done in the context of studies on intracranial recordings in non-human primates and MEG and ECoG recordings in humans. In particular it will be addressed how cross-frequency interactions serve to support cognition by organizing neuronal processing over different temporal scales.

### TALK 1: DYNAMIC FRONTO-PARIETAL INTERACTIONS DURING ATTENTIONAL CONTROL

**Sara Szczepanski[1], Rachel Kuperman[2], Kurtis Auguste[2,3], Josef Parvizi[4,5], Robert Knight[1]; [1]University of California, Berkeley [2]Children's Hospital and Research Center, Oakland, CA, [3]University of California, San Francisco, [4]Laboratory of Behavioral and Cognitive Neurology, [5]Stanford University, Stanford**

Attention, critical to visual perception and goal-directed behavior, enables allocation of limited resources depending on current task demands. Frontal and parietal cortical areas, referred to as the fronto-parietal attentional control network, are crucial for controlling the attentional selection process. Although numerous studies have examined the functions of this network using various neuroimaging techniques, considerably less is known about how these frontal and parietal areas interact dynamically to produce behavior on a fine spatio-temporal scale in humans. We examined the temporal dynamics and interactions within and between regions of the fronto-parietal network using electrocorticography (ECoG). ECoG signals were measured directly from subdural electrodes implanted in patients undergoing intracranial monitoring for localization of epileptic foci. Subjects (n=8) performed a dynamic reaction time task, requiring attentional allocation to either the right or left visual field and detection of targets. Phase-amplitude coupling (PAC) between high gamma power (70-250 Hz) and delta/theta phase (2-5 Hz) within electrodes over frontal, parietal, and occipital cortex increased when subjects attended to the contralateral (vs. ipsilateral) visual field. These PAC modulations tracked attentional performance across single trials. We also found significant increases in phase coherence in the delta (2-4 Hz) and theta (5-8 Hz) frequency bands between intrahemispheric frontal, parietal, and visual electrodes that was enhanced for attention to the contralateral (vs. ipsilateral) visual field. These results highlight the roles of PAC and phase coherence as mechanisms for coordination within and between human fronto-parietal and visual areas, which adjust parameters on a sub-second basis depending on momentary attentional demands.

### TALK 2: SLOW MODULATION OF CROSS-FREQUENCY OSCILLATORY DYNAMICS IN THALAMOCORTICAL NETWORKS

**Peter Lakatos[1,2], Annamaria Barczak[1], Monica O'Connell[1]; [1]Nathan Kline Institute, Orangeburg, NY [2]NYU School of Medicine**

When temporally regular stimulus sequences are attended, the brain's rhythmic excitability fluctuations become aligned to these via oscillatory entrainment, in order to sharpen and stabilize the stimulus representation. The goal of our study was to examine the global, long time-scale dynamics of entrainment in primary auditory cortex and thalamus in non-human primates performing an intermodal selective attention task. For all subjects, neuroelectric activity was recorded simultaneously using two linear electrode arrays positioned either in corresponding primary auditory cortex (A1) regions of the two hemispheres, or auditory thalamic regions and ipsilateral A1. By analyzing changes in layer-specific neuronal ensemble activity of A1 and simultaneous thalamic activity on the timescale of seconds, we identified a counterphase slow (< 0.1 Hz) fluctuation of two discrete thalamocortical operational modes. One of these was characterized by high amplitude delta-theta frequency band neuronal activity, oscillatory entrainment to the attended stimulus stream, stable response amplitudes and good behavioral performance. The other distinct operational mode was characterized by high amplitude alpha oscillations, generally suppressed, more variable event

related responses and poor behavioral performance. We also found that coupling between the amplitude of gamma oscillations and the phase of lower, alpha vs. delta-theta band oscillatory activity followed the same counterphase dynamics, resulting in alpha vs. delta-theta patterning of high frequency neuronal ensemble activity and neuronal firing respectively. We propose that the slow counterphase modulation of oscillatory dynamics in thalamocortical networks reflects intermittent dominance of "task positive" and "task negative" large-scale functional networks in regulating and utilizing information processing resources.

### TALK 3: MULTIPLEXED CROSS-FREQUENCY INFORMATION TRANSFER DURING CONTINUOUS SPEECH PERCEPTION

Hyojin Park[1], Gregor Thut[1], Joachim Gross[1]; [1]Institute of Neuroscience and Psychology, University of Glasgow, Glasgow, United Kingdom

Comprehension of coherent speech entails neural representation from early perceptual processing to higher cognitive functions as a network. Cortical oscillations are promising tools to study this network considering their inherent spectrotemporal characteristics. We previously found that segmentation and coding of speech relies on a nested hierarchy of entrained cortical oscillations. Speech entrains the phase of delta and theta and the amplitude of gamma oscillations in the auditory cortex. Importantly, phase entrainment is stronger in the right auditory cortex and amplitude entrainment is stronger in the left auditory cortex. Based on this asymmetry, we further investigated top-down directional information transfer on left and right auditory cortices (LAC and RAC) using transfer entropy. MEG data from 22 participants was obtained during passive listening to a 7-minute real-life story (intelligible speech) and the same story played backward (unintelligible speech). We performed transfer entropy analysis within and between the relevant frequency bands (delta, theta, gamma) and identified cortical regions of information transfer that was significantly stronger in intelligible than unintelligible speech. Our results revealed that delta phase in the left inferior frontal gyri including BA44/45/47 regions and right temporal regions modulated delta phase in LAC. Interestingly, the left hemisphere delta phase results match information transfer from gamma to delta phase in LAC, and the right hemisphere delta phase results match information transfer from theta to delta phase in LAC. This suggests that multiplexed directed interactions between entrained brain oscillations across cortical areas could be an important mechanism for cortical processing of continuous speech streams.

### TALK 4: HOW COUPLED ALPHA AND GAMMA OSCILLATIONS MIGHT SERVE TO ALLOCATE ATTENTION

Ole Jensen[1], Eelke Spaak[1], Bart Gips[1], Til Ole Bergmann[1], Mathilde Bonnefond[1]; [1]Donders Centre for Cognitive Neuroimaging, Radboud University, The Netherlands

In our daily lives we are bombarded with sensory input. Thus networks in the brain must rely on powerful mechanism for limiting and prioritizing the input flow in order to prevent information overload. In the rat hippocampus, it is well established that neurons representing different spatial representations fire at different phases of the theta cycle. This mechanism limits the information presented by producing sweeps of spatial representations organized according to excitability. Similarly, we hypothesize that alpha oscillations provide a mechanism for ordering visual input according to 'relevance'. This alpha band activity is under top-down control. Gamma oscillations phase-locked to the alpha oscillations serve to keep competing representations apart in time. Further, neuronal synchronization in the gamma band provides a strong feed forward drive. As a result sweeps representing short 'to-do-lists' organized as a temporal phase code is produced in every alpha cycle. Empirical support for such a mechanism will be discussed. These studies are based on MEG in humans performing various kinds of cross-model, memory and spatial attention task. Further empirical support includes findings in non-human primates. Finally predictions and future work required for testing the framework will be discussed.

## Mini-Symposium Session 9

### FRESH PERSPECTIVES ON SOCIAL PERCEPTION: FROM FUNCTIONAL SPECIALIZATION TO CONNECTIVITY

**Tuesday, March 31, 10:00 am - Noon, Grand Ballroom B/C**

**Chair: Emily S. Cross, Radboud University Nijmegen, Bangor University**

**Speakers: Kami Koldewyn, Emily S. Cross, Zeynep Saygin**

Over the past decade, a growing interest in the neurobiological foundations of how we perceive and interact with others has emerged. While the idea of a "social brain" is not new (c.f., Brothers, 1990), the past several years have seen ever-increasing neuroimaging studies seeking to map the neural correlates of myriad social perceptual processes, ranging from how we perceive bodies or faces to how we make sense of others' actions and social interactions. This minisymposium highlights three novel findings in this domain, each stemming from a distinct methodological approach. Kami Koldewyn introduces the discovery of a portion of the superior temporal sulcus specialized for perceiving dynamic social interactions. This region was identified with targeted functional localization scans, which confirm this region to be distinct from nearby brain areas sensitive to other social perceptual cues, including biological motion, faces, and bodies. Emily Cross highlights how effective connectivity approaches, such as dynamic causal modeling, offer new ways to test models of social action perception. Her work uses DCM to evaluate a predictive coding model of action observation and demonstrates how familiarity alters effective connectivity between sensorimotor cortical regions. Finally, Zeynep Saygin uses structural connectivity and resting-state functional connectivity to explore functional specialization for several social perceptual fea-

tures, including faces, bodies, and theory of mind. Her data provide converging evidence for a tight link between functional and anatomical connectivity and function. Together, the presentations emphasize how different methodological approaches can complement each other and together fuel novel discoveries in the social perception domain.

## TALK 1: IS A REGION IN THE POSTERIOR SUPERIOR TEMPORAL SULCUS (PSTS) SELECTIVELY ENGAGED IN THE PERCEPTION OF SOCIAL INTERACTIONS?

**Kami Koldewyn[1], Sarah Weigelt[2], Kilian Semmelmann[2], Nancy Kanwisher[3]; [1]Bangor University, [2]Fakultät für Psychologie, Ruhr-Universität Bochum, [3]Massachusetts Institute of Technology**

Successful social behavior requires the ability to perceive not just individuals and their behavior, but pairs of people and the interactions between them. Social interactions are multifacted, subtle, and important. We can quickly discern if two people are cooperating or competing, flirting or fighting, and helping or hindering. The brain basis of this remarkable ability has remained largely unexplored. Here, using fMRI, we show that a region in the superior temporal sulcus, identifiable in the majority of subjects individually with a short functional localizer scan, responds about twice as strongly when viewing pairs of people interacting with each other compared to pairs of people acting independently. This selective response to seeing social interactions is unlikely to be accounted for in terms of simple perceptual features because the same region responds more to interactions than independent actions whether the agents are people depicted in video clips, people in point-light displays, or simple animated shapes. This functional response is nearby but both distinct from, and not explainable by, previously reported cortical responses to biological motion, faces, and other people's thoughts. Although the precise computations conducted and representations extracted in this region remain to be discovered, our evidence points to a specialized role of this region in the perception of dynamic social interactions.

## TALK 2: THE MODULATION OF SENSORIMOTOR CONNECTIVITY BY FAMILIARITY DURING ACTION OBSERVATION

**Emily S. Cross[1,2], Thomas Gardner[2]; [1]Behavioural Science Institute; Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, [2]School of Psychology, Bangor University**

Watching another person's actions engages a network of sensorimotor brain regions collectively termed the action observation network (AON). Previous research suggests the AON is more active when watching familiar compared to unfamiliar actions. More recent evidence suggests the relationship between AON engagement and action familiarity is not as straightforward as previously thought, leading to a re-examination of how an observer's prior action experience shapes perception of others in motion. We examined how observed movement familiarity modulates connections between sensorimotor brain regions using dynamic causal modeling (DCM), a type of effective connectivity analysis. Twenty-one subjects underwent fMRI scanning whilst viewing whole-body movements that varied in terms of their familiarity. Participants' task was to either predict the next posture the dancer's body would assume or to respond to a non-action related attentional control question. To assess individuals' familiarity with each movement, participants rated each video on a measure of visual familiarity outside the scanner. Parametric analyses showed more activity in left middle temporal gyrus, inferior parietal lobule and inferior frontal gyrus as the videos were rated as increasingly familiar. These clusters of activity formed the regions of interest for DCM analyses, which revealed an attenuation of top-down modulation (influence from anterior to posterior nodes of the AON), as well as attenuation in the corresponding reciprocal connection when participants observed videos rated as more familiar. The findings provide support for a predictive coding model of AON function, as well as illuminate how effective connectivity approaches can advance understanding of social action perception.

## TALK 3: CONNECTIVITY FINGERPRINTS FOR THE SOCIAL BRAIN

**Zeynep Saygin[1,2], David E. Osher[1,3], Kami Koldewyn[4], John Gabrieli[1], Rebecca Saxe[1], Nancy Kanwisher[1]; [1]Brain and Cognitive Sciences, MIT, [2]Martinos Center, MGH, [3]Department of Psychological and Brain Sciences, Boston University, [4]School of Psychology, Bangor University**

A fundamental hypothesis in neuroscience is that connectivity mirrors function at a fine spatial grain across the brain. Previous research supports this hypothesis by demonstrating that the degree of voxelwise face-selectivity in the fusiform gyrus of individual subjects can be predicted from that voxel's connections to the rest of the brain (its unique connectivity fingerprint), measured through diffusion-weighted imaging (DWI). Here we asked whether resting-state functional connectivity (fcMRI) can also predict face-selectivity in the fusiform, whether structural or functional connectivity fingerprints also predict other visual selectivities throughout the brain, and whether connectivity fingerprints exist for higher-level social cognition. We found that both fcMRI and DWI connectivity predicted face selectivity in the fusiform more accurately than did a group analysis of face-selectivity from other subjects. Further, the subset of connections that best predicted face-selectivity were similar between DWI and fcMRI. We performed similar comparisons of DWI and fcMRI connectivity fingerprints for the rest of cortex, for body, object, and scene perception, and for theory-of-mind activation. These data provide converging evidence from both DWI and fcMRI that i) connectivity and function are tightly linked at a voxelwise scale across the whole brain, and ii) functionally-selective voxels can be predicted from either DWI or fcMRI data alone. These results also raise the possibility that connectivity fingerprints direct the functional specialization of cortex in development. Finally, this work provides researchers and clinicians with tools to infer functional brain maps from connectivity alone in individuals who cannot be functionally scanned (e.g., comatose subjects, sleeping infants).

# Poster Schedule

Poster sessions are scheduled for Saturday-Tuesday in Pacific Concourse Exhibition Hall of the San Francisco Hyatt Regency. All attendees must present their CNS 2015 name badge to enter the exhibit hall. Do not leave personal items in the poster room.

The presenting author must be present during the assigned session. You may post your materials on the board assigned to you at any time after the "Set-up Begins" time (listed below), but before the beginning of the assigned poster session. You must remove your poster promptly no later than the time listed above in "Take-down Complete." Any posters left up after the "Take-down Complete" time may be discarded.

Note that presenters are asked to set up poster in advance of their session and to leave their poster up for a period following their session (see your specific session for hours). This is to allow attendees to view posters outside the formal session times.

Only registered poster presenters, wearing a CNS 2015 meeting badge, for the current session and exhibitors will be allowed in the exhibit hall during set up and take-down hours. All other attendees will be turned away at the door. No attendee or exhibitor will be allowed to enter the exhibit hall after the Closed for the Day- No Entry hours.

| Poster Session | Date | Setup Begins | Session Begins | Session Ends | Take-Down Completed |
|---|---|---|---|---|---|
| A | Saturday, March 28 | 3:00 pm* | 3:30 pm | 5:30 pm | 5:45 pm |
| B | Sunday, March 29 | 7:30 am* | 8:00 am | 10:00 am | 12:30 pm |
| C | Sunday, March 29 | 12:30 pm* | 3:30 pm | 5:30 pm | 5:45 pm |
| D | Monday, March 30 | 7:30 am* | 8:00 am | 10:00 am | 12:30 pm |
| E | Monday, March 30 | 12:30 pm* | 1:30 pm | 3:30 pm | 5:00 pm |
| F | Monday, March 30 | 5:00 pm | 5:30 pm | 7:30 pm | 7:45 pm |
| G | Tuesday March 31 | 7:30 am* | 8:00 am | 10:00 am | 12:00 pm |

* Please note that only scheduled registered poster presenters may enter the exhibit hall during the half hour set-up time. All other attendees may only enter when the exhibit hall opens.

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## People's Choice Poster Award

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# Poster Session A

## ATTENTION: Auditory

### A1

**SEARCHING FOR MULTIPLE AUDITORY TARGETS** Marissa L. Gamble[1], Marty G. Woldorff[1]; [1]Duke University — Navigating our complex auditory world requires the selection of relevant auditory stimuli from the irrelevant. One mechanism that may enable this process to occur rapidly is the creation of a template of the relevant auditory stimulus, to which incoming stimuli are compared. Previously, we reported an Early Bilateral EEG Negativity (EBN) ~60 ms post-stimulus indicating rapid identification of designated-target deviant sounds (Gamble & Woldorff, In press). This occurred prior to the orientation of attention towards the target (N2ac, Gamble & Luck, 2011) and does not occur when the target is presented alone, suggesting a formation of a "relational template". Our template-capacity limitations and the influence of the presence of multiple deviants on the processing of relevant deviants are unknown. Here, as in our previous studies, trials consisted of 10 tones rapidly presented to the left and right ears. To address the template-capacity limitations, two Search Conditions were employed: Single-Search where only one deviant tone was relevant, and Dual-Search, where two deviant tones were relevant. To address the influence of multiple deviants, two trial types were employed: One-Deviant trials where only one of the 10 tones was a deviant, and Two-Deviant trials, where two were deviants. Participants were slower in the Dual-Search versus Single-Search condition, although no difference in the EBN suggests a longer-latency source of the behavioral effect. In contrast, the presence of multiple deviants seemed to reduce the Two-Deviant-trial EBNs, indicating that the presence of a second salient or deviant stimulus may interfere with rapid identification and processing.

### A2

**THE EFFECT OF ATTENTION ON CORTICAL SENSORY WAVEFORMS, THE P1-N1-P2 AND T-COMPLEX, IN POLISH AND ENGLISH LISTENERS** Monica Wagner[1], Valerie Shafer[2], Mitchell Steinschneider[3]; [1]St. John's University, Queens, New York, [2]The Graduate Center, City University of New York, [3]Albert Einstein College of Medicine, Bronx, New York — Selective attention modulates the P1-N1-P2 and T-complex, components of the auditory evoked potentials (AEPs), through long-range input from networks supporting attention. Our previous work revealed that the P1-N1-P2 and T-complex index cortical representation of the time-varying spectro-temporal features of the spoken word. Currently, we investigate whether selective attention enhances feature detection at early cortical stages of processing in native-English and native-Polish listeners. Auditory-evoked potentials (AEPs) were recorded from two groups of English and Polish participants while they listened to nonsense words pairs within two testing sessions separated by two months or more. In one of the testing sessions, participants performed a syllable identification task to the second word in the pairs and in the alternate session, they did not engage in a behavioral task. Testing sessions were counterbalanced across the two subject groups. AEPs to the first word in the word pairs were analyzed. Results reveal a processing negativity within the P1-N1-P2 and T-complex patterns for the behavioral task condition, in both counterbalanced participant groups. However, representation of spectro-temporal feature processing remains unchanged for all testing conditions irrespective of attention. Results identify spectro-temporal feature representation within sensory waveforms for varying task conditions, which is necessary as the P1-N1-P2 and T-complex patterns may serve as phenotypic markers identifying auditory deficits in feature processing.

### A3

**TWO'S COMPANY, BUT MORE'S A PARTY: THETA-BAND TRACKING IN THE COCKTAIL PARTY** Dillon Hambrook[1,2], Matthew Tata[1,2]; [1]University of Lethbridge, [2]Canadian Centre for Behavioural Neuroscience — Crowded acoustic environments pose a difficult computational problem, yet your brain is able to select a single stream of sounds from a mixture of competing sounds with ease. This is the cocktail party problem. Endogenous oscillations have been hypothesized to facilitate communication between brain areas supporting memory, decision making, and response planning. Neural oscillations are also influenced by exogenous stimuli like speech. Low frequency (3-8 Hz) electroencephalogram activity tracks quasi-periodic changes in the energy envelope of speech. This tracking is enhanced for attended speech. One theory suggests that selective entrainment of neuroelectric activity to the acoustic dynamics of a single stream gives that stream privileged access to synchronized networks which are the substrates for encoding memories, planning responses and making decisions. In this model, competing inputs are unsynchronized and are thus excluded from the dominant network. Evidence from experiments with two competing talkers suggests that selective entrainment may be a mechanism by which the brain solves the cocktail party problem; however, it is unclear how such a mechanism functions in more crowded environments. Using a multi-speaker virtual-reality audio system we simulated a 'cocktail party' with up to seven simultaneous speakers at distinct locations while listeners engage in a selective listening task. By cross-correlating the EEG response with signals derived from the dynamics of individual acoustic streams we identify phase-locked activity unique to each stream. We show reduced phase-tracking of the target stream as distractors are added to the scene. Furthermore, phase-locked power differentiates correctly and incorrectly encoded targets.

### A4

**SELECTIVE ATTENTION TO MEMORY REPRESENTATIONS OF AUDITORY OBJECTS** Sung-Joo Lim[1], Jöran Lepsien[1], Malte Wöstmann[1], Jonas Obleser[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences — Selective attention is known to facilitate perceptual processing as it enhances the precision of stimulus encoding into working memory. While most of attentional modulation on perceptual processing is investigated within the visual domain, it is less clear how neural mechanisms of selective attention can modulate auditory processes. Furthermore, is selective attention equally effective in highlighting representations already encoded into auditory working memory? Here, we used a retrospective cue in an auditory pitch-change-detection task to examine the effect of object-based selective attention during memory retention. On each trial, 17 adult listeners (20–30 years) encoded two sequentially presented syllables that were equally task-relevant. In some trials, a cue was given during maintenance to indicate which of the syllables in memory would be probed at the end of the trial. We found that orienting attention to a specific item in memory led to effective selection of the attended syllable (faster response) and improvement (higher accuracy) in detecting its precise acoustic change. Psychophysical modeling results also demonstrated a trend towards improved perceptual precision of the cued item in working memory. Underlining the inherently sequential nature of auditory information, sequential position of a to-be-probed syllable during encoding modulated the representational quality: When probing auditory syllables that had been followed by a second syllable during encoding, there was a significant detriment in performance. The results suggest that the precision of auditory object representations in working memory can be enhanced by selective attention, but it is not entirely robust to perceptual interference.

### A5

**LATERALIZED ALPHA OSCILLATIONS REFLECT ATTENTIONAL SELECTION OF SPEECH IN NOISE** Malte Wöstmann[1,2], Björn Herrmann[1], Burkhard Maess[3], Jonas Obleser[1]; [1]Max Planck Research Group "Auditory Cognition", Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany, [2]International Max Planck Research School on Neuroscience of Communication, Leipzig, Germany, [3]MEG and Cortical Networks Unit, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany — When attention is directed to particular objects in the left or right half space, neural alpha oscillations (~10 Hz) increase in the ipsilateral and decrease in the contralateral cerebral hemisphere. This alpha lateralization has been evidenced in anticipation of visual and somatosensory stimulation. It is

less clear whether (1) alpha lateralization can also index spatial attention to one of two ongoing speech streams, and whether (2) alpha lateralization temporally aligns with the presented speech signal. In a magnetoencephalography (MEG) study, human participants listened to two streams of four spoken digits each. To increase task difficulty, both streams were spoken by the same talker, presented concurrently to both ears, and precisely aligned to the same word rate of 0.67 Hz. Participants were cued on each trial to attend to the stream on one ear and to ignore the other. Following acoustic stimulation, participants had to report the digits from the to-be-attended stream by choosing from a visual array of digits. Indicating significant stream interference, participants reported more digits from the to-be-ignored stream compared to random digits that did not occur in either stream. In the MEG, we found that alpha oscillations during acoustic stimulation increased ipsi- and decreased contralaterally to the attended stream. Notably, alpha lateralization fluctuated at the 0.67-Hz word rate and the magnitude of the 0.67-Hz fluctuations was reduced in erroneous trials. The current findings show that the temporal alignment of alpha power lateralization with speech reflects the attentional selection of target speech against a distractor.

### A6

### OLDER AND YOUNGER ADULTS CAN REDUCE THE COCKTAIL PARTY EFFECT BY LISTENING WITH THE RIGHT EAR

Lisa Payne[1], Chad Rogers[2], Sujala Maharjan[1], Arthur Wingfield[1], Robert Sekuler[1]; [1]Brandeis University, [2]Washington University — Auditory attention is crucial to the ability to selectively listen to a single speech stream in a multi-source environment. The difference in parietal EEG alpha (8-13 Hz) power across hemispheres can indicate the direction of auditory attention (Kerlin et al, 2010; Frey et al, 2014). It is not known if decreased modulation of attention-related alpha plays a role in the difficulty in hearing that older adults often experience in a noisy environment. The effect of directed attention on the ability of adults to selectively filter out distracting information was assessed in a dichotic listening task. Subjects were cued to attend to the left or right before listening to streams of four unrelated words presented to each ear. They then indicated whether a spoken probe word had been a member of to-be-attended stream. In young adults, attend-right trials had greater parietal and right-temporal alpha activity than attend-left trials. Older adults showed a weaker instantiation of this pattern. The attend-right bias evident in the alpha oscillations was also observed in the behavioral data. Both groups were more accurate when attending right; both made more false alarms to a word from the unattended stream when attending left. Older adults showed partial modulation of cortical alpha, and were more likely to false alarm to a word from the unattended stream, particularly when attending left. We hypothesize that the right-ear bias during directed attention to streams of spoken words reveals an interaction between spatial attention and the dominance of the left hemisphere for processing language.

## ATTENTION: Spatial

### A7

### SALIENT SOUNDS ACTIVATE VISUAL CORTEX: DISENTANGLING AUTOMATIC AND VOLUNTARY EFFECTS WITH EVENT-RELATED POTENTIALS

John J. McDonald[1], Alannah T. Wallace[1], Ashley C. Livingstone[1], Viola S. Störmer[2], Wenfeng Feng[3], Steven A. Hillyard[3]; [1]Simon Fraser University, Canada, [2]Harvard University, [3]University of California San Diego — Salient peripheral sounds trigger a contralateral event-related potential (ERP) positivity over the occipital scalp. This auditory-evoked contralateral occipital positivity (ACOP) is present even when the eliciting sound is task-irrelevant, suggesting that it is caused by the automatic deployment of visual attention to the location of the sound. Here, we tested this automatic-ACOP hypothesis in a cross-modal cueing task by varying the predictive nature of a lateral auditory cue. The cue was followed after 1000 ms by a masked visual target, and in different conditions, 80% of targets appeared at the location of the cue (predictive-cue blocks) or at a mirror-symmetric location on the opposite side of fixation (counter-predictive-cue blocks). Participants were instructed to attend to the most probable target location and to discriminate the identity of the target regardless of its location. In the predictive-cue condition, the ACOP was present 250–500 ms post-cue and was followed by a sustained contralateral occipital negativity previously linked to the voluntary deployment of attention (called biasing-related negativity, BRN). If the automatic-ACOP hypothesis is correct, the ACOP should remain positive in the counter-predictive cue condition – that is, even when the task is to voluntarily re-direct attention to the opposite side of fixation. Our findings supported this prediction: the ACOP polarity was unaffected by the predictive nature of the cue (while the BRN became more positive in the counter-predictive cue condition). Thus, the present study helps to disentangle the automatic ACOP from occipital activations driven by the voluntary deployment of visual attention.

### A8

### RESPONSE SELECTION DOES NOT CONTRIBUTE TO INHIBITION OF RETURN

Edmund Wascher[1], Sven Hoffmann[2], Daniel Schneider[1]; [1]IfADo - Leibniz Research Centre for Working Environment and Human Factors, [2]German Sport University Cologne — Inhibition of return means delayed responses for targets at a cued compared to targets at uncued locations. It is assumed to reflect delayed re-allocation of attention towards a previously attended location. Besides an attentional mechanism, IOR could also be due to a cue-evoked inhibition to respond towards a cued target. In the present study, IOR with simple, compatible and incompatible choice responses were compared and tracked by means of event-related EEG activity. Cueing effects were evaluated for 8 intervals between cue and target, from 80 ms to 1240 ms. IOR was amplified with simple responses but did not differ between compatible and incompatible responses. Attention related ERP correlates were constant across CTOAs as were in parts behavioral effects. Early, rather sensory ERP components, varied with time, reflecting sensory or attentional interaction of cue and target processing. All these effects did not vary with response requirements in the choice response tasks, indicating that response selection does not contribute to IOR.

### A9

### FACILITATION AND SUPPRESSION IN OBJECT BASED SELECTIVE ATTENTION

Jane Couperus[1,2], Colin Quirk[1]; [1]Cognitive Science, Hampshire College, [2]Neuroscience and Behavior Program, University of Massachusetts at Amherst — Object-based attention studies have shown that facilitation spreads across objects (Egly, Driver, and Rafal, 1994), enhancing processing of unattended locations on attended objects. More recently, a pilot study suggested that suppression of unattended distractor objects within an attended object may limit the spread of attention (Couperus 2014). However, these initial findings did not account for how the cue location might influence this interaction as the cue location was confounded with the distractor location in several conditions. Thus, this study sought to clarify the role of cue location and distractor suppression in object based attention. Eighteen adults (ages 18-34) completed an object-based attention task similar to Egley et al. (1994). Participants were asked to identify the orientation of a target object at one of four ends of two rectangles. The target location was validly cued on 70% of trials. The remaining 30% of targets were located on either the same object or a different object. As in previous studies, results show the spread of attention across the attended object when no distractor was present ($F(2,34)=8.03$, $p=.003$). However, when a distractor was present participants showed an effect of cue validity ($F(6,102)=3.63$, $p=.031$), but did not show significant spread of attention across the object. Participants were not significantly slower when the target was invalidly cued on a different object as compared to the same object when a distractor was present ($t(17)=-1.52$, $p=.137$). These data indicate that while attention does spread across objects this phenomenon is not as robust in the presence of distractors.

### A10

### THE NEGLECTED LEFT HEMISPHERE: CHRONIC RIGHT NEGLECT ON A LINE BISECTION TASK

Juliana Baldo[1], Francesca Fortenbaugh[1,2,3], Krista Schendel[1], Lynn Robertson[1,2], Nina Dronkers[1,4]; [1]VA Northern California Health Care System, Martinez, CA, [2]Department of Psychology, University of California, Berkeley, CA, [3]Veterans Affairs Boston Healthcare System, MA, [4]Department of Neurology, University of California, Davis, CA — Research on visual neglect has typically focused on the identification of regions within the right hemisphere which, when damaged, lead to visual-spatial and attentional deficits. However, neuroimaging studies in healthy individuals have reported bilateral activation in parietal regions during visual-spatial tasks.

These results, in conjunction with observations that neglect symptoms can and do occur following left hemisphere damage, suggest a potentially critical role for the left hemisphere in visual-spatial processing. Here, we present the results of 98 chronic left hemisphere stroke patients who performed a line bisection task as part of the Western Aphasia Battery. Utilizing a voxel-based lesion symptom mapping (VLSM) approach, we found that a leftward bias in line bisection (i.e. right-sided neglect) was most critically associated with a small region of left posterior inferior parietal cortex, at the superior border of the angular gyrus. This finding remained when we covaried for the degree of patients' overall aphasia severity, suggesting that the result could not be attributed to language impairment. This is the first large-scale VLSM study of hemispatial neglect in chronic left-hemisphere stroke patients, and the results demonstrate a critical role of left posterior inferior parietal cortex in the veridical perception of linear extent. While it is well established that the most profound and long-lasting neglect symptoms are observed in right hemisphere patients, these results suggest that, just like strategies for treating visual neglect, it is time for researchers to draw their attention to the left.

### A11

**MIGRAINEURS AND THEIR ATTENTION TO VISUAL EVENTS DURING MIND WANDERING** Julia W. Y. Kam[1], Marla J. S. Mickleborough[2], Chelsea Eades[1], Todd C. Handy[1]; [1]University of British Columbia, [2]University of Saskatchewan — Although migraine is traditionally categorized as a primary headache disorder, the condition is also associated with pathologies in visual attentional function that persist in-between headache events. Namely, relative to controls, migraineurs show both a heightened sensitivity to nominally unattended visual events, as well as decreased habituation responses at sensory and post-sensory (cognitive) levels. Here we used event-related potentials (ERPs) to examine whether cortical hypersensitivities in migraineurs extend to mind wandering, or periods of time wherein we transiently attenuate the processing of external stimulus inputs as our thoughts drift away from the on-going task at hand. Participants performed a sustained attention to response task (SART) while they were occasionally queried as to their attentional state––either "on-task" or "mind wandering". We then analyzed the ERP responses to task-relevant stimuli as a function of whether they immediately preceded an on-task vs. mind wandering report. We found that despite normative heightened visual sensitivities in our migraine group, they nevertheless manifest a reduced cognitive response during periods of mind wandering relative to on-task attentional states, as measured via amplitude changes in the P3 ERP component. This suggests that our capacity to attenuate the processing of external stimulus inputs during mind wandering is not necessarily impaired by the class of cortical hypersensitivities characteristic of the interictal migraine brain.

### A12

**TOP-DOWN INFORMATION FLOW IN AN ALPHA OSCILLATORY NETWORK DURING VISUOSPATIAL ATTENTION ORIENTING** Nicolas Bedo[1], Sam M. Doesburg[2,3], Lawrence M. Ward[1]; [1]University of British Columbia, [2]Hospital for Sick Children, Toronto, [3]University of Toronto — Neuroimaging and lesions studies indicate that visual attention is controlled by a distributed network of brain areas. The covert control of visuospatial attention has also been associated with retinotopic modulation of alpha-band oscillations within early visual cortex, which are thought to underlie inhibition of ignored areas of visual space. The relation between distributed networks mediating attention control and more focal oscillatory mechanisms, however, remains unclear. We localized brain areas involved in visuospatial attention orienting using magnetoencephalographic (MEG) imaging and investigated frequency-specific Granger-type causal interactions among activated regions using transfer entropy. Deployment of attention to one side of visual space was associated with greater top-down information flow in the alpha-band between various brain areas involved in attention control and early visual areas ipsilateral to the attended location. These results indicate that distributed network interactions mediated by alpha oscillations exert top-down influences on early visual cortex to promote inhibition of processing for ignored areas of visual space.

### A13

**NEURAL CORRELATES OF VOLUNTARY VISUOSPATIAL ATTENTION VARY WITH READING ABILITY** Jessica Green[1], William Brixius[1], Kristina Drake[1], Taylor Ryan[1]; [1]University of South Carolina — Attentional deficits are common in reading disabilities, including reduced orienting responses, difficulty suppressing peripheral information, and decreases in executive function. However, the interaction between reading ability and attention in individuals without such learning disabilities remains unclear. Studies of visuospatial attention often report reading-direction biases in task performance at the group level, with better performance for targets appearing on the right for left-to-right readers, but individual differences in these processes have not been examined. Here, we had participants complete a variety of measures pertaining to reading ability, reading habits, and ADHD, and then perform a classic voluntary visuospatial cueing task while we recorded their EEG. We then examined the relationship between individual differences in reading ability and differences in behavioural and electrophysiological correlates of attentional control. Reading ability correlated with a host of attention-related processes, including hemispheric asymmetries in sensory processing, amplitude of fronto-parietal control activity, suppression of the to-be-ignored side of space, and location biases in target processing. Overall, neural activity diverged for leftward and rightward shifts of attention for good readers but not for poorer readers, with downstream consequences for target processing. Our results show that even within a high-functioning university student population, variability in reading skills can lead to substantial differences in basic attention skills and their neural correlates.

## EMOTION & SOCIAL: Development & aging

### A14

**MENTAL ROTATION FOR ASD AND PERSPECTIVE TAKING FOR TD IN IMITATION** Masahiro Kawasaki[1], Hidetsugu Komeda[2], Toshiya Murai[3], Yasuko Funabiki[3]; [1]Department of Intelligent Interaction Technology, Graduate School of Systems and Information Engineering, University of Tsukuba, [2]Hakubi Center, Kyoto University, [3]Department of Psychiatry, Graduate School of Medicine, Kyoto University — Autism spectrum disorder (ASD) is known to be difficult to communicate with others. To address the issue about what leads to the communication disorders, we focused on a movement imitation and compared the performance and neural activity between the ASD and typical development (TD) subjects. Eighteen TD and 18 ASD subjects participated in electroencephalograph (EEG) experiments. In the task, both right and left hands were presented in PC display. Either right or left hand tapped a key, and then subjects must imitate the movement with the same hand as soon as possible. Each subject completed 3 sessions. In the first session, they performed the task without the instruction of the strategy. After that, we asked subjects about the strategy. In the second and third sessions, they performed the task with the same and different strategies from the first session, respectively. As the results of the interviews and reaction times, most ASD subjects used mental rotation where they rotated the representations of PC's hands and superimposed them with their hands in their minds. In contrast, most TD subjects used perspective taking where they superimposed the representation of their hands to PC's hands from other view in their minds. Moreover, the ASD subjects' performance for using different strategy (third session) was worse than using the same strategy (second session). EEG results showed the modulations of the frontal activity in the ASD subjects, which suggested that the ASD subjects used the egocentric strategy and the frontal executive systems in the movement imitations.

### A15

**THE RELATIONSHIP BETWEEN GESTURES AND LANGUAGE IN ADULTS WITH WILLIAMS SYNDROME** Philip Lai[1,2,3], Talent V. Dang[1], Ursula Bellugi[1], Judy Reilly[3]; [1]The Salk Institute for Biological Studies, [2]University of California, San Diego, [3]San Diego State University — Williams Syndrome (WS) is a genetic disorder with a unique cognitive profile characterized by hyper-sociability. Spoken language has been found to be a strength of the syndrome. One particular mode of communication that has not been inves-

tigated is the use of communicative gestures in adults with WS. Previous research in children with WS has found fewer gestures produced than their peers. This study examines gestures and their complexity in 13 adults with WS and 10 typically developing (TD) adults. Gestures were coded for unimanual versus bimanual and complexity (simple vs. complex). Complex gestures were further categorized by movement, hand shape, and orientation. There were no differences in length of interview. The TD group on average produced almost twice as many gestures as the WS group (p=.05). Furthermore, the use of unimanual gestures was similar, but the TD group used more bimanual gestures (p=.01). For complexity, there was no difference in the use of simple gestures, but the TD group produced more complex gestures (p=.02). A comparison of complex gestures showed no differences for hand shape, but significant differences in movement (p=.02) and orientation (p=.01) with the TD group using more. Although very gregarious, individuals with WS are less likely to utilize communicative gestures along with their speech. This reduced use of gestures may persist throughout development in the WS group, as they rely more on the spoken channel than other aspects of communication.

## A16

### LOW ANTERIOR CINGULATE THICKNESS ASSOCIATED WITH IRRITABILITY IN 4-7 YEAR OLD CHILDREN

Maria Kharitonova[1], Joel Voss[1], Jonathan O'Neal[1], Margaret Briggs-Gowan[2], Lauren Wakschlag[1,3]; [1]Northwestern University Feinberg School of Medicine, Chicago, IL, [2]University of Connecticut Health Center, Farmington, CT, [3]Institute for Policy Research, Northwestern University, Evanston, IL — Severe irritability is both prevalent (occurring in 3% of the general population) and predictive of psychopathology across the lifespan. Although severe irritability begins in childhood, detailed understanding of its neuroanatomical components and consequences for developmental outcomes are lacking. One possibility is that severe irritability is associated with abnormal development of prefrontal regions involved in emotional regulation, including primarily medial prefrontal and anterior cingulate cortex. Here we examined this hypothesis by analyzing prefrontal structure using MRI in 4.5-7.5 years old children with extremely high (above 80th percentile; N = 20) and low (below 40th percentile; N=18) scores on the Temper Loss scale of the Multidimensional Profile of Disruptive Behavior (MAP-DB), which provides an observational measure of irritability. Cortical thickness of dorsal and rostral right anterior cingulate cortex (ACC) was significantly lower for high versus low temper loss participants, controlling for effects of age ($t(34) = 2.5$, $p = 0.02$ for rostral ACC; $t(34) = 2.0$, $p = 0.05$ for dorsal ACC). These findings are consistent with the growing literature linking ACC to emotion regulation, and advance understanding of the developmental etiology of severe irritability in young children. Follow-up analyses of these data will examine associations between ACC structure and both symptom severity and performance on a battery of executive-function tests. These findings add to our growing understanding of how the structural maturation of the brain relates to developmental and clinical phenotypes.

## A18

### SOCIOECONOMIC STATUS PREDICTS PREFRONTAL CORTEX VOLUME ACROSS THE LIFESPAN: A BIG DATA, CROSS-SECTIONAL MRI STUDY

Katherine Swett[1], Yuankai Huo[1], Elyce Williams[3], Susan Resnick[2], Bennett Landman[1], Laurie Cutting[1]; [1]Vanderbilt University, [2]National Institute on Aging, [3]Hunter College — Socioeconomic status (SES) is well-established as a critical predictor of many cognitive and clinical outcomes, including language ability, memory, and cognitive control. Neuroimaging studies have found that across age groups, lower SES is associated with lower whole brain volume, as well as decreased gray matter volume (GMV) in regions key to these cognitive deficits: prefrontal cortex (PFC) and hippocampus. Despite a critical link between SES and these specific brain structures, no studies to date have done a cross-sectional examination of SES and PFC volume across the lifespan. In this study, we performed a cross-sectional analysis of GMV for over 5000 subjects ranging in age from 5-85. The gray matter segmentation was conducted by a whole-brain (133 label) multi-atlas segmentation framework, which used the Advanced Normalization Toolkit (ANTs) with SyN image similarity criteria in registration and Non-local STAPLE in label fusion. Results from age predictions of whole-brain GMV replicated those found by previous groups, with increased volume until adolescence, followed by post-adolescent decrease. In a subpopulation of subjects (n=1950) findings showed that age, sex, and SES (as defined by education level) significantly predicted at least 20% of volume in each PFC region of interest, accounting for over 50% of variance in bilateral middle frontal gyrus. When controlling for age and sex, education significantly predicted more than 5% of variance in superior frontal gyrus gray matter, and 1-3% of variance in other prefrontal areas. These findings confirm the critical role of SES in PFC gray matter volume across the lifespan.

## A19

### PERCEIVED STRESS AND UNCINATE WHITE MATTER INTEGRITY IN OLDER ADULTS

Christa Watson[1], Nihar Patel[1], Matthew Wynn[1], Joel H. Kramer[1], Brianne M Bettcher[1]; [1]University of California, San Francisco — Chronic, perceived stress has been linked with negative health outcomes, including cognitive decline. Recent data has linked cortisol levels with greater diffusivity in the uncinate fasciculus and the inferior longitudinal fasciculus (ILF) in mildly stressed older men. Limited information exists, however, on the association between perceived stress and white matter integrity in older adults and whether this relationship is independent of depressed mood. 101 normal older adults (Mean Age (SD) = 72.3 (6.3)) underwent a 3.0T MRI diffusion tensor brain scan and completed self-report measures on depression (Geriatric Depression Scale; GDS) and perceived stress (Perceived Stress Scale, PSS). DTI regions of interest (uncinate: left and right; ILF: left and right ) were constructed from the JHU ICBM-DTI-81 white matter labels and mean fractional anisotropy (FA) was extracted using FSL. Partial correlation analyses between ROI FA values and the PSS were run with age, education, gender, and GDS as control variables. The PSS was inversely correlated with FA in both the left and right uncinate, independent of demographics and depression scores (left: $r = -.19$, $p = 0.05$; right: $r = -.24$, $p = .02$). The ILF was not significantly correlated with perceived stress (left: $p = .44$; right: $p = .73$). In conclusion, chronic, perceived stress is associated with poorer white matter microstructure in the uncinate in a cohort of community-dwelling older adults, independent of self-report depressive symptoms. The uncinate may be differentially associated with perceived stress given that it connects prefrontal and temporal cortices, regions identified in stress literature.

## A20

### ALTERED NETWORK CONNECTIVITY IN FRONTOTEMPORAL DEMENTIA WITH C9ORF72 HEXANUCLEOTIDE REPEAT EXPANSION.

Suzee E Lee[1], Anna M Khazenzon[1], Andrew J Trujillo[1], Christine C Guo[1], Jennifer S Yokoyama[1], Sharon J Sha[1], Leonel T Takada[2], Anna M Karydas[1], Nikolas R Block[1], Giovanni Coppola[3], Mochtar Pribadi[3], Daniel H Geschwind[3]; [1]University of California, San Francisco, [2]University of Sao Paulo, [3]University of California, Los Angeles, [4]Mayo Clinic — Hexanucleotide repeat expansion in C9orf72 represents the most common genetic cause of familial and sporadic behavioral variant frontotemporal dementia (bvFTD). Previous studies show that some C9orf72 carriers with bvFTD exhibit distinctive atrophy patterns whereas others show mild or undetectable atrophy despite severe behavioral impairment. To explore this observation, we compared intrinsic connectivity network integrity in 14 bvFTD, 14 sporadic bvFTD, and 14 healthy controls. Both patient groups included five patients with comorbid motor neuron disease. Voxel-based morphometry delineated atrophy patterns, and seed-based intrinsic connectivity analyses enabled group comparisons of the salience, sensorimotor, and default mode networks. Despite contrasting atrophy patterns in C9orf72 carriers versus non-carriers, patient groups showed topo- graphically similar connectivity reductions in the salience and sensorimotor networks. Patients without C9orf72 expansions exhibited relative increases in default mode network connectivity compared to controls and mutation carriers. Across all patients, behavioral symptom severity correlated with diminished salience network connectivity and heightened default mode network connectivity. In C9orf72 carriers, salience network connectivity reduction correlated with atrophy in the left medial pulvinar thalamic nucleus, and this region further showed diminished connectivity with key salience network hubs. The findings suggest that bvFTD with or without the C9orf72 expansion shows convergent large-scale network breakdowns despite distinctive atrophy patterns. Medial pulvinar degeneration may contribute to the syndrome in C9orf72 carriers

by disrupting salience network connectivity. Task-free functional magnetic resonance imaging shows promise in detecting early- stage disease may provide a unifying biomarker across diverse anatomical variants.

# EMOTION & SOCIAL: Person perception

## A21

### THE ELECTROPHYSIOLOGICAL CORRELATES OF UNCONSCIOUS PROCESSING OF OWN- AND OTHER- RACE FACES

Jie Yuan[1], Shimin Fu[1]; [1]Tsinghua University — Neuroimaging and electrophysiological methods have provided unparalleled access to how race is processed consciously in human brain. The unconscious processing of race, however, is poorly understood, especially its neural underpinnings. In two experiments, we investigated the neural substrates of unconscious processing of own- (Chinese) and other-race (Caucasian) faces using Event-Related Potential. In Experiment 1, we rendered upright faces invisible with Continuous Flash Suppression paradigm. After the unconscious section, a conscious section was conducted as control condition. We found that own-race faces elicited a smaller P1 and a larger N170 component than other-race faces over the occipito-temporal sites. The pattern of P1 component could be interpreted that the other-race faces attract more attention than own-race faces. The larger N170 effect of own-race faces could be due to more expertise and experience with own-race members. The conscious condition elicited similar results. To rule out an alternative account that the low level stimulus differences between own- and other-race faces elicited these effect, we conducted Experiment 2 with inverted faces. The participants had no experience with both inverted own- and other-race faces, meanwhile the physical properties of inverted faces were identical with upright faces. As predicted, we didn't observe any significant results in both unconscious and conscious conditions. In Experiment 2, we ruled out the alternative account. Together, we discovered the electrophysiological correlates of unconscious processing of race for the first time. These neural evidences show that race could not only be processed consciously, but also be processed in our unconscious mind.

## A22

### SPECIFIC HYPOACTIVATION OF RIGHT TEMPORO-PARIETAL JUNCTION IN AUTISM AT THE SOCIALLY AWKWARD MOMENTS OF A SITCOM

Peter C. Pantelis[1], Lisa Byrge[1], J. Michael Tyszka[2], Ralph Adolphs[2], Daniel P. Kennedy[1]; [1]Indiana University-Bloomington, [2]California Institute of Technology — People with autism spectrum disorders (ASD) often have difficulty comprehending social situations in the complex, dynamic contexts encountered in the real world. To study the brain under conditions which approximate naturalistic social situations, we measured brain activity with fMRI while participants watched a full-length episode of the sitcom The Office. Having quantified the degree of social awkwardness at each moment of the episode, as judged by an independent sample of 46 controls, we found that both individuals with ASD (n = 17) and control participants (n = 20) showed reliable activation of a neural system commonly associated with higher-level social inferences (i.e. the "mentalizing network") during the more awkward moments. However, individuals with ASD showed less activity than controls in a region near right temporo-parietal junction (RTPJ) extending into the posterior end of the right superior temporal sulcus (RSTS). Further analyses suggested that, despite the free-form nature of the experimental design, this group difference was specific to this RTPJ/RSTS area of the mentalizing network; other regions of interest showed similar activity across groups with respect to both location and magnitude. These findings add support to a body of evidence suggesting that RTPJ/RSTS plays a special role in social processes across modalities and may function atypically in individuals with ASD navigating the social world.

## A23

### ELECTROPHYSIOLOGICAL CORRELATES OF EMOTIONAL FACE LEARNING IN SOCIAL ANXIETY DISORDER

Claudia Schulz[1], Julian Hagemann[1], Thomas Straube[1]; [1]University of Muenster — Face perception and face recognition are crucial abilities for everyday interactions. Interindividual differences in face learning can also be seen in event-related potential (ERP) correlates of face perception. For people suffering from social anxiety disorder (SAD), with about 12% a highly prevalent disorder, faces constitute a relevant, disorder-related category of stimuli. Patients show attentional and interpretational biases; however, it is not yet clear whether they also display changes in face memory. Moreover, a memory bias could be related to the emotional expression of the face. Therefore, patients with SAD and healthy controls (HC) participated in a learning study of emotional faces (happy, angry, neutral). The EEG was recorded thorough learning and test. Behaviorally, we observed a main effect of emotion on accuracy, response times and signal detection parameters, irrespective of participant group. During learning, we observed P1 and N170 effects of emotion and a tendency of a group effect. In the test phase, an N250 familiarity effect proceeded to LPC, while effects of emotion and group were only marginally present in the current data. These data are generally in line with previous learning studies with emotional faces in healthy controls, but only partially argue for a memory bias for emotional faces in patients with SAD.

## A24

### NEURAL SIGNATURES OF BOTH TRAIT AND VALUE LEARNING GUIDE SOCIAL DECISIONS

Leor M. Hackel[1], Bradley B. Doll[1], David M. Amodio[1]; [1]New York University — Social life involves learning about others through positive or negative experiences. However, in social encounters, people typically look beyond the immediate value of the interaction to also encode higher-level trait attributes, and both factors may influence future social behavior. We designed a functional MRI experiment to dissociate value and trait learning in an economic game: participants (N = 31) made choices to play with one of four individuals who could share money ("Deciders") or with one of four slot machines. Deciders and slots were each associated with different degrees of value (absolute amount of money shared) and generosity (proportion of available money shared), which were uncorrelated. Computational modeling of behavior indicated that participants learned both generosity and value information and used a weighted combination of these to make choices. For both human and slot trials, reward prediction errors during feedback correlated with BOLD signal in ventral striatum, as in past work, while generosity prediction errors correlated with BOLD signal in ventral striatum as well as a broader set of regions previously implicated in social impression updating (ventrolateral prefrontal cortex, posterior cingulate cortex, and inferior parietal lobule; Mende-Siedlecki et al, 2012). Finally, during choice, BOLD signal in ventromedial prefrontal cortex correlated with an expected value signal that integrated value and trait knowledge. This work suggests that learning about people through feedback involves the updating of value representations as well as more abstract trait representations—through neural mechanisms that are not uniquely social—and that the integration of both learning mechanisms supports social decision-making.

## A25

### EXTRAPOLATION OF SOCIAL INFORMATION TO PHYSICALLY SIMILAR INDIVIDUALS CONTRIBUTES TO STEREOTYPING

Brandon Levy[1], Chris I. Baker[1]; [1]Laboratory of Brain and Cognition, National Institute of Mental Health/NIH — Previous evidence demonstrates that social evaluations of a face will transfer to morphed versions of the same face even when the transformed face is perceived as a new identity (Todorov et al., 2010). The current study investigated whether this similarity-driven generalization of social information functions at a group level to induce stereotyping. Morphing software was used to create three different groups of faces with high degrees of within-group similarity. A subset of individuals from each group appeared in an investment game in which they returned or kept money invested with them by the participant. Individuals from one group returned the investment on 80% of trials while those from the other two groups did so on 50% and 20% of trials, respectively. Participants then replayed the game, this time choosing whether to invest with novel individuals from each group while receiving no feedback as to whether each individual returned or kept the investment. Paired t-tests showed that the behavior of the individuals seen in the first investment game substantially influenced the frequency with which participants chose to invest with physically similar individuals in the second game, as well as explicit trustworthiness ratings of those individuals. This effect occurred despite a complete lack of information with which to judge the trustworthiness of the

novel individuals in the second game, suggesting that information about a subset of individuals is readily utilized to create group-level stereotypes that bias evaluations of perceptually similar individuals.

### A26

**ACTIVATION DURING A FACIAL EMOTION OBSERVE/IMITATE TASK AND SOCIAL COGNITIVE PERFORMANCE: AN FMRI ANALYSIS USING PARTIAL LEAST SQUARES.** Colin Hawco[1], Natasa Kovacevic[2], Anil Malhotra[3], Robert Buchanan[4], A. Randal McIntosh[2], Aristotle Voineskos[1]; [1]Centre for Addiction and Mental Health, University of Toronto, [2]Baycrest Geriatric Hospital, University of Toronto, [3]Zucker Hillside Hospital, Hofstra North Shore-LIJ School of Medicine, [4]Maryland Psychiatric Research Center — Social cognition is a fundamental behaviour process. The purpose of the present study was to examine relationships between neural activation during an emotional scanning task with performance on social cognitive measures. Twenty-three healthy participants (age range 18-50) performed a task intended to engage socio-emotional brain networks. Participants observed emotional or neutral faces in one scan, while imitating the faces in another scan during the same session. First, GLM analysis in SPM replicated previous studies using this paradigm, showing bilateral motor and premotor activity and right dominant activity in the inferior frontal and parietal cortex (the right fronto-parietal network). Five social cognitive scores were derived from social cognitive tests (the Penn Emotion Recognition Task, the Relationships Across Domains task, and the 3 parts of the Awareness of Social Inference Test). Using a PCA we found that scores on all tests loaded principally on one component. Factor scores were entered into a behavioural partial least squares (PLS) analysis calculating relationships between social cognition and neural activity. There were three significant latent variables, correlating social cognition to processing emotional faces while imitating, processing emotional faces while observing, or processing neutral faces. There were negative correlations between social cognition and neural activity in extended regions outside the fronto-parietal network (e.g. anterior frontal, fusiform, anterior cingulate, cerebellum) while both observing and imitating emotional faces, but a positive correlation in fronto-parietal regions during imitation. This suggests those with better social cognitive ability may make use of more constrained networks centered around the fronto-parietal system.

# EMOTION & SOCIAL: Self perception

### A27

**DISTINCT STRUCTURAL BRAIN CORRELATES OF SELF-FOCUSED VERSUS OTHER-FOCUSED THOUGHT** Carissa Philippi[1], Maia Pujara[1], Conrad Gudmundson[1], Julia Glueck[1], Michael Koenigs[1]; [1]University of Wisconsin-Madison — Neuroimaging studies have consistently implicated a network of brain regions—medial prefrontal cortex (mPFC), posterior cingulate (PCC), and retrospenial cortex (Rsp)—in thinking about oneself and others. Whereas self-focused thought reliably engages mPFC, other-focused thought recruits PCC and Rsp. To date, few studies have investigated the neurostructural basis of self- and other-processing using performance-based tasks. In the present study, we examined whether performance-based measures of self-focus and other-focus (from a sentence completion task) predicted cortical thickness in mPFC, PCC, and Rsp in healthy adults (n=26 with no history of psychiatric or neurological conditions). We found that higher self-focus predicted greater cortical thickness in mPFC, whereas higher other-focus predicted greater cortical thickness in Rsp. These results are consistent with previous functional neuroimaging studies associating activity in the mPFC and Rsp with self- and other-processing, respectively. Furthermore, these data provide novel evidence for the utility of performance-based measures in elucidating the neural basis of self-reflection and social cognition. More broadly, given the prevalence of such impairments in a variety of psychiatric disorders, future work could examine associations among these psychological processes and mPFC/Rsp structure and function across different psychiatric disorders (e.g., depression, autism, antisocial personality disorder).

### A28

**EMOTIONAL VALENCE MODULATES SELF VS. OTHER ACTIVATION IN MPFC** Eric C. Fields[1,2], Kirsten Weber[3,2], Ben Stillerman[2,1], Nathaniel Delaney-Busch[1,2], Candida Ustine[4], Ellen Lau[5], Gina R. Kuperberg[1,2]; [1]Tufts University, [2]Martinos Center for Biomedical Imaging, Mass. General Hospital, [3]Max Planck Institute for Psycholinguistics, [4]Medical College of Wisconsin, [5]University of Maryland — The region of the brain most consistently associated with self-related processing is the medial prefrontal cortex (mPFC). While the mPFC has been argued to be specialized for self-related processing, it has more often been seen as being part of a broader "mentalizing" network used for thinking about both the self and others. In previous work we examined the interaction of self-relevance and emotional valence using ERPs. These studies showed that an early indicator of semantic processing (the N400) is sensitive to positive expectations about the self and that self-relevance and valence can interact in complex ways to determine how attentional resources are allocated (as indexed by the late positive component). Building on this work, we were interested in how emotional valence would modulate the effect of self-relevance in mPFC, and we examined this question with functional MRI. We used two-sentence social vignettes in a 2 (Self-Relevance: self-relevant, other-relevant) x 3 (Emotion: positive, neutral, negative) design, e.g.: A man knocks on Sandra's/your hotel room door. She/You see(s) that he has a tray/gift/gun in his hand. Results revealed an interaction effect: there was more mPFC activity to self-relevant than other-relevant positive scenarios, but no effect of self-relevance on neutral or negative scenarios. Interestingly, this is similar to the pattern we observed on the N400 component of the ERP. Thus one interpretation of the present fMRI results is that participants maximally engaged the mentalizing network when they their self-relevant expectations about positive incoming information were confirmed by the input.

### A29

**THE NEURAL SUBSTRATES OF INDIVIDUAL AND COLLECTIVE SELF-DISCREPANCY** Zhenhao Shi[1], Yuqing Zhou[2], Shihui Han[2]; [1]University of Pennsylvania, [2]Peking University — People are intrinsically motivated to pursue positive self-attributes that they ideally would possess, while confronting the discrepancy between the actual self and the ideal self can be frustrating. This is true not only when one reflects on his personal self-concept, but also when one sees the self as part of a group. Using functional magnetic resonance imaging, the present study examined the neural mechanisms of individual and collective actual–ideal self-discrepancy. We scanned 58 Chinese college students (29 female; age = 21.67±2.13) while they performed individual and collective self-discrepancy judgment tasks. During the individual self-discrepancy task, subjects evaluated the discrepancy between their actual self and ideal self in terms of possessing positive attributes (e.g. "smart", "brave") on a 4-point scale (from "very close to "very discrepant"). During the collective self-discrepancy task, subjects performed similar judgments regarding the discrepancy between actual Chinese people and ideal Chinese people. Conjunction analyses revealed that larger actual–ideal self-discrepancy, both individual and collective, was linked to stronger activations in brain areas related to craving and negative emotion such as bilateral striatum and anterior insula. The right striatal activities to individual and collective self-discrepancy were correlated with each other among those with higher dispositional interdependent self-construal, and those higher in collectivism, but not otherwise. Our findings suggest common neural substrates for individual and collective self-discrepancy in Chinese. Moreover, collectivistic/interdependent individuals, compared to individualistic/independent ones, exhibit greater co-recruitment of these substrates when reflecting on individual and collective self-discrepancy.

### A30

**I SAW MINE FIRST: SELF-RELEVANCE AS OWNERSHIP IN TEMPORAL ORDER JUDGMENT** Grace Truong[1], Kevin Roberts[1], Cassie Cowie[1], Rebecca Todd[1]; [1]University of British Columbia — How does self-relevance via ownership affect the way we selectively attend to objects in the environment? Previous research shows that objects owned by the self command greater levels of attention and are remembered better compared to equivalent objects that are owned by another. However, these measures reflect post-stimulus responses to ownership status. To investigate whether

self-relevance can influence pre-stimulus cognitive processes, we employed a temporal order judgment (TOJ) task in an object ownership context. We predicted that self-relevant objects would elicit a prior entry effect: when two items are presented simultaneously, previously cued or more salient stimuli are perceived as appearing first, thus reflecting an attentional set deployed before stimulus onset (Williams et al., 1988). Participants first learned the arbitrarily assigned ownership statuses of a series of everyday objects and were tested for recall on these categories until performance was at ceiling. In the subsequent TOJ task, participants viewed pairs of objects (one owned by self, one owned by another) presented asynchronously and reported which appeared first. Results from multi-level logistic regression showed participants were more likely to perceive self-owned objects first if presented simultaneously with an other-owned object, suggesting a bias in initial attentional deployment. Further analysis showed this self-bias was completely dissociable from degrees of independent and interdependent self-construal. The current work demonstrates how self-relevance shapes selective attention, and highlights the distinction between the self as an object of perception ("Me") and the self as an experiential agent or subject of perception ("I").

# EMOTION & SOCIAL: Emotion-cognition interactions

## A31

### NEURAL BASIS OF INHIBITING SOCIALLY UNACCEPTABLE LOVE

Ryuhei Ueda[1], Hiroshi Ashida[1], Nobuhito Abe[2]; [1]Kyoto University Graduate School, [2]Kokoro Research Center, Kyoto University — The neural basis of love has gradually been delineated in studies using functional neuroimaging techniques. However, few studies have examined which brain mechanisms are responsible for inhibiting "immoral" behavior such as cheating or marital infidelity. Here, we used functional magnetic resonance imaging (fMRI) to identify the brain regions contributing to the success and failure of inhibiting socially unacceptable love. During fMRI scanning, thirty-six male participants were presented with photographs of the faces of (a) attractive females with a significant other, (b) attractive females without a significant other, (c) unattractive females with a significant other, and (d) unattractive females without a significant other. The participants were asked to rate how much they wanted to be romantically involved with each female using an 8-point scale (from 1 = very negative to 8 = very positive). The participants rated attractive females higher than unattractive females, and this effect was associated with activation in the ventral striatum. The participants also rated females with a significant other lower than females without a significant other, and this effect was associated with activation in the lateral parietal cortex. Critically, the participants demonstrating willingness to be romantically involved with females with a significant other over females without a significant other were characterized by inefficient activation of control-related prefrontal areas and a heightened sensitivity to reward (as measured by questionnaires). These results provide a neural explanation for why some people are willing to engage in socially unacceptable love.

# EMOTION & SOCIAL: Self perception

## A32

### REFINING A NEUROSCIENCE APPROACH TO PERSONALITY MEASUREMENT: THE ANPS 3.0

Laura Feren[1], Kenneth Davis[2]; [1]Brandman University, Member of the Chapman University System, Irvine, CA, [2]Pegasus International, Greensboro, NC — Factor analysis is a driving influence in personality theory as a personality parsing tool. However, personality psychology needs a new tool to build on the Big Five base and advance personality theory. Jaak Panksepp has offered a neuroscience approach. Synthesizing anatomical, pharmacological, and physiological brain research, Panksepp presented evidence for seven primary emotional brain systems, six of which may provide the foundation for human personality. We call these six systems SEEKING, ANGER, FEAR, CARE, SADNESS, and PLAY. Davis, et al. (2003) published the Affective Neuroscience Personality Scales (ANPS), which measured these six primary emotions. Davis et al. related these six scales to the Big Five and showed how the Big Five dimensions did not accurately measure these six inherited emotional systems and their influence on personality and psychopathology. Davis & Panksepp (2011) published the revised ANPS 2.4 to improve scale reliabilities. The ANPS has been criticized recently (Barrett et al., 2014) in part for low scale reliabilities. The current project improves ANPS psychometrics by expanding from a 4-point to a 6-point scale, and also adds a Social Dominance scale. We use factor analysis to suggest that the Behavioral Activation System (Carver & While, 1994) is not closely related to any of these primary brain emotions or to Social Dominance but is likely related to an impulsive lack of approach regulation, and that Spirituality is principally related to the CARE emotion. We also offer descriptive adjectives for the six Affective Neuroscience Personality Scales that enhance their verbal descriptions.

## A33

### SELF-DISTANCING REDUCES VMPFC ACTIVITY DURING INTER-RACIAL MENTORING INTERACTIONS

Jordan Leitner[1], Ozlem Ayduk[1], Rodolfo Mendoza-Denton[1], Chad Forbes[2]; [1]University of California, Berkeley, [2]University of Delaware — Extant research suggests that White teachers experience concern that their Black students will perceive them as prejudiced. Consequently, White teachers may become self-focused and anxious when giving critical feedback to Black students. One possible way to mitigate this self-focus and anxiety is through self-distancing, a strategy wherein people view their experiences from an 3rd person perspective. However, it remains unclear whether self-distancing influences neural processes in regions linked to self-focus and anxiety. In the current research, White participants adopted either a self-distanced perspective that discourages self-focused attention, or a self-immersed perspective that encourages self-focused attention. Participants then conveyed positive and negative feedback to a Black student confederate while continuous EEG and coder-rated anxiety were measured. To estimate the neural generators of EEG activity associated with participants' feedback to the Black confederate, we conducted source-localization analyses for the -200 to 400 ms epoch surrounding the delivery of feedback. A dipole model that included bilateral sources in the motor cortex (to account for hand motions), occipital cortex (to account for visual processing), lateral prefrontal cortex, and ventral medial prefrontal cortex (vmPFC) explained 97% of total EEG variance. Bootstrapping path analyses revealed that compared to participants in the self-immersion condition, participants in the self-distancing condition showed significantly less source waveform activity in the vmPFC in the 200ms following the delivery of feedback, which in turn predicted lower ratings of anxiety. These findings suggest that in potentially stressful inter-racial interactions, self-distancing reduces anxiety by decreasing processing in neural regions linked to self-focused attention.

# EXECUTIVE PROCESSES: Monitoring & inhibitory control

## A34

### SEX DIFFERENCES IN NEUROPHYSIOLOGICAL RESPONSES MODULATED BY IMPULSE CONTROL

Kazufumi Omura[1], Kenji Kusumoto[1]; [1]Yamagata University — The amplitudes of the N2 and P3 components of event-related potentials (ERPs) may be related to personality traits such as impulsivity, and gender may impact these ERP components. However, there are few studies focusing on the interaction between personality traits and sex differences. This study evaluated how sex differences in the amplitudes of the N2 and P3 components during a continuous performance task (CPT) are related to impulse control. Twenty-seven healthy participants were asked to perform an AX-type CPT (Go/Nogo task) with EEG recording. Participants then completed the Barratt impulsiveness scale, version 11 (BIS-11), and the effortful control (EC) scale to self-report personality measures related to impulse control. We found that males showed significantly larger N2 amplitudes in the frontal area than females in the Nogo condition. In addition, the N2 amplitude in the Nogo condition was positively correlated with the BIS attentional subscore, but was negatively correlated with the EC attentional subscore in males only. Interestingly, the Nogo-P3, which has been linked to response-related cognitive processes, did not differ between sexes and there were no significant relationships between its amplitudes and BIS or EC attentional subscores. These findings suggest that the Nogo-N2 amplitude, which is modulated by trait impulsivity and

executive attention, is more sex-sensitive than the Nogo-P3, and may be related to sex-specific inhibitory controlling mechanisms during the early stage of stimulus evaluation.

## A35

### LARGE-SCALE NETWORK DYNAMICS UNDERLYING LIST-METHOD DIRECTED FORGETTING

Babu Adhimoolam[1], Teena Moody[2], Barbara Knowlton[2]; [1]University of California San Francisco, [2]University of California Los Angeles — Adaptive learning requires motivated or directed forgetting of irrelevant information in order acquire new information. Motivated or directed forgetting has been well studied in the laboratory using the List method, in which subjects are presented with a list of words and are then directed to either remember or forget these words. If subjects receive a forget instruction, they will exhibit better memory for a subsequent list than if they are instructed to remember the initial list. Here we investigate the network changes during learning of a second list, after either a Forget or a Remember instruction. Subjects were 17 healthy young adults scanned using 3T MRI. By using ROI-ROI connectivity analysis (results corrected using FDR, $p < 0.05$) we show that seeds in the left inferior frontal and left middle frontal regions, show anti-correlations with the default mode network (posterior cingulate, precuneus and right angular gyrus) during list 2 encoding following the Forget cue. We also found positive correlations between seeds in the bilateral frontopolar and dorsolateral part of the prefrontal cortex with the posterior, parietal and anterior nodes of the DMN. The left inferior frontal anti-correlation with the posterior nodes of DMN was unique to forget condition and was not seen in remember condition. These results underscore distinct connectivity signatures between nodes of DMN with fronto-parietal regions during list 2 encoding during the forget condition. Our results have important implications to understand directed forgetting from a network perspective and provide insights into dynamic network reconfiguration during intentional forgetting and remembering.

## A36

### VASCULAR RISK FACTORS INFLUENCE PERFORMANCE ON INHIBITORY CONTROL TASKS MORE THAN AGE IN HEALTHY ELDERS

Alexandra Roach[1,2], Samuel Lockhart[2,3], Charles DeCarli[2]; [1]University of South Carolina Aiken, [2]University of California Davis, [3]University of California Berkeley — Within the context of normal cognitive aging, there is substantial heterogeneity in cognitive deficit. We examined whether vascular risks such as diabetes mellitus, hypertension, hyperlipidemia, or the presence of the apolipoprotein E e4 allele (APoE e4), a cardiovascular disease risk factor more commonly associated with Alzheimer's disease, affect cognitive decline. We selected three inhibitory control paradigms (Flanker arrow task, Stroop color-naming task, Go/No-Go task) each designed to engage slightly different aspects of inhibitory control to help uncover the root of the heterogeneity observed in age-related cognitive decline. Thirty-nine young adults (mean age = 24.6), and 40 older adults (mean age = 77.5), participated. All healthy older adults were recruited from the University of California at Davis Alzheimer's Disease Center longitudinal cohort study. While we found the expected global slowing in reaction time in older compared to younger adults, we found no age-related decline in accuracy on any task. Amongst the older adults, we found a significant association between diabetes and all three tasks. Participants with diabetes were significantly slower overall than those free from disease on both the Flanker and the Stroop tasks. Older adults with diabetes were more accurate on No-Go trials as a function of number of preceeding Go trials, as their overall slower response time allowed for complete processing of the No-Go cue, leading to fewer false alarms. For the Stroop task, APoE e4 presence resulted in global slowing independent of trial type. These findings provide significant insight into what types of biological influences affect cognition.

## A37

### COMPARING THE PREDICTED ACTIVATIONS OF AN ACT-R COGNITIVE MODEL WITH HUMAN FMRI BOLD RESPONSE IN A DIFFICULT VISUAL DISCRIMINATION TASK

Daniel M. Roberts[1,2], George A. Buzzell[1,2], Raja Parasuraman[1,2], Craig G. McDonald[1,2]; [1]George Mason University, [2]Center of Excellence in Neuroergonomics, Technology, and Cognition — Models of human cognition built within a general cognitive architecture, such as ACT-R, can serve to focus theories of specific aspects of cognition. Forming a model within an architecture restricts the flexibility of parameter selection and forces potentially abstract concepts to be made explicit. Models of human cognition built within cognitive architectures have traditionally been fit to measures of human behavioral performance, such as accuracy and response time. However, the behavioral assessment of model fit has more recently been supplemented by comparing model-generated predictions of neurophysiology to data gleaned from human cognitive neuroscience experiments, using standard neuroimaging techniques [Anderson, J. R., Fincham, J. M., Qin, Y., & Stocco, A. (2008). A central circuit of the mind. Trends in Cognitive Sciences, 12(4), 136–143]. Here, twenty-four human participants completed a difficult visual discrimination task in which they reported both stimulus identity and their certainty of response, while fMRI was acquired. A cognitive model of the same task was implemented within the ACT-R cognitive architecture, modeled to fit the behavioral responses of the human participants. Of particular interest is the timing of activation within ACT-R's "goal" module, which serves to maintain the model's task state and has been previously associated with the anterior cingulate cortex (ACC). The ACC is one region within medial frontal cortex that was observed to be differentially activated for certain relative to uncertain perceptual decisions among the human participants. A comprehensive comparison of the human neuroimaging data and the predicted activation based on the ACT-R model are presented.

## A38

### DISENTANGLING NEURAL SUBSTRATES SUPPORTING MEMORY- VERSUS CONTROL-BASED CONTRIBUTIONS TO THE CONGRUENCY SEQUENCE EFFECT

Jiefeng Jiang[1], Tobias Egner[1]; [1]Duke University — To achieve goal-directed action, habitual but contextually inappropriate responses to goal-irrelevant distracter stimuli must be overcome. Resolving conflict from distracters can be mediated by retrieving and applying an appropriate attentional states (cognitive control), and/or by retrieving the response associated with similar, previously encountered stimuli from memory. Behaviorally, both of these processes result in improved conflict resolution following conflict on the previous trial (the congruency sequence effect, CSE). To tease apart the neural substrates supporting priming of control states versus that of stimulus-response associations, in producing the CSE, we analyzed behavioral and fMRI data acquired while subjects (N = 15) performed a prime-probe conflict task. Here, subjects had to ignore a prime arrow stimulus (pointing either left, right, up, or down) that preceded an image of a face that could be oriented left, right, up, or down, and the direction of which had to be indicated by the subject. In addition to manipulating prime-probe congruency, trial sequences could either have the exact arrow and/or face repeated (identity priming condition), a change in physical stimuli but not in direction (categorical priming condition), or a change in both physical stimuli and direction (control priming condition). Behaviorally, we observed significant CSE in all three conditions. However, preliminary fMRI results revealed that distinct brain regions were involved in mediating the CSE depending on whether it represented priming of cognitive control (anterior cingulate cortex), priming of category-response associations (posterior parietal cortex))- or priming of stimulus-response associations (putamen).

## A39

### CONFLICT ADAPTATION IN BILINGUALS: THE IMPORTANCE OF BEHAVIORAL DATA IN COGNITIVE NEUROSCIENCE

Oliver Sawi[1,2], Hunter Johnson[1], Kenneth Paap[1]; [1]University of Connecticut, [2]San Francisco State University — When studies include both behavioral and neuroscience data, strong conclusions are sometimes made even when the behavioral evidence is weak- this practice could prove detrimental to cumulative progress. We suggest that in at least one controversial research domain (bilingual advantages in executive functioning (EF)), that the behavioral variables are playing, at best, a supporting role to neuroscience data. This diminished attention to the quality of the behavioral evidence often leads to, in our view, inappropriately strong conclusions. A highly cited study (Abutalebi et al., 2012), which appears to be a well-balanced synthesis of behavioral and neuroscience data, concludes that bilinguals adapt to conflict better than monolinguals - as indexed by differential interference effects across blocks between bilinguals and monolinguals. However, the behavioral data do not directly support the conclusion by NHST, parameter estimation, or Bayes analysis. Furthermore, others have reported either no language-group

differences or the reverse pattern. The present study extends the scope of the protocol described in (Abutalebi et al., 2012) from multiple blocks in a single session to a second session on another day. 78 participants completed a flanker interference task similar to the version employed by (Abutalebi et al., 2012) in two sessions. A factorial ANOVA (with days, blocks, and trial type as repeated measures, and language group as a between-subjects? factor) was conducted. There was no evidence supporting the conclusion that bilinguals adapt to conflict more efficiently than monolinguals; there were no bilingual advantages on either day, and no interaction of language group X day.

### A40

### CONTROL MECHANISMS IN BILINGUAL APHASIA

Teresa Gray[1], Swathi Kiran[1]; [1]Boston University — We examined cognitive control (CC) in bilingual aphasia in order to determine whether deficits in language control (LC) are specific to the language domain or indicative of more general cognitive deficits. Preliminary data were collected from 10 Spanish-English healthy bilingual adults (HBA) (M = 48.5; SD = 11.3) and 4 Spanish-English bilingual adults with aphasia (BAA) (M = 40; SD = 10.4). We project to recruit 20 HBA and 20 BAA. Participants completed a language history questionnaire and four tasks (two non-linguistic: NL-Flanker, NL-Color/Shape and two linguistic: LT-Flanker, LT-Triad) designed to evaluate CC in linguistic and non-linguistic contexts and included both congruent and incongruent conditions. For HBA and BAA, separate paired samples t-tests were performed to evaluate the effect of condition (congruent/incongruent) on accuracy and RT for each task. For HBA, RT results revealed a congruency effect (CE) (i.e., faster RTs on congruent vs. incongruent conditions) on all tasks, whereas for BAA, no CE was observed (LT-Flanker: HBA: $p < .05$, BAA: $p = .83$; NL-Flanker: HBA: $p < .01$, BAA: $p = .24$; LT-Triad: HBA: $p < .01$, BAA: $p = .33$; NL-Color-shape: HBA: $p < .001$, BAA: $p = .07$). No significant differences were found on accuracy, except for the color/shape task (HBA and BAA: $p < .05$). Preliminary results suggest that HBA demonstrate intact mechanisms of LC and CC, whereas BAA results reveal a lack of CE in LC and CC, indicating impaired control mechanisms in both domains. All results are indicative of domain general cognitive control.

### A41

### MODULATION EFFECTS OF EMOTION/MOTIVATION ON RESPONSE INHIBITION

Hsin-Ju Lee[1], Wen-Jui Kuo[1]; [1]National Yang-Ming University — Emotion and motivation are two essential factors to affect the way we behave. Yet, how our brain reacts in response to the interaction of emotion and motivation and action control is unclear. In action control literature, the stop-signal task is a long well-established paradigm to study action inhibition. It requires the participants to react as fast as possible to the go cues and to stop the initiated actions as accurate as possible when stop-signals occur. In this study, by providing a monetary reward in various situations, the two factors, i.e., emotion and motivation, are included to see how they interact with action inhibition processes. In addition to behavioral measurements, functional MRI was conducted to investigate their neural substrates. In the results, there was no difference across conditions in behavior data, which was consistent with previous behavioral findings. However, the BOLD data showed several interesting findings. First, greater activation was found in the vmPFC for successful stopping trials (SST) than unsuccessful stopping trials (USST). The USST showed higher activity than the SST in bilateral sensorimotor cortex. Compare to the emotional neutral condition, the frontoparietal networks showed higher activation level by both the positive and negative emotion conditions, suggesting that the attention control networks were sensitive to the evoked emotional perturbation in our study.

## EXECUTIVE PROCESSES: Working memory

### A42

### AGE-RELATED CHANGES IN NEURAL OSCILLATIONS UNDERLYING DISTRACTION AND INTERRUPTION

Yixuan Ku[1,2], Theodore Zanto[2], Adam Gazzaley[2]; [1]The Key Lab of Brain Functional Genomics, MOE & STCSM, Institute of Cognitive Neuroscience, School of Psychology and Cognitive Science, East China Normal University, Shanghai, China, [2]Department of Neurology, Physiology and Psychiatry, University of California, San Francisco, San Francisco, USA — In this study, we assessed age-related neural oscillations underpinning working memory processes, in the context of interference (to-be-ignored distractions or to-be-attended interruptions). Both types of interference deteriorated working memory performance, with older adults exhibiting a disproportional decline. These performance declines in aging were associated with diminished posterior alpha oscillations as well as less fronto-posterior alpha coherence, suggesting weakened top-down control from the prefrontal cortex in aging. Although alpha oscillations were observed to underlie declines in both types of interference, a functional dissociation was observed such that alpha activity and coherence were affected in aging prior to distraction and after an interruption, but not vice versa. Additionally, older adults exhibited a decline in disengaging from an interruption, as indexed by prolonged frontal theta activity, providing further evidence that deficits in prefrontal cortex cognitive control underlie interference control problems in aging. Together, these results suggest age-related deficits in working memory performance during interference stems from deficient fronto-posterior oscillatory alpha and theta activities that serve to inhibit impending distraction and release temporarily attended interruptions from working memory.

### A43

### INFORMATION FLOW IN THE MENTAL WORKSPACE

Alexander Schlegel[1], Prescott Alexander[1], Peter Tse[1]; [1]Dartmouth College — The brain is a vastly complex and interconnected information processing network. In humans, this network supports a mental workspace that enables many abilities such as scientific and artistic creativity. A central theoretical and technical challenge facing neuroscience is to understand the neural basis of such complex cognitive processes. Does information processing underlying these processes occur in isolated regions or distributed throughout the brain? How does the flow of information within the network contribute to specific cognitive functions? Current approaches have limited ability to answer these questions. Here we report novel multivariate methods that enable analysis of information flow within the mental workspace as participants manipulate visual imagery. We find that mental representations share a common format throughout the cortex via the distributed flow of information. Mental manipulation entails distributed processing with sparser information sharing and flow. These findings challenge existing, modular models of the neural basis of higher-order mental functions.

### A44

### GENETIC MODULATION OF CONCUSSION AND FOOTBALL EXPOSURE EFFECTS ON COGNITIVE TASK PERFORMANCE AND FUNCTIONAL NEURAL CONNECTIVITY

Eleanna Varangis[1], Kelly Giovanello[1,2], Kathleen Gates[1], Stephanie Lane[1], Kevin M. Guskiewicz[1]; [1]The University of North Carolina at Chapel Hill, [2]UNC Biomedical Research Imaging Center — Recent studies have shown a link between concussions (or subconcussive episodes) sustained earlier in life and memory problems, dementia, and Alzheimer's Disease (AD) later in life. However, little is known about individual differences in the long-term effects of concussion, and specifically whether genetic risk factors for AD, such as the Apolipoprotein-ε4 (APOE-ε4) allele, may better account for some of these effects or interact with concussion and exposure history to influence cognitive functioning years after concussive injury. In the present study, participants between the ages of 50-65 (N=63) were classified based on concussion history (0-1 or 3+), football exposure (college or college+NFL), and APOE-ε4 allele status (APOE-ε4+ or APOE-ε4-). Participants completed two batteries of neurocognitive tasks, and performed an fMRI-adapted N-back task to assess functional connectivity during working memory performance. Neurocognitive task results revealed an overall trend towards specific deficits in the domain of memory across all sub-groups. Results from the functional connectivity analyses revealed that concussion history accounted for differences in connectivity strength within a fronto-parietal working memory network. Additionally, APOE-ε4 status accounted for differences in the magnitude of functional connectivity strength, specifically in its interaction with both exposure and concussion history. These findings suggest that the functional neural connectivity observed during working memory performance is altered by concussion history and the interaction between concussion history, football exposure, and APOE-ε4 status.

## A45

### TRANSCRANIAL DIRECT CURRENT STIMULATION DIFFERENTIALLY AFFECTS SUBTASKS DURING SIMULATION OF A REAL-WORLD MULTI-TASK.

Melissa Scheldrup[1], Jessica Vance[1], Eric Blumberg[1], Richard McKinley[2], Raja Parasuraman[1], Pamela Greenwood[1]; [1]George Mason University, [2]Air Force Research Laboratory — Complex multi-tasks – which make simultaneous demands on separate cognitive components - are important for every day functioning as well as many technical occupations. Improving performance of multi-tasks would benefit from heightening the cognitive systems that are engaged through training or noninvasive brain stimulation. Transcranial direct current stimulation (tDCS) has been used to facilitate single task performance (reviewed in Coffman et al. 2014), but only recently used to facilitate multi-tasks (Scheldrup et al., 2014). Performance of multi-tasks requires coordination of attention between subtasks (Strobach et al., 2014). Based on evidence that dual-task performance is mediated by a network involving right anterior cingulate and right dorsolateral prefrontal (rDLPFC) cortices (Kondo et al., 2004; Dosenbach et al., 2007), we hypothesized that stimulation of rDLPFC by tDCS could enhance performance on a dual-task simulation of aircraft carrier operations - Warship Commander (WSC). WSC is composed of subtasks, one loading verbal working memory (WM) and another loading spatial WM. Participants were randomly assigned to sham (n=19), anode (n=18), or cathode (n=18) stimulation over the rDLPFC (contralateral shoulder reference). We found that the anode over rDLPFC significantly reduced performance on the verbal WM task compared to the cathode. Errors on the spatial WM subtask were marginally higher with cathode compared to sham and anode stimulation. These results indicate that the stimulation induced a processing tradeoff, such that enhancement of rDLPFC had no effect on spatial WM, while benefiting verbal WM. Inhibition of rDLPFC impaired performance on spatial WM while conferring a benefit for verbal WM.

## A46

### THE REPRESENTATIONAL CAPACITY OF THE HUMAN PREFRONTAL CORTEX: A HIGH-RESOLUTION FMRI STUDY

Patricia Shih[1], David Badre[1]; [1]Brown University — The prefrontal cortex (PFC) supports complex behaviors by providing flexible task representations. It has been proposed that neurons in the PFC that show mixed selective responses combine as a population to produce distributed representations of all combinations of task-relevant dimensions. This high-dimensional capacity theoretically allows any combinatorial mixture of features to be read out in support of flexible cognitive control. However, it is unknown whether high-dimensional capacity is unique to PFC or is, alternatively, a fundamental and general computational characteristic of association cortices. Critically, it is necessary to test whether the high-dimensional capacity observed in non-human primate PFC is conserved in humans, capable of the most complex of behaviors without extensive training. Thus, this study aimed to estimate the dimensional capacity of human PFC and other cortical areas in the human brain, using a similar pattern classification approach as has been implemented in the non-human primate. Human participants were scanned with high-resolution fMRI while performing two-item sequential memory tasks, adapted from studies in monkeys. We found that many combinations of task aspects (cues/task-types) were indeed decodable in distributed voxels within PFC, implicating high-dimensional capacity and consistent with non-human primate PFC. However, high representational capacity was observed in additional neocortical areas as well, particularly within occipital cortex. By contrast, other regions, such as motor and parietal, showed relatively low dimensional capacity, encoding fewer task representations. We consider these results with regard to the functional organization and computational nature of the neocortex – both in PFC and in the brain more broadly.

## A47

### FURTHER INVESTIGATION OF EVENT-RELATED ALPHA SYNCHRONIZATION AS INHIBITORY CONTROL DURING A WORKING MEMORY TASK

Christina Merrick[1], Tiffany K Jantz[2], Ezequiel Morsella[1,3], Mark W Geisler[1]; [1]San Francisco State University, [2]University of Michigan, [3]University of California, San Francisco — Frequencies in the alpha band have traditionally been regarded as representing an 'idling' rhythm that arises when brain regions are at rest (e.g., when eyes are closed). Several recent working memory (WM) studies have challenged this view by demonstrating that alpha power systematically increases with the number of items held in WM (Jensen, Gelfand, Kounios & Lisman, 2002; Klimesch, Doppelmayr, Schwaiger, Auinger & Winkler, 1999). In order to explain this increase in alpha power, Klimesch, Sauseng, and Hanslmayr (2006) proposed that event-related alpha synchrony reflects a top down, inhibitory control process. During a WM task, this type of alpha inhibition is present in task-irrelevant brain areas, which may help to prevent distracting information from interfering with task-relevant information (Klimesch et al. 2006). To further explore this hypothesis, a WM task was employed that allowed us to manipulate memory load (2 vs. 4 Letters) and to capture spontaneous moments of active rehearsal—the component process in which mental representations are activated reiteratively, through intentional, top-down processing (Johnson & Johnson, 2009). In line with the alpha-inhibition hypothesis, we observed increased alpha synchronization in parietal and occipital areas not involved with the task, but alpha desynchronization in the left frontal lobe and right medial temporal lobe, areas that may play a role in verbal WM. In addition, we examined event-related spectral perturbation, and observed alpha desynchronization, after moments of spontaneous rehearsal. Our results provide additional evidence that event-related alpha synchronization plays a functional role in top-down inhibitory control.

## A48

### THE RELATIONSHIP OF WORKING MEMORY CAPACITY AND CONFLICT MONITORING: AN ERP STUDY

Jason Sattizahn[1], Yanli Lin[2], Sian Beilock[1], Jason Moser[2]; [1]The University of Chicago, [2]Michigan State University — Individual differences in working memory capacity (WMC) reflect differences in the ability to maintain task-relevant information, especially during situations involving monitoring conflict between two competing tasks or stimuli. Conflict monitoring is thought to be largely subserved by the anterior cingulate cortex (ACC), whose activity can be captured by the response-locked event-related potential (ERP) component known as error-related negativity (ERN). Yet, little is known about the relation between variation in WMC and the ERN. We examined the relationship of participants' (N=39) trait level of WMC and conflict monitoring as evidenced by the ERN. Participants were administered two complex span tasks (i.e., operation and reading span), from which we created a composite working memory score. A tertiary split separated the highest (higher WMC, N=12) and lowest (lower WMC, N=13) scoring groups. ERN was measured by recording ERP data during a relatively low WM-demand, two-choice arrow-based Flankers task, and averaged across participants' error trials. Higher WMC individuals showed a decreased ERN amplitude compared to lower WMC participants despite behavioral performance being equal between the two groups. On low-demanding tasks, higher WMC participants seem less likely to engage in conflict monitoring compared to their lower WMC peers. This is in contrast to findings that higher WMC individuals engage in conflict monitoring to a greater extent during more demanding tasks. Higher WMC may be able to more optimally engage conflict monitoring when needed and disengage when it is not beneficial to a task.

## A49

### VISUAL WORKING MEMORY AND FILTERING OUT DISTRACTORS: EVIDENCE FOR AN AGE-SPECIFIC DELAY IN FILTERING

Kerstin Jost[1], Ulrich Mayr[2], Tina Schwarzkopp[1]; [1]RWTH Aachen University, [2]University of Oregon — The capacity of working memory (WM) varies across individuals and declines with age. Whereas the ability to filter out irrelevant information has proven critical for general individual differences in visual WM, other factors seem to be responsible for the age-related differences in WM. We present data of a series of experiments that support earlier findings of an age-related delay in filtering. In a visual short-term memory task (i.e., change-detection task) targets were presented along with distractors. The contralateral delay activity of the EEG measured during the retention interval was used to track the number of stored items and to assess filtering efficiency. The data suggest that older adults do not have a general impairment in filtering, but that efficient filtering is delayed. Moreover, this filtering delay is specific for older adults and is not observed in WM-equated younger adults. A detailed analysis of early visual potentials reveals that already during early perceptual selection older adults are less focused on the targets than young adults. As a result, distractors may initially be

encoded into WM, and then need to be suppressed after the fact, during the course of maintenance. This apparent, early filtering deficit is consistent with the view that in older adults, proactive control over attentional settings is less efficient than in young adults.

### A50

### RETROSPECTIVE VERSUS REFLECTIVE MODULATION OF INTERNAL REPRESENTATIONS

Bo-Cheng Kuo[1], Shih-Kuen Cheng[2], Yei-Yu Yeh[1]; [1]Department of Psychology, National Taiwan University, Taiwan, [2]Institute of Cognitive Neuroscience, National Central University, Taiwan — Recent studies have shown that retrospective cues can direct attention to bias internal representations in visual short-term memory (VSTM), thereby suggesting a selective modulation of maintenance-related neural activity. Similarly, refreshing current attention of previously viewed item modulates the activity in the areas relevant to the stimulus category. Here we use functional magnetic resonance imaging to investigate whether retrospective modulation in VSTM involves categorically specific biasing of neural activity in a manner similar to that which occurs for refreshing. Participants (N = 18) performed a cued variant of VSTM task. Two sample stimuli (face and scene) were shortly presented (each for 800 ms) in randomised order, followed by a numerical cue (1500 ms) indicating whether to remember (retrospective cue) or refresh (reflective cue) the first or second stimulus. After a retention interval (for 6 sec), a test stimulus was presented (for 1000 ms). Participants were instructed to make a matched or non-matched judgment based on the cued stimulus for retrospective cues. In contrast, participants were asked not to make any responses but think back and visualise the cued stimuli that had just viewed when reflective cues appeared. A no-cue VSTM task served as a control condition. By presenting retrospective and reflective cues, we show a similar top-down modulation in scene-selective areas: enhancing activity for scene stimulus but suppressing activity for face stimulus compared to VSTM control task. Together, our results elucidate that both retrospective and reflective modulation rely on a common top-down mechanisms for goal-directed maintenance and refreshing of internal representations.

### A51

### EFFECTS OF RTMS ON THE EEG SIGNAL ARE MORE PREDICTIVE OF CHANGES IN RECALL PERFORMANCE THAN STIMULATION SITE

Michael J. Starrett[1], Nathan S. Rose[1], Adam C. Riggall[1], Jason Samaha[1], Bradley R. Postle[1]; [1]University of Wisconsin-Madison — Recently, Zokaei et al. (2014) showed that repetitive transcranial magnetic stimulation (rTMS) can alter recall precision for the direction of motion in a test of visual short-term memory (STM). To investigate the neurophysiological bases of these effects, we repeated their rTMS procedure while simultaneously recording EEG. Subjects remembered two random-dot kinematogram (RDK) stimuli (one red, one green; presented sequentially, each for .3 sec plus .1 sec backward mask), then responded to a color-coded recall cue. In each of two variants of the task, a few sec separated RDK#1 from RDK#2, and RDK#2 from the recall cue. A four-pulse train of 20 Hz rTMS (110% of adjusted motor threshold) could be applied to either left MT+ (functionally defined) or left postcentral gyrus ("S1"; intended as an "active control" region). Trial types ("early rTMS" (following RDK#1), "late rTMS" (following RDK#2), or "no rTMS") each occurred unpredictably, with p=0.33. Group-level time-frequency analyses of the EEG reveal broadband phasic responses to stimuli, and sustained elevated power in the 10-15 Hz range across both delay periods. Group-averaged behavior, however, shows no clear effect of rTMS target (i.e., MT+ vs. S1) or rTMS timing. Instead, within-subject behavioral variability most closely tracks rTMS modulation of delay-period activity recorded over MT+, regardless of targeted site. When rTMS has the effect of "sharpening" the band of elevated delay period activity (e.g., narrowing it to 11-14 Hz) we observe higher recall precision; when rTMS has the effect of desynchronizing delay period activity, in contrast, we see lower recall precision.

## LANGUAGE: Development & aging

### A52

### CROSS MODAL PLASTICITY IN DEAF CHILDREN WITH COCHLEAR IMPLANTS

David Corina[1], Shane Blau[1], Todd Lamarr[1], Laurie Lawyer[1], Lee Miller[1], Sharon Coffey-Corina[1]; [1]University of California, Davis — The goal of this study was to use ERP techniques to assess the presence of cross-modal plasticity in deaf children with cochlear implants. There is concern that under conditions of deafness, cortical regions that normally support auditory processing become reorganized for visual function. The conditions under which these changes occur are not understood. We collected ERP data from 22 deaf children (ages 1 year-8 years) with cochlear implants. Method. We used an auditory odd-ball paradigm (85% /ba/ syllables vs. 15% FM tone sweeps) to elicit a P1-N1 complex to assess auditory function. We assessed visual evoked potentials in these same subjects using an intermittent peripheral radial checkerboard while children watched a silent cartoon. This condition was designed to elicit a P1-N1-P2 visual evoked potential (VEP) response. Using published norms of auditory P1 latencies (Sharma & Dorman 2006), we categorized deaf children as showing normal (n=14) or abnormal auditory development (n = 8). Results. Deaf children with abnormal auditory responses were more likely to have abnormal visual evoked potentials (8/8) compared to deaf children with normal auditory latencies (3/14). The aberrant responders showed a VEP off-set response that was larger than the VEP onset response (a pattern opposite of what is normally observed in VEP studies). VEP data show an unusual topographic distribution with extension to midline site Cz. Conclusion. These data suggest evidence of cross-modal plasticity in deaf children with cochlear implants. We discuss the contributions of signed and spoken language experience in the expression of these results.

### A53

### TIP-OF-THE-TONGUE STATES ACROSS THE LIFESPAN: DIFFERENT PROBLEMS FOR DIFFERENT AGES?

Meredith Shafto[1], Cam-CAN[2], Lorraine Tyler[1]; [1]Department of Psychology, University of Cambridge, Cambridge, CB2 3EB, UK, [2]Cambridge Centre for Ageing and Neuroscience (Cam-CAN), University of Cambridge and MRC Cognition and Brain Sciences Unit, Cambridge, UK, www.cam-can.com — One of older adults' most often reported concerns are the temporary word finding failures known as "tip of the tongue states" (TOTs), which are associated with age-related declines in grey and white matter. However, forgetting words is a common complaint at any age, and it is unclear if similar processes underpin TOTs at different ages. Word retrieval requires multiple component processes, including lexical (phonological and semantic) access, cognitive control processes involved during production failures, and speeded processing underpinning fluent production. We asked whether these components show differential effects of age, suggesting different causes of word finding failures across the lifespan. To address this issue, we tested adults aged 18-88 from the Cambridge Centre for Ageing and Neuroscience (Cam-CAN) cohort who have structural MRI scans. We used a range of production measures, including picture naming accuracy and speed, different types of naming errors, word fluency, and phonological and semantic priming. Factor analysis provided three naming components: accuracy, fluency, and lexical access. While increasing values for all three components predicted lower TOTs, this relationship differed by age for the different factors: fluency scores predicted TOT rates across the lifespan; accuracy effects became stronger with increasing age, and lexical access was uniquely predictive of TOTs for older adults. Likewise, grey matter broadly predicted performance for the fluency component, but was specific to older adults or lower grey matter for lexical access. Results support previous evidence that age-related TOT increases reflect changes in lexical access, but that general processes predict TOTs across the lifespan.

### A54

### POWER AND PHASE SYNCHRONY OF NEURAL OSCILLATIONS EVOLVE OVER THE FIRST YEAR OF LIFE AND REFLECT PHONETIC PERCEPTUAL NARROWING

Silvia Ortiz-Mantilla[1], Jarmo A Hämäläinen[2], April A Benasich[1]; [1]Rutgers, The State University of New Jersey, [2]University of Jyväskylä, Finland. — Perceptual narrowing is a developmental process that promotes neural representation and efficient processing of sensory informa-

tion. During the first year of life, as infants build language-specific phonetic maps, their universal perceptual language abilities progressively narrow to favor more specific native language processing. To explore the oscillatory mechanisms underlying perceptual narrowing, 6- and 12-month-old infants born into English monolingual families were presented with native and non-native syllables differing in voice-onset-time. Dense array EEG/ERPs were mapped into age-appropriate brain templates. Source modeling placed dipoles in auditory and frontal cortices. Temporal-spectral analyses were conducted in source space using a 2-50 Hz frequency range over -300 to 930 ms with 1Hz wide frequency bins and time resolution of 50 ms. Changes in frequency amplitude, as a function of time relative to stimulus presentation (spectral power), and consistency of phase alignment across trials (synchrony) were evaluated using temporal spectral evolution (TSE) and inter-trial phase locking (ITPL) respectively. We found less theta power at 12 months than at 6-months-of-age with greater power in the left auditory source for native and in right for non-native syllables. To resolve phonetic differences, 6-month-old infants require a longer period of phase synchronization (50-400 ms) while at 12 months, a shorter period (50-200 ms) is sufficient. Our results suggest that as phonetic perceptual narrowing takes place across age, processing of phonetic information becomes faster and more efficient. Spectral power captures the neural plasticity that occurs over native specialization and the increase in processing speed is reflected in more precise phase synchronization.

### A55

### SPEECH ENCODING IN QUIET AND BACKGROUND NOISE DIFFERS BETWEEN INFANTS AND YOUNG ADULTS: A COMPLEX AUDITORY BRAINSTEM RESPONSE (CABR) INVESTIGATION

Gabriella Musacchia[1,2], Silvia Ortiz-Mantilla[1], Cynthia Roesler[1], Julie Byrne[1], April Benasich[1]; [1]Rutgers University, [2]Montclair State University — The ability to understand and respond to speech in the first year of life is indicative, and can be predictive, of later language ability. In order to understand speech, the listening brain must decode and encode dynamically rich acoustic cues often in noisy environments. While infant speech perception is quite sophisticated, discrimination of tones in noise and short formant transitions (<40 ms) are not yet fully mature. The complex Auditory Brainstem Response (cABR) provides an objective measure of subcortical speech processing that has been shown to successfully gauge speech processing differences associated with both auditory expertise and language disorders. To investigate the developmental timeline of speech and speech processing in noise, we tested a group of awake infants in the first year of life and a group of young adults. Speech stimuli were delivered monaurally at 70 dB via ear insert, in blocks of quiet and 60 dB background noise. Brainstem responses were recorded with a standard vertical montage and averaged according to condition. These data are the first to show speech and speech-in-noise brainstem responses in infants. We found differences between infants and adults in the formant transition period of the speech stimulus in quiet as well as higher resistance to the degrading effects of noise in the infant sample. Our results suggest that processing of a subset of speech sounds continues to develop both during and after the first year, even in typically developing infants, and that background noise may impact infant perception differently than in adults.

### A56

### PRESERVED SYNTACTIC PROCESSING AND ITS RELATIONSHIP TO GREY MATTER INTEGRITY IN THE CAM-CAN COHORT

Karen L. Campbell[1], Cam-CAN[2], Lorraine K. Tyler[1]; [1]University of Cambridge, [2]Cambridge Centre for Ageing and Neuroscience (Cam-CAN), University of Cambridge and MRC Cognition and Brain Sciences Unit, Cambridge — No one likes a null result. Nowhere is this more true than in the field of cognitive aging. However, there are certain abilities which do not decline with age. For instance, we have previously shown that syntactic processing is relatively preserved (e.g., Tyler et al., 2010), despite the fact that the frontotemporal system underlying this process shows extensive grey matter atrophy with age. This raises the question: how does the aging brain accomplish this fundamental process? The present study addressed this question using a large, population-derived sample (N = 604, aged 18-88) from the Cambridge Centre for Ageing and Neuroscience (www.cam-can.org). This sample is sufficiently large and spans a wide enough age-range to enable us to test the generality of our initial findings of no age difference in syntactic processing, and to examine how this ability relates to grey matter integrity within the frontotemporal system. Participants performed a language comprehension task which measured their sensitivity to syntactic ambiguity and performance on this task was related to their segmented grey matter images using a voxel-based morphometry approach. We show that syntactic processing is indeed not affected by age, and that performance on this task becomes increasingly dependent on grey matter integrity within middle temporal regions of the frontotemporal system with age. These findings reiterate that the aging brain can remain resilient, and in many ways, these resiliencies are far more challenging and important to explain than the losses.

### A57

### STATISTICAL LEARNING OF TONE SEQUENCES IN DYSLEXIA

Janani Iyer[1], Psyche Loui[2]; [1]University of California, Berkeley, [2]Wesleyan University — Individuals with developmental dyslexia (DD) have reading difficulties despite explicit reading instruction, suggesting possible deficits with implicit learning. Little is known about the source of the implicit learning difficulties, or the extent to which these implicit learning deficits might extend to nonlinguistic domains. Here we disentangle the learning of event frequency and conditional probability in implicit learning ability in DD using tone sequences generated from a finite-state grammar in a novel musical system (Loui et al, 2010). Twelve individuals with DD and 13 matched controls listened to grammatical sequences for 30 minutes. Frequency learning was tested before and after exposure using a probe-tone paradigm (Krumhansl, 1990). Probability learning was tested post-exposure using two-alternative forced choice tests of recognition and generalization. Results from control subjects showed significant frequency learning, as indicated by higher correlation with the exposure corpus in post-exposure compared to pre-exposure probe tone ratings ($p<0.01$). This frequency learning was not observed for DD participants ($p=0.80$), suggesting a frequency learning deficit for tone sequences in DD. Both groups generalized their knowledge of the grammar to identify novel instances above chance (control: $p<0.01$; DD: $p<0.05$), but only controls recognized sequences heard during exposure above chance ($p<0.05$). These results extend previous results on implicit learning deficits in children with DD (Vicari et al, 2003) to suggest that implicit learning difficulties in individuals with DD may stem from difficulty with frequency learning but not probability learning.

### A58

### AGE-RELATED SHIFTS IN HEMISPHERIC DOMINANCE FOR SYNTACTIC PROCESSING

Michelle Leckey[1,2], Kara D. Federmeier[1,2]; [1]University of Illinois at Urbana-Champaign, [2]The Beckman Institute for Advanced Science and Technology — Recent findings have shown that syntactic anomalies elicit a left hemisphere P600 event-related potential (ERP) response alongside a right hemisphere N400 effect in a young adult sample with no history of familial sinistrality. Given that the aging literature has documented a tendency to change from asymmetry of function to a more bilateral pattern with advancing age, 24 older adults (age 60+) underwent EEG recording whilst making judgments on simple two-word phrases. Whereas the left hemisphere P600 response remained in the older adult sample, the N400 effect was no longer present and instead the right hemisphere also elicited a P600 response. Together these findings suggest that, as with many other cognitive functions, syntactic processing becomes more bilateral with age, with the right hemisphere being capable of the same type of processing as the dominant left hemisphere. The possibility that this more bilateral functioning is due to a decrease in interhemispheric inhibition across the lifespan is discussed.

## LANGUAGE: Other

### A59

### A "FAST" FMRI LOCALIZER OF COMPONENT PROCESSES IN READING

Jeffrey Malins[1], Nina Gumkowski[1], Bonnie Buis[1], Peter Molfese[1], Stephen Frost[1], Ken Pugh[1], Robin Morris[2], Einar Mencl[1]; [1]Haskins Laboratories, [2]Georgia State University — Our primary aim was to develop an fMRI localizer of orthographic, phonological, and semantic components of word reading that is both relatively brief and also sensitive to individual differences. On each trial, subjects are rapidly presented with a set of four printed items, in a sequential fashion (stimulus duration, 250ms; ISI 200ms). Trials con-

sist of real words, pseudowords, or a false font of letter-like symbols. Sets of real words are semantically related (FORK/DISH/SPOON/BOWL), orthographically related with consistent phonology (BOAT/COAT/GOAT/FLOAT), orthographically related with inconsistent phonology (BOMB/TOMB/COMB/WOMB), or unrelated in orthographic, phonological, and semantic properties (CLAY/LAWN/FLEA/VASE). We tested this protocol with a group of adult typical readers (N = 19) using a 3T scanner; subjects completed four functional runs each five minutes in length. Analyses uncovered several brain regions with a well-established role in reading: (1) a contrast between unrelated words and false font isolated the visual word form area in the left fusiform gyrus; (2) pseudowords showed greater activation than unrelated words in left inferior frontal gyrus (IFG); (3) bilateral IFG showed sensitivity to the consistency of mappings between orthography and phonology; and (4) left IFG and parahippocampal areas were sensitive to semantic similarity. Furthermore, brain-behavior analyses revealed that the extent to which individuals recruited these regions was related to reading performance outside of the scanner. These results suggest this protocol is not only a powerful tool for localizing component processes, but is also sensitive to individual differences in the reading circuit.

## A60

### EMOTIONAL BALANCE? INFERENCES IN LEFT AND RIGHT HEMISPHERES

Connie Shears[1], Adriana Ariza[1], Jay Kim[1], Erika Sam[1]; [1]Chapman University — Conflicting theoretical perspectives posit hemisphere differences for processing emotional language (Smith & Bulman-Flemming, 2006; Beeman, 1993). We examined hemisphere differences for the formation of causal inferences based on texts that were positive, neutral, or negative, to test whether the right hemisphere (favored for inferences and emotions) would form more causal inferences than the left hemisphere (favored for word recognition and categorization). Utilizing a divided-visual-field paradigm, responses to target words were measured in four experiments. Experiment 1 measured responses to target words that were related to inferences relative to explicit text targets; Experiment 2 modified inference-relative targets to be valence-inconsistent; and Experiments 3 and 4 modified the texts to be present, rather than past, tense. Interactions between valence and formation of inferences depended upon hemisphere. Despite the theoretical suggestions that emotional language and inference formation should combine to produce right over left hemisphere advantages, results demonstrated a division of labor across valences. Findings suggest the left hemisphere may be as important to inference formation as the right hemisphere when positive emotions are being processed.

## A61

### THE EFFECTS OF PERCEIVED SIMILARITY AND TRAINING ON NOVEL SPEECH ACQUISITION: AN FMRI STUDY

Victoria Wagner[1], Pilar Archila-Suerte[1], Ferenc Bunta[1], Arturo E. Hernandez[1]; [1]University of Houston — The current study sought to understand brain plasticity in adults associated with acquiring novel speech sounds of differing perceived similarity to native speech. English monolinguals underwent training session for native and novel bi-syllabic nonwords of varying perceived similarity while undergoing fMRI. Neuroimaging data was analyzed using ROIs based on previous literature. Overall, more similar stimuli elicited greater activation than less similar stimuli in bilateral caudate, left Heschl's gyrus, bilateral insula, right middle temporal gyrus, and bilateral putamen. Looking at the effects of training, there was greater activation for more similar compared to less similar stimuli in bilateral caudate, left Heschl's gyrus, left insula, right MTG and bilateral putamen, at the beginning of training while there was no difference for the final segment of training. Looking at the effect of training within the levels of similarity, more similar stimuli elicited greater activation in right STG at the beginning of training compared to the end of training. Investigating the effects of training on the less similar stimuli, there was greater activation at the end of training in right caudate, left insula, and bilateral putamen compared to the beginning of training, suggesting that participants were in the process of engaging new motor speech commands for these sounds. These results suggest that perceived similarity affects the neural recruitment involved with the acquisition of novel speech sounds.

## A62

### PERFORMANCE ON HIGHER-LEVEL LANGUAGE TASKS FOLLOWING LEFT ANTERIOR CINGULATE CORTEX LESION

Venugopal Balasubramanian[1]; [1]Seton Hall University — Does the left anterior cingulate cortex play a role in higher-level language functions? The current study attempts to answer this question. Method: Subject. JG, a 64 year-old male with a medical history of intracerebral hemorrhage induced lesion to the anterior inferior medial frontal lobe, and anterior cingulate cortex (ACC), served as the subject. Procedure: Clinical evaluation revealed moderate impairments in orientation, visual perception, verbal learning, and immediate and delayed memory for stories, and normal performance on Boston Naming Test, and low normal range in sentence comprehension on Token Test. The experimental tasks utilized in this study targeted higher-level language: Discourse Comprehension Test (DCT), Discourse production task (DPT) which involved immediate recall of propositions from the stories presented, and Linguistic Ambiguity Comprehension Test which assessed comprehension of lexical (LA), surface structure (SSA), and deep structure ambiguities (DSA). Results: JG's overall scores of 16 on the DCT was well below the scores (37.4) reported for normal controls, on DPT task his recall of the propositions in three stories has ranged between 0% and 20%, and on LACT, JG's scores were as follows: LA= 5, SSA = 3, and DSA = 1 which were well below the scores reported for normal controls (LA =10, SSA = 7.75, and DSA= 9.50). These results seem to offer support for the potential role of ACC in higher level language. This conclusion finds support in the emerging approach to the 'networks of brain' (Sporn, 2011) that allocates a central position to the ACC within the network.

## A63

### WHAT'S YOUR FUNCTION NARRATIVE CONJUNCTION? EVENT-RELATED BRAIN POTENTIALS TO NARRATIVE CONJUNCTION IN SEQUENTIAL IMAGE PROCESSING

Neil Cohn[1], Marta Kutas[1]; [1]University of California at San Diego — Visual narratives using sequential images often depict successive images with different characters, thereby requiring these images to be "conjoined" into a larger spatial environment containing all the characters (1). We used event-related brain potentials (ERPs) to determine whether these patterns require processing beyond that when characters are not involved in this type of narrative conjunction. Congruous Non-Conjunction sequences depicted a visual narrative starting with frames showing two characters, followed by a critical panel repeating the image of only the second character (i.e., [AB][AB][B]… with letters representing characters). Congruous Conjunction sequences showed the first character in one frame, then the second character in the next ([AB][A][B]…). Incongruous Non-Conjunction sequences started with different characters, then changed characters in the critical panel ([AC][AC][B]…), while incongruous Conjunction sequences began with two characters, showed the first character, then switched to a different character in the critical panel ([AC][A][B]…). An anterior negativity was greater to critical Conjunction panels than to Non-Conjunction panels, regardless of congruity. In addition, a posterior P600 was larger to panels in Conjunction sequences than Non-Conjunction sequences, and larger to incongruous sequences than congruous ones. Finally, regression analysis indicated that the anterior negativity effect was modulated by participants' frequency of reading Japanese comics growing up, consistent with corpus research showing this pattern more in Japanese than American comics (2). Thus, the comprehension of this narrative construction is modulated by fluency in specific "visual languages." 1. N. Cohn, Cognitive Science, 2013. 2. N. Cohn, et al. Frontiers in Psychology, 2012.

## A64

### PHONOLOGICAL SELECTION WITHIN POSTERIOR LEFT FRONTAL CORTEX

Malathi Thothathiri[1], Michelle Rattinger[1]; [1]George Washington University — Selecting and ordering speech sounds is a crucial component of language production. Based on prior evidence linking the left frontal cortex to selection and language processing, we hypothesized a role for this area in phonological selection. Using functional magnetic resonance imaging, we examined activation within a priori regions of interest (ROIs) to investigate sub-specialization. ROIs included posterior frontal regions associated with sequencing and phonological processing (BA 6, 44/6, 44/6/9, BA 44), and an anterior frontal region associated with controlled language processing

(BA 45/47). Participants (N=14. Mean age=22.13) covertly described visual scenes that depicted transitive actions involving two characters (e.g. "the surfer chased the surgeon"). In the baseline comparison condition, they covertly named single characters. We manipulated phonological onset overlap between nouns during the critical trials (Overlap: surfer, surgeon. Non-overlap: surfer, gymnast). Previous behavioral research suggests that onset overlap generates interference during multi-word production. We hypothesized that the resolution of such interference would require phonological selection, leading to greater activation in the overlap than the non-overlap condition. Results showed significantly greater activation for overlap versus non-overlap in the BA 6, BA 44/6, BA 44/6/9 and BA 44 ROIs but not in the BA 45/47 ROI (p's<.05). Whole-brain analyses (uncorrected voxel p<.001) corroborated these results. These results suggest sub-specialization within left frontal cortex whereby posterior portions, specifically near the prefrontal/premotor junction, may be involved in phonological selection. Damage to this region may impair the ability to select and sequence phonological representations, offering a potential explanation for production deficits in aphasia.

### A65

### NEURAL CORRELATES OF PROBABLISTIC CATEGORY LEARNING IN APHASIA

Sofia Vallila-Rohter[1], Swathi Kiran[1]; [1]Boston University — Probabilistic category learning has been extensively researched in cognitive neuroscience in order to better understand the processes and mechanisms engaged in learning (Ashby & Maddox, 2005). Despite major advances in our understanding of category learning, however, little remains known about probabilistic category learning in post-stroke aphasia and its consequence on language relearning in these individuals. Only recently has research explored category learning in patients with aphasia, demonstrating that some patients show intact category learning while others do not (Vallila-Rohter & Kiran, 2013). In the current study, therefore, we used functional magnetic resonance imaging (fMRI) to better understand the neural mechanisms engaged in nonlinguistic category-learning in patients with aphasia (PWA). Four PWA and three control participants completed our study. In a feedback-based task, participants learned to categorize fictional animals. Animals were established along a continuum based on the percentage of features shared with each of two prototypes. A perceptual-motor baseline required participants to determine whether animals appeared alone or in a pair. Behavioral analyses revealed that two profiles of learning arose among PWA and controls: learners and nonlearners. Behavioral differences were reflected in differential neural engagement during learning. Learners in both groups were found to produce few clusters of activation (Training > Baseline). Of particular interest, PWA engaged right middle frontal gyrus (MFG) and right inferior frontal gyrus (IFG). Control learners recruited IFG bilaterally. Nonlearners produced patterns of diffuse activation bilaterally in frontal, temporal and visual regions, suggestive of increased effort, monitoring and executive functioning throughout learning.

## LANGUAGE: Semantic

### A66

### SEMANTIC MEMORY DEFICITS IN TBI PATIENTS: AN FMRI AND MVPA ANALYSIS

Fanpei Gloria Yang[1], Tracy L Luks[2], Sara LaHue[2], Pratik Mukherjee[2], Peng-Yu Chen[1]; [1]National Tsing Hua University, Hsinchu, Taiwan, [2]University of California San Francisco, USA — Research has reported that patients with mild traumatic brain injury (TBI) suffer from impaired verbal memory using measures of neuropsychological testing. Verbal memory deficits might arise from failure in semantic control. The present study aims to study the semantic network in TBI patients in semantic competition and use an alternative fMRI analysis method, multi-voxel pattern analysis (MVPA), by using machine learning algorithm based on radial basis function (RBF) kernels to the classification of healthy controls and patients with TBI. Sixteen controls (12 males, 4 females, mean age=28.25, SD=7.56) and Nineteen patients (14 males, 5 females, mean age=31.27, SD=9.45) participated in the study. Subjects were asked to decide whether words in a pair were related, indicating their decision by pressing the buttons. Each trial contained the first pair as a probe, the second pair as a target, and a focal point. We had three conditions: consistent, inconsistent, and control. All image processing was performed using SPM5. We selected beta values of region of interest (ROI), left middle frontal gyrus (LMFG), left inferior frontal gyrus (LIFG), left precentral gyrus, left parahippocampul gyrus, left precuneus and thalamus, as the features for training the classifier. We found that when using the RBF kernel with all features, MVPA proved capable of discriminating at above-chance levels between healthy controls and patients with TBI. Additionally, using the RBF kernel with features only from left middle frontal gyrus and left inferior frontal gyrus performs better than former. The results suggested that MVPA can be used to distinguish the patients from healthy controls. The patients' worse performance of semantic competition might mainly result from the dysfunction of LMFG and LIFG.

### A67

### CLOSE, BUT NO GARLIC: PERCEPTUOMOTOR AND EVENT KNOWLEDGE ACTIVATION DURING LANGUAGE COMPREHENSION

Ben D. Amsel[1], Katherine A. DeLong[1], Marta Kutas[1]; [1]University of California, San Diego — Recent research has shown that language comprehension is guided by knowledge about the organization of objects and events in long-term memory. We use event-related brain potentials (ERPs) to determine the extent to which perceptuomotor object knowledge and event knowledge are immediately activated during incremental language processing. Event-related but anomalous sentence continuations preceded by single-sentence event descriptions elicited reduced N400s, despite these words' poor fit within local sentence contexts. Anomalous words sharing particular sensory or motor attributes with contextually expected words also elicited reduced N400s, despite being inconsistent with global context (i.e., event information). We show that this perceptuomotor-related facilitation is not due to lexical priming between words in the local context and the target, or associative or categorical relationships between the expected and unexpected targets. Exploratory analyses were consistent with non-identical time courses and neural generators of object and event knowledge activation. We also showed that performance on the category fluency test accounts for significant variance in the timing and amplitude of N400 expectancy effects. Overall our results suggest that perceptual and motor object knowledge and generalized event knowledge are immediately available to constrain expectations about upcoming language input.

### A68

### AM I LOOKING AT A CAT OR A DOG? TAXONOMIC INTERFERENCE IN THE EYE MOVEMENTS OF PATIENTS WITH PRIMARY PROGRESSIVE APHASIA.

Robert Hurley[1], Marsel Mesulam[1], Wei Huang[1], Joel Voss[1], Emily Rogalski[1], Mustafa Seckin[1]; [1]Northwestern University — Object naming and word comprehension impairments are common in neurodegenerative language disorders, known as Primary Progressive Aphasias (PPA). Loss of word meaning in PPA is associated with taxonomic blurring: words such as "dog" and "cat" are still recognized as referring to animals, but are no longer differentiated conceptually, resulting in coordinate errors in matching words to objects. In this study we used eye tracking methods to investigate how comprehension deficits in PPA affect verbally-cued visual search. Participants were shown noun cues followed by an array of 16 objects, and were tasked with pointing to the relevant object. The array included the target object and 15 foils that were either taxonomically related or unrelated to the target. Nine PPA patients with impaired word comprehension, 6 PPA patients with preserved comprehension, and 14 age-matched controls completed the study. Patients with comprehension impairments spent a disproportionate amount of time viewing related foils, an effect which was not present in the patients with preserved comprehension. This effect was primarily driven by a tendency for poor comprehenders to direct gaze back and forth, repeatedly, between a set of related foils on each trial. This suggests patients were accumulating and weighing evidence for a probabilistic rather than definitive mapping between the noun and several candidate objects. In contrast, controls and "good comprehenders" almost never directed gaze back to a previously-viewed foil. Neurodegeneration in PPA thus appears to distort word-to-object pathways prior to severing them, causing uncertainty in naming and recognition.

### A69

### EFFECTS OF SEMANTIC CONTEXT ON PROCESSING QUANTIFIER SCOPE AMBIGUOUS SENTENCES

Veena Dwivedi[1], Leslie Rowland[2], Kaitlin Curtiss[1]; [1]Brock University, [2]McGill University — In previous behavioural and ERP work we proposed that quantifier scope ambiguous (QSA) sentences of the form Every kid climbed a tree were processed using a shallow, heuristic mechanism. That is, readers did not interpret QSA sentences using algorithmic rules to disambiguate whether just one tree was climbed, or several. RTs/ ERPs for disambiguating continuation sentences such as The tree(s) was/were in the playground did not differ empirically from their controls. In contrast, other works have shown a preference for the singular continuation, which is the interpretation expected if QSA sentences are interpreted using algorithmic rules. Perhaps participants did not deeply process QSA sentences because every, which is a context-dependent quantifier, was previously presented without context. In the current self-paced reading study, 30 participants read 3 sentence discourses; first, a pre-context sentence such as The kids spotted the park during the long walk, followed by QSA context sentences (Every kid climbed a tree), and as in previous work, these were followed by either plural or singular continuation sentences. The hypothesis was that the addition of a pre-context sentence would result in greater attention in interpreting every, followed by deeper processing of the rest of the sentence. This would result in 'algorithmic first' processing. If so, then on-line RTs would reflect differences between the singular continuation and its control. Instead, preliminary results reveal that the addition of the pre-context sentence did not change the RT pattern as compared to previous work, suggesting that heuristic first processing is a general processing strategy.

### A70

### TRACKING LEXICAL AMBIGUITY RESOLUTION WITH ITEM-LEVEL MULTI-VOXEL PATTERN ANALYSIS

Elizabeth Musz[1], Sharon L. Thompson-Schill[1]; [1]University of Pennsylvania — In order to comprehend a sentence that contains a homonym, readers must select the ambiguous word's contextually appropriate meaning. We used item-level analyses of multi-voxel patterns to track the outcome of this ambiguity resolution, by measuring the similarity between neural patterns evoked by two distinct meanings of the same word. We first scanned subjects while they read sentences that biased the interpretation of homonyms toward their most frequent, dominant meaning (e.g. money bank), and then measured the multi-voxel patterns evoked by each homonym. We then presented subjects with the same homonyms, but in sentence contexts that biased the interpretation toward a subordinate, less common meaning. For these subordinate-biased sentences, we also manipulated the relative location of the disambiguating information: the resolving context either preceded the homonym (prior-subordinate; e.g., "river…bank"), or followed it (delayed-subordinate; e.g., "bank…river"). A whole-brain searchlight analysis revealed that in bilateral inferior frontal gyrus, the delayed-subordinate and dominant patterns were more similar than the prior-subordinate and dominant patterns. Follow-up analyses reveal that this effect may be partly driven by greater mean responses for delayed-subordinate than prior-subordinate items. Additionally, in left inferior temporal gyrus, the strength of each homonym's meaning dominance predicted the similarity between the dominant-biased and subordinate-biased homonym patterns, regardless of context position. These findings demonstrate the use of item-level, similarity-based analyses to measure the activation of contextually inappropriate word meanings.

### A71

### DO SENTENTIAL CONSTRAINT AND WORD EXPECTANCY EXERT SEPARABLE EFFECTS ON EYE MOVEMENTS DURING READING?

Kara D. Federmeier[1], Mallory C. Stites[1], Edward W. Wlotko[2]; [1]University of Illinois, [2]Tufts University — An eye-tracking study was conducted to investigate the separable contributions of sentential constraint and expectancy (cloze probability) on reading times. These two factors have been shown to have different effects on event-related potentials (ERPs) elicited during reading (Federmeier, Wlotko, De Ochoa-Dewald, & Kutas, 2007), but eye-tracking work has previously confounded them (Rayner & Well, 1996). The current study employs the stimuli from Federmeier et al. (2007), in which sentences with strong or weak constraint were completed with expected or unexpected (but plausible) words, the latter of which were critically matched for cloze probability across contexts. Findings revealed a graded effect of cloze probability on target word reading times, with no additional effect of constraint, replicating N400 patterns elicited by these stimuli. Overall sentence reading times were differentially inflated in strong constraint contexts with unexpected endings, mirroring the frontal positivity these stimuli also elicit. This parallel effect could index reinterpretation of the sentence triggered by the unexpected word. Analyses at an individual item level reveal correlations between ERP amplitudes and reading times on those words. This novel analysis strategy gives us the unique ability to identify relationships between brain electrical activity elicited during word-by-word sentence reading and their behavioral consequences in a different set of readers, which could help to identify the currently underspecified functional role of the frontal positivity effect.

### A72

### IDENTIFYING THE COGNITIVE LOCUS OF DEFICITS IN CONNECTIVITY DURING LEXICO-SEMANTIC PROCESSING IN AUTISM

Emily Coderre[1], Barry Gordon[1,2], Kerry Ledoux[1]; [1]Cognitive Neurology/Neuropsychology; Department of Neurology; Johns Hopkins University, [2]Department of Cognitive Science; Johns Hopkins University — Language deficits are a core symptom of autism spectrum disorders (ASD), particularly semantic integration of linguistic stimuli. However, semantic integration of non-linguistic stimuli such as pictures is not affected. This disassociation suggests that semantic processing is intrinsically intact in ASD but lexico-semantic connections are selectively disrupted. Such deficits may be associated with underconnectivity of long-range brain networks, such as those connecting language and semantic areas, in ASD compared to normal controls (NCs). We compared event-related potentials (ERPs) and electroencephalographic (EEG) coherence, a measure of neural synchronization, between high-functioning individuals with autism (HFAs) and NCs during semantic integration of pictures and words. We predicted similar N400 effects (larger negative amplitudes for unrelated than related stimulus pairs) between groups for pictures, but a smaller N400 effect for words in HFAs vs. NCs. We predicted similar coherence patterns in the theta band (associated with semantic processing) between HFAs and NCs for picture stimuli, reflecting intact visuo-semantic processing; but reduced left fronto-parietal coherence relative to NCs for word stimuli, reflecting impaired connectivity between lexical and semantic areas. NCs showed similar N400 effect magnitudes and theta coherence patterns for words and pictures. HFAs showed a larger N400 effect and greater centro-parietal theta coherence for pictures than for words. In group comparisons, HFAs showed smaller N400 effects than NCs for both pictures and words, but greater fronto-parietal theta coherence than NCs for words. The increased fronto-parietal coherence but smaller N400 effects for HFAs could suggest reduced efficiency of this functional connection during lexico-semantic integration in ASD.

## LONG-TERM MEMORY: Episodic

### A73

### CORTICAL REACTIVATION DURING MENTAL REPLAY IN AMNESIA

Marie St-Laurent[1], R. Shayna Rosenbaum[1,2], Rosanna K. Olsen[1], Bradley R. Buchsbaum[1,3]; [1]Rotman Research Institute at Baycrest, [2]York University, [3]University of Toronto — Neural reactivation occurs when patterns of brain activity elicited during event perception are reinstated at retrieval. It is assumed that reactivation takes place when a memory representation is vivid and specific. Several studies have applied Multivoxel Pattern Analysis (MVPA) to functional magnetic resonance imaging (fMRI) data to quantify neural reactivation in healthy populations. However, MVPA's potential as a tool to quantify memory impairment in clinical populations is relatively unexplored. With the current study, we used MVPA to assess the quality of memory representation in an individual with developmental amnesia due to a stroke that affected diencephalic structures. We tested NC, an individual with developmental amnesia, and 19 healthy age-matched controls on an fMRI task during which they viewed and mentally replayed a set of 11 short videos multiple times. We first used a pattern classifier trained and tested on independent sets of retrieval trials. NC's classification was normal on this measure, indicating that, despite his amnesia, his patterns of brain activity at retrieval were just as consistent and stimulus-specific as

those of controls. We used a second classifier, however, that was trained on perception trials and tested on retrieval trials in order to quantify neural reactivation. NC's classification on this measure was lower than classification in any of the controls, indicating that his patterns of brain activity were not modeled on activation patterns evoked during perception to the same extent as in controls. Our results demonstrate that MVPA can be used to quantify reduced memory specificity in single clinical cases.

## A74

### DISSOCIABLE HIPPOCAMPAL NETWORKS ARE ENGAGED IN AUTOBIOGRAPHICAL MEMORY RETRIEVAL DURING EVENT GENERATION AND DETAIL ELABORATION.

Signy Sheldon[1], Brian Levine[2,3]; [1]McGill University, [2]Rotman Research Institute, [3]University of Toronto — While it is clear that the hippocampus is critical for autobiographical memory (AM), it is unclear how the hippocampus interacts with cortical regions to support different aspects of AM retrieval, namely the search for a memory (construction) versus the detailed re-experiencing of that event (elaboration). Given recent findings that anterior and posterior segments of the hippocampus support different mnemonic processes, we considered this question by investigating the different contributions of anterior/posterior hippocampal networks to AM construction and elaboration. We also compared these contributions to constructing and elaborating on non-episodic information. fMRI data was collected as 27 participants were cued to retrieve an AM (construction) and then recover the associated episodic details (elaboration). In two non-episodic conditions, they were cued to retrieve and elaborate on a specific spatial location or features of an imagined object. During the AM construction phase, the left anterior hippocampus was preferentially connected to a pattern that included the angular gyrus, inferior temporal gyrus and anterior prefrontal cortex. During AM elaboration, the left posterior hippocampus was associated with a connectivity pattern that included posterior neural regions such as the posterior cingulate, the precuneus and visual association cortices whereas the left anterior hippocampus was associated with a pattern that included the bilateral inferior and superior temporal gyri. Distinct patterns of anterior and posterior hippocampal connectivity also emerged for the two non-episodic conditions. These findings are discussed in the context of the processing requirements during critical aspects of AM retrieval and hippocampal functional specialization.

## A75

### OBESITY IN VETERANS IS ASSOCIATED WITH CHANGES IN HIPPOCAMPAL MORPHOLOGY

Michael V. Stanton[1,2], Salil Soman[1,2], Tong Sheng[1,2], J. Kaci Fairchild[1,2], Jordan M. Nechvatal[1,2], Ansgar J. Furst[1,2], Maheen M. Adamson[1,2], Peter J. Bayley[1,2]; [1]VA Palo Alto, [2]Stanford University — Obesity has been associated with a number of cognitive impairments in humans including deficits in executive function and memory. However, the literature is limited on how these deficits are mediated by specific brain regions. One suggestion is that obesity may be related to hippocampal dysfunction. Accordingly, we explored the relationship between hippocampal morphology and obesity in a sample of Veterans (N=110, mean age = 46.74, SD = 11.51, 97 males) among whom excess weight is a major health problem (nationally, 78% are either overweight or obese). We used clinical interviews and self-report instruments to obtain health-related data. Hippocampal subfield volumes were obtained from structural MRI images using Freesurfer segmentation processing. Regression models were run, predicting values of hippocampal subfields from body mass index (BMI) while adjusting for sex, age, intracranial volume, presence of posttraumatic stress disorder (PTSD), and presence of depression (Beck Depression Inventory). Results showed that BMI predicted greater width of the left hippocampal fissure ($p<.05$). A trend was also found for greater BMI to predict a reduced right CA1 hippocampal volume. In conclusion, obesity may be associated with changes in hippocampal morphology and a reduction in the volume of certain hippocampal subfields. These brain alterations may have negative implications for cognitive performance, specifically memory performance among obese and overweight veterans.

## A76

### AN FMRI STUDY OF PERCEPTUAL AND CONCEPTUAL PROCESSING DURING MEMORY ENCODING

Wei-Chun Wang[1], Roberto Cabeza[1]; [1]Duke University — Recent work indicates that medial temporal lobe regions traditionally thought to subserve episodic memory may also be critical for perceptual discriminations. The current study seeks to investigate 1) whether such effects extend to conceptual discriminations and 2) whether medial temporal lobe regions that support perceptual and conceptual discriminations also relate to subsequent memory. Twenty healthy participants completed study-test blocks in an fMRI scanner. The encoding task consisted of a triplet odd-one-out face or word discrimination task and the retrieval task consisted of a recognition memory test for either faces or words. Preliminary analyses indicate that, for both perceptual and conceptual discriminations, activity in frontal regions increased as a function of task difficulty. On the other hand, temporal regions – particularly the anterior medial temporal lobes – negatively related to task difficulty. Furthermore, these frontal and medial temporal regions partially overlapped with regions showing subsequent memory effects for both faces and words. These results indicate that frontal and temporal regions subserve both the on-line processing of perceptual and conceptual information as well as the subsequent recognition of this information.

## A77

### WHOLE-BRAIN CHANGE IN FUNCTIONAL CONNECTIVITY ASSOCIATED WITH SUCCESSFUL AND UNSUCCESSFUL RECOLLECTION

Danielle King[1], Marianne de Chastelaine[1], Rugg Michael[1]; [1]Center for Vital Longevity and School of Brain and Behavioral Sciences, University of Texas at Dallas — Previous studies have demonstrated that functional connectivity between distinct brain regions increases as a function of recollection success (e.g., King et al., under review; Schedlbauer et al., 2014; Watrous et al., 2012). For instance, in one study, regions that showed increased activity during successful relative to unsuccessful recollection also demonstrated enhanced recollection-related changes in connectivity with a widely distributed set of brain regions (King et al., under review). However, previous analyses investigated changes in connectivity with only a limited set of brain regions that are known to play a role in episodic memory. Here, we examined recollection-related changes in connectivity throughout the entire brain. Participants were scanned during an associative recognition task. Separate psychophysiological interactions (PPI) analyses were conducted for 90 seed regions (defined by the AAL atlas) to estimate changes in functional connectivity associated with successful and unsuccessful recollection. For each seed region, the mean parameter estimate of connectivity change associated with both successful and unsuccessful recollection was extracted for each of 90 target regions, which were then entered into two separate whole-brain seed-target connectivity matrices. We then applied Graph Theory metrics to characterize whole-brain network properties associated with successful and unsuccessful recollection. The results of these analyses demonstrated significant differences in the patterns of whole-brain functional connectivity associated with successful and unsuccessful recollection. Specifically, the networks differed in terms of the overall density of connections, as well as the regions that showed the greatest change in functional connectivity during successful or unsuccessful recollection.

## A78

### BASE RATE MANIPULATIONS INDUCE MODULATIONS WITHIN THE POSTERIOR PARIETAL CORTEX

Amy Frithsen[1], Michael Miller[1]; [1]University of California, Santa Barbara — Previous work has shown that activity within the dorsal posterior parietal cortex (PPC) is modulated by changes in base rate information. When the probability of an old item is high, criterion levels are laxed and activity is attenuated. Conversely, when the probability of an old item is low, criterion levels are increased and activity is augmented. While this result has been reproduced within the dorsal PPC areas, it is not yet clear if the same modulation holds true for the more ventral PPC subregions. In order to test this claim, we had twenty subjects take a remember/know test while in an fmri scanner. Subjects were correctly told that during the likely condition 70% of the test items were old and that during the unlikely condition only 30% of the items were old. Responses were separated according to condition and response type (remember and know). Behavioral results showed a modest, yet statistically significant

shift in criterion with subjects adopting a relatively more strict criterion in the unlikely compared to the likely condition. This was most evident for know responses. Neural results replicated (although to a lesser magnitude) a modulation in dorsal PPC activity between condition, with the superior parietal lobule (SPL) more active during the unlikely condition. For the ventral PPC regions, the reverse pattern was observed. Specifically, ventral activations tended to be greater in the likely condition. These results are discussed in terms of how they may be related to theories as to how this area contributes to memory retrieval.

## A79

### CATEGORY-SPECIFIC PATTERNS OF RECOGNITION MEMORY SIGNALS IN PERIRHINAL AND PARAHIPPOCAMPAL CORTEX

Chris Martin[1], Stefan Köhler[1,2]; [1]Brain and Mind Institute, Western University, [2]Rotman Research Institute, Baycrest Centre — A substantial body of research has identified item-based recognition memory signals in perirhinal cortex (PrC) that can be observed even in the absence of recovery of episodic context. Recent fMRI evidence suggests, however, that parahippocampal cortex (PhC) may also carry such signals for items from specific visual categories. The stimulus dimensions that determine whether item-based memory signals are localized in PrC or PhC remain unknown. Evidence obtained in non-mnemonic tasks suggests that PhC may specifically represent objects that are large in real-world size and stationary - properties that make them relevant as potential landmarks for navigation. Here we employed multi-voxel pattern analysis of fMRI data to investigate the impact of object mobility on recognition-memory signals in the medial temporal lobe. To address this issue we examined patterns of activity in PrC and PhC related to recognition memory for buildings (stationary), trees (stationary), and planes (mobile). During scanning, participants discriminated between previously studied and novel items. To minimize any influence of contextual information we excluded trials in which participants reported recollection. In right PhC, we observed patterns of activity that allowed us to classify recognition decisions for buildings and trees, but not planes. By contrast, in right PrC we were able to classify recognition decisions only for planes. Our findings confirm that both PrC and PhC carry item-based recognition memory signals (devoid of context). Moreover, these data suggest that mobility is a critical determinant as to whether category specific memory signals are localized in PrC or PhC.

## A80

### ERP SUBSEQUENT MEMORY EFFECTS DIFFER BETWEEN INTER-ITEM AND UNITIZATION ENCODING TASKS

Siri-Maria Kamp[1], Regine Bader[1], Axel Mecklinger[1]; [1]Saarland University — In the "subsequent memory paradigm", brain activity is recorded during the encoding phase of a memory experiment. In the analysis, trials are sorted into those that are associated with successful retrieval in the memory test and those that are not. Contrasting these trial groups reveals brain activity associated with successful encoding and subsequent retrieval. The ERP components that are most frequently reported as exhibiting "subsequent memory effects" are the P300 and the (typically) frontally distributed slow wave. However, to date, a clear characterization of the circumstances under which each subsequent memory effect is observed is missing. We tested the hypothesis that the P300 subsequent memory effect is observed during unitization encoding, while the frontal slow wave effect occurs in an inter-item encoding condition under otherwise matched study phases of a recognition memory experiment . Forty-two participants were presented either with word pairs together with a definition that allowed to combine the word pairs to a new concept (unitization encoding), or together with a sentence frame (inter-item encoding). Performance on the recognition test did not differ between encoding conditions. The frontal slow wave subsequent memory effect was observed in both encoding conditions, but the parietal (P300) subsequent memory effect occurred only in the unitization encoding condition. We propose that the P300 subsequent memory effect occurs when the components of an association are integrated in a single configuration and form a unitized representation, while the frontal slow wave effect reflects processes more generally involved in associative encoding.

## A81

### LARGE-SCALE FUNCTIONAL NETWORK ORGANIZATION DYNAMICALLY CHANGES ACROSS AUTOBIOGRAPHICAL MEMORY RETRIEVAL PROCESSES

Cory Inman[1], G. Andrew James[2], Katherine Watts[3], Stephan Hamann[1]; [1]Emory University, [2]University of Arkansas for Medical Sciences, [3]National Institutes of Health — Autobiographical memory (AM) retrieval involves the orchestration of multiple cognitive and neural processes that evolve over an extended time period, including memory access and subsequent elaboration. Previous neuroimaging studies have contrasted memory access and elaboration processes in terms of regional brain activation and connectivity within coordinated multi-region networks rather than between specific regions like the hippocampus and prefrontal cortex (PFC). Using fMRI, we tested the hypothesis that early, access-related retrieval processes would primarily recruit fronto-temporal connectivity involved in memory search processes and later, elaboration-related processing would primarily recruit occipito- and fronto-parietal connectivity involved in imagery and working memory processes. Healthy adults generated specific AMs to personal cue words in a pre-scan session and were later cued to retrieve the AMs during scanning. We used moving-window cross-correlation and graph theory analyses to examine dynamic changes in the strength and organization of connectivity among regions involved in AM retrieval. Consistent with our hypotheses, dynamic cross-correlation analyses revealed a stronger fronto-temporal network during the early-access period and stronger occipital- and fronto-parietal connections in later-elaboration periods that persisted throughout retrieval. Whole brain graph theory analyses revealed that the right ventrolateral PFC and left anterior hippocampus were more central to integrating distributed information early in retrieval, while the bilateral occipital cortices were increasingly more central during late-elaboration periods. These findings provide evidence that accessing and reconstructing memories from one's personal past involves specific, dynamic changes from more anterior to posterior connectivity as an autobiographical memory is accessed, selected, elaborated upon, and maintained in working memory.

## A82

### FUNCTIONAL AND STRUCTURAL DIFFERENCES IN THE ANTERIOR HIPPOCAMPUS UNDERLYING IMPAIRED ASSOCIATIVE ENCODING IN OLDER AS COMPARED TO MIDDLE-AGED ADULTS

Kristin Nordin[1], Jonas Persson[1], Elna-Marie Larsson[2], Hedvig Söderlund[1]; [1]Uppsala University, Uppsala, Sweden, [2]Uppsala University Hosptial, Uppsala, Sweden — Episodic memory performance often decreases with age, especially for associative memory. The anterior hippocampus is frequently engaged during associative encoding, and is also the part of the hippocampus that shows age-related reductions in volume. Although much is known about differences between young and old adults, less is known about those in middle age, when cognitive and cerebral changes are starting to occur. Here we scanned middle-aged and older adults (40-50/60-70 years old) during deep encoding and recognition of word-pairs. The middle-aged group's superior performance was not reflected in more hippocampal activity overall, neither during encoding or retrieval, but in more left anterior activity during successful encoding. During successful recognition, on the other hand, the older group showed activity in the right posterior hippocampus not present in the middle-aged. Structurally, left anterior hippocampal volume was greater in middle-aged than old participants and volume within this region correlated positively with performance across age groups. This suggests that the commonly observed associative deficit in older adults is due to impaired anterior hippocampal function during encoding, which, in turn, is mediated by age-related atrophy, and that more hippocampal engagement is required during successful recognition, possibly as a compensatory mechanism.

## A83

### TRANSCRANIAL DCS STUDIES EXAMINING THE ROLE OF THE PARIETAL CORTEX IN RECOGNITION

Denise Pergolizzi[2], Elizabeth F. Chua[2]; [1]The Graduate Center, CUNY, [2]Brooklyn College, CUNY — We previously found that transcranial direct current stimulation (tDCS) over the parietal cortex increased false recognition when false recognition was relatively high. Here, we first asked if parietal stimulation increased false recognition

when rates were low. Participants received parietal (2 mA; n=18), prefrontal (2 mA; n=18), or sham (n=18) tDCS during an item and source recognition test, which had low rates of false recognition. Kruskal-Wallis tests showed that the mean ranks for false recognition differed between groups ($p<0.05$; parietal = 21.17, prefrontal = 26.06, and sham = 35.28), but not true recognition. Contrary to our previous findings, post-hoc tests revealed this to be driven by lower false recognition for parietal compared to sham participants, $p<.05$. One possibility for these differences for high and low rates of false recognition is that contextual cues from the experiment interact with mnemonic functions of the parietal cortex. To examine this, we randomly presented external cues at test, which validly predicted upcoming memoranda as old or new 75% of the time. Participants received parietal (2 mA; n=16), prefrontal (2 mA; n=15), or sham (n=17) tDCS during test. Preliminary results from an ANCOVA model revealed, when controlling for baseline recognition, the parietal group integrated cues marginally more than sham ($p<.098$) during validly cued hits, but less than frontal ($p<.05$). The parietal group showed marginally increased performance compared to frontal ($p<.051$) but decreased compared to sham ($p<.09$) during invalidly cued correct rejections. This provides preliminary evidence that the parietal cortex may integrate external cues into recognition judgments.

## A84

### INDIVIDUAL DIFFERENCES IN ASSOCIATIVE LEARNING AND DELAYED RETRIEVAL PREDICTED BY WHITE MATTER CONNECTIVITY

Kylie H. Alm[1], Ashley Unger[1], Tehila Nugiel[1], Hyden R. Zhang[1], Tyler M. Rolheiser[1], Vanessa Troiani[2], Ingrid R. Olson[1]; [1]Temple University, [2]Geisinger Autism and Developmental Medicine Institute — There are striking individual differences in the ability to learn and later retrieve information. It is possible that behavioral variability can be explained by white matter variability. Two candidate tracts are the uncinate fasciculus (UF) and the inferior fronto-occipital fasciculus (IFOF). The UF connects the anterior/medial temporal lobes to orbitofrontal cortex and has been implicated in episodic and semantic memory retrieval (Metzler-Baddeley et al., 2011). The IFOF connects extrastriate cortex with lateral/orbital frontal cortices and has been implicated in semantic memory retrieval (Duffau, 2013). However, interpretation of these literatures is clouded by testing of older and disordered populations and an over-reliance on neuropsychological tests. We used diffusion tensor imaging in 17 neurologically normal adults. Participants performed an associative learning task where they learned face-landscape pairs over the course of 400 trials. After a 30 minute filled delay, there was a surprise recognition test. Tractography was performed to compute axial diffusivity (AD) and mean diffusivity (MD) of the UF and IFOF. There was a significant relationship between performance on the associative learning task and microstructural integrity of the left UF ($p = .04$), as well as a marginally significant relationship with the left IFOF ($p = .07$). After the delay, memory performance continued to be related to UF microstructure ($p = .02$), but not IFOF microstructure ($p = .31$). These findings suggest that both the UF and IFOF play a role in the initial learning of associations; yet, only the UF is important for facilitating the delayed retrieval of such associations.

## A85

### ELECTROPHYSIOLOGICAL CORRELATES OF MEMORY INTRUSIONS

Robin Hellerstedt[1], Mikael Johansson[1], Michael C. Anderson[2]; [1]Lund University, [2]University of Cambridge — Involuntary retrieval of unwanted episodic memories is a core symptom of posttraumatic stress disorder. With an aim to investigate the neurocognitive mechanisms underlying such intrusions, electrophysiological measures of brain activity were recorded while the participants engaged in a think/no-think task. The left hand word (stimulus word) of previously encoded word pairs was presented in green or red font. The participants were instructed to think of the associated right hand word (response word) when the stimulus word was presented in green (think condition) and to avoid thinking of the response word when the stimulus word was presented in red (no-think condition). The participants rated the extent to which they thought of the response word in the end of each trial. These ratings were used to contrast intrusion trials to non-intrusion trials within the no-think condition. Intrusions were predicted to be reflected in a left parietal positivity, an ERP correlate of recollection. Surprisingly, the ERP results revealed that this recollection effect was absent for intrusions, indicating that this component reflects controllable retrieval processes. Intrusions were instead related to a central negative slow wave 600-750 milliseconds post stimulus presentation. Similar negativities have been related to working memory maintenance, so this effect may reflect activation of the response word in working memory. Consistent with this interpretation, a similar effect was present in the think condition. The duration of the effect was shorter for intrusions, suggesting that the participants managed to purge the intruding response word out of working memory in the no-think condition.

## A86

### CONTENT-SPECIFIC NEURAL CORRELATES OF MEMORY RETRIEVAL

Amie N. Doidge[1], Edward L. Wilding[1], Lisa H. Evans[1]; [1]Cardiff University Brain Research Imaging Centre, School of Psychology, Cardiff University, UK — The sensitivity of event-related potentials (ERPs) to content-specific episodic retrieval is not well established. There is good evidence to suggest that memory for faces exhibits a different neural signature than memory for words. Mixed results, however, have been obtained from studies with memoranda other than faces. One confound in many of these studies is that memory accuracy has not typically been matched. In the absence of this, any difference between neural activities could be due to relative task-difficulty. Here, ERPs were acquired in a memory task where piloting determined that the accuracy of memory judgments was equivalent for visually presented words encoded under two conditions. At study, words were followed either by a visual image of the item denoted by the word or a blank screen, which prompted participants to imagine the denoted item. A signature of successful episodic retrieval was present over left-parietal scalp between 500 and 800ms post-stimulus for both conditions. An additional anteriorly-distributed modulation in the same time period was evident for imagined items only. These data provide strong evidence to suggest relative task-difficulty is not responsible for content-specific indices of successful episodic retrieval. One possibility is that this anterior modulation is sensitive to the recovery of operations engaged when items were encoded. This interpretation gains support from the frontal distribution of this modulation, alongside data suggesting that lateral and medial anterior prefrontal cortex have similar functional properties.

## A87

### BOUNDARY CONDITIONS FOR PREPARATORY RETRIEVAL PROCESSING

Angharad N. Williams[1], Lisa H. Evans[1], Edward L. Wilding[1]; [1]Cardiff University Brain Research Imaging Centre (CUBRIC), School of Psychology, Cardiff University, UK — In several event-related potential (ERP) studies of preparatory retrieval processing, neural activity associated with preparing for episodic retrieval is more positive-going at right-frontal sites than activity associated with preparing to complete tasks with no episodic demand. This activity has been proposed to index retrieval mode, which is a task set that ensures stimuli are treated as cues for episodic retrieval. This effect has been observed in experiments requiring frequent switches between two tasks. In contrast to the general task-switching literature, however, limited attention has been paid in ERP memory studies to design elements which might influence how people can prepare for episodic retrieval. Here, the factors of the predictability of task-switching requirements and time to prepare were manipulated. When the sequence of the cue that signalled which task to complete was predictable, and the interval between participant response and the next cue (response-cue interval, RCI) was 1200ms, there was no evidence for an ERP index of retrieval mode. This index was evident, however, when the task-cue sequence was unpredictable and the RCI was 500ms. Moreover, it was evident following the task-cue on the first trial of a given task only (switch trials), contrasting with several previous findings where it was evident only on the second successive trial of the same task (stay trials). These findings highlight the need to consider design factors to constrain explanations for when preparation for episodic retrieval is enabled, and, consequently, to understand the benefits that preparation for episodic retrieval affords.

## A88

### PARAMETRIC TRUE AND FALSE MEMORY CONFIDENCE EFFECTS IN VISUAL REGIONS AND PREFRONTAL CORTEX

Sarah Kark[1], Scott Slotnick[1], Elizabeth Kensinger[1]; [1]Boston College — Prior work has reported increased activation in visual processing regions and prefrontal cortex (PFC) during true and false memory (Chua et al., 2004; Slotnick & Schacter,

2004). The present study extended this research by examining how visual activity and PFC activity tracked subjective confidence in true and false memory judgments. During fMRI, thirteen participants (aged 19-35) studied line-drawing outlines of photos, followed by the complete photo. Participants were then shown outlines of the previously studied and new photos and asked to make an old-new recognition judgment and a sure-unsure confidence rating. Parametric modulation analyses were conducted to examine how activity in visual regions and PFC varied as a function of confidence during true and false memory. Activity in late visual regions (BA19/37) showed a significant positive modulatory effect of confidence ratings for both hits and false alarms (FAs), and a conjunction analysis confirmed that these regions tracked confidence for both true and false memories. While the parametric Hits>FAs contrast revealed a stronger parametric relation in the ventral visual pathway (BA20), the FAs>Hits contrast revealed no activity in the ventral visual pathway but a stronger parametric relation in the left lateral PFC (BA9). These findings demonstrate shared underlying visual activity (BA19/37) may support subjective memory experience for true and false memory, suggesting a general role in memory confidence. These results also indicate a sensory signature in BA20 specific for increasing confidence in veridical memories, while activity in lateral PFC appears to be specific for increasing confidence in illusory memories.

### A89

### THE UPS AND DOWNS OF REPEATED STUDY: AN FMRI INVESTIGATION OF COMPETITIVE MEMORY INTERFERENCE

Zachariah Reagh[4], Elizabeth Murray[4], Michael Yassa[4]; [1]Department of Neurobiology and Behavior, [2]Institute for Memory Impairments and Neurological Disorders, [3]Center for the Neurobiology of Learning and Memory, [4]University of California, Irvine — Many theories assume that repeated study enhances memory representations. We recently proposed Competitive Trace Theory (Yassa & Reagh, 2013), an account of how hippocampal computations can influence memory representations. One hypothesis arising from this theory is that repetition of an identical stimulus can induce highly similar but not perfectly overlapping memory traces, which can compete for representation during retrieval. This would result in enhanced recognition of the information at the cost of diminishing episodic details. We demonstrated behavioral evidence for this effect in a recent publication (Reagh & Yassa, 2014). The present study replicated this behavioral outcome of enhanced target recognition and diminished similar lure discrimination with stimulus repetition, and utilized fMRI to investigate the neural mechanisms of this tradeoff. Toward this end, we developed a novel high-resolution fMRI scanning sequence (1.8mm isotropic voxels) that captures the medial temporal lobes similarly to our prior work, but also includes most of the frontal and parietal cortices. We demonstrate evidence for a dynamic interplay among hippocampal and neocortical regions with repeated study events and subsequent memory judgments over these items. We take our findings as support for Competitive Trace Theory. We furthermore posit that repetitions of a stimulus may speed up consolidation processes via competitive interference, leading to a strong semantic trace but diminished episodic details for a given memory representation.

## LONG-TERM MEMORY: Semantic

### A90

### FILLING OR KICKING THE BUCKET: CONTROLLED SEMANTIC RETRIEVAL IS RELATED TO MICROSTRUCTURAL CHANGES IN LONG-RANGE FIBER PATHWAYS.

Ingrid Olson[1], Kylie Alm[1], Tehila Nugiel[1], Ashley Unger[1], Molly Split[1], Tyler Rolheiser[1]; [1]Temple University — In everyday conversation, we make many rapid choices between competing concepts and words in order to accurately convey our intent. Coherent communication is made possible by a complex language processing system that requires us to interpret sensory input, access our semantic memory, then select the concepts and words that will best carry out communication. Intraoperative stimulation studies in patients with gliomas have implicated a uniquely human white matter tract called the inferior fronto-occipital fasciculus (IFOF) in semantic retrieval (Duffau, 2013). The IFOF connects extrastriate cortex to lateral/orbital frontal cortices. Here, we used diffusion tensor imaging (DTI) in a cohort of neurologically normal young adults to further investigate the relationship between this tract and semantic processing. Deterministic tractography was performed to compute the fractional anisotropy (FA) and mean diffusivity (MD) of the IFOF. A control white matter tract believed to play a role episodic memory, the uncinate fasciculus (UF; see Alm et al., this conference), was also examined. In the semantic retrieval task (Snyder et al., 2010), participants were presented with a series of nouns and asked to generate the first verb that came to mind for each noun. Nouns were manipulated in terms of retrieval demand, indexed by association strength and reaction time. Our results revealed a significant relationship between semantic retrieval and IFOF microstructure, but not UF microstructure. These results indicate the IFOF not only plays a role in language processing, but is also specifically involved in the computations required for accurate, controlled semantic retrieval.

### A91

### PANTOMIMING OBJECT USE DECOUPLES FUNCTIONAL CONNECTIVITY BETWEEN TEMPORAL AND PARIETAL TOOL-SELECTIVE AREAS

Frank E. Garcea[1,2], Bradford Z. Mahon[1,2,3]; [1]Department of Brain and Cognitive Sciences, University of Rochester, [2]Center for Visual Science, University of Rochester, [3]Department of Neurosurgery, University of Rochester Medical Center — The ability to manipulate a tool according to its function requires the integration of visual, conceptual, and motor information, a process subserved in part by left parietal cortex (LPC). However, it remains poorly understood how LPC integrates these disparate types of knowledge during conceptual processing and object use. Here we used functional magnetic resonance imaging (fMRI) and functional connectivity analyses to study parietal representations of manipulable objects during task-based and resting state fMRI. In Experiment 1, participants viewed pictures of tools, animals, faces, and places in a category localizer experiment; voxels in LPC were clustered according to their patterns of functional connectivity with regions in the temporal, occipital and frontal lobes that also exhibited differential BOLD responses for tool stimuli compared to the other object categories. One cluster, in the inferior and lateral portion of LPC, expressed privileged functional connectivity to the motor system. A second cluster, in the anterior IPS, expressed privileged functional connectivity to ventral and lateral temporal cortex. A third cluster in superior parietal cortex expressed privileged functional connectivity to dorsal occipital cortex. In Experiment 2, we measured the degree to which task modulations altered the patterns of functional connectivity documented in Experiment 1. We found that functional connectivity between LPC and the ventral stream selectively decreased during object use pantomiming. These findings indicate that object use pantomiming decouples temporal-parietal functional connectivity, and outline a framework that generates novel predictions about the causes of some forms of upper limb apraxia.

### A92

### AN EXAMINATION OF MEMORY CONSOLIDATION DURING SLEEP USING AUDITORY WORD PAIRS

Jessica Creery[1], Robert Hurley[1], Ken Paller[1]; [1]Northwestern University — Sleep has been shown to be important for memory consolidation, although the mechanisms by which memories can be strengthened during sleep are not well understood. A powerful way to examine these mechanisms is through auditory stimulation during sleep, which can reactivate memories without producing arousal from sleep. Prior studies showed that Targeted Memory Reactivation (TMR) with sounds associated with prior learning can strengthen memories for cued information compared to memories for uncued information (reviewed by Oudiette & Paller, 2013). Sound cues can also provide a time-locking event for when reactivation presumably happens during sleep. We designed the current study to seek electrophysiological signs of memory processing during sleep, such as N400 potentials, which are known to reflect semantic processing with words. During an evening session, 16 participants learned 60 related and 60 unrelated word-pairs (e.g., table-chair, bike-ocean). Next, participants slept overnight, and 30 unrelated word-pairs were presented repeatedly during stage-2 and slow-wave sleep. After participants awoke, they took a recall test followed by a recognition test. EEG recordings throughout the experiment tracked sleep physiology and also allowed an examination of specific brain potentials to word pairs presented during wake and during sleep. We compared recall and recognition of the 30 cued pairs to the 30 uncued pairs. The memory benefit for cued words over uncued words was related to electrophysiological signals elicited in associ-

ation with cue presentations during sleep. Thus, we were able to use TMR during sleep to provide leverage on identifying electrophysiological signals relevant for memory reactivation.

## A93

### PUN COMPREHENSION: NEURAL BASIS FOR MAKING SENSE OF DOUBLE MEANINGS

Peng-Yu Chen[1], Fan-pei Gloria Yang[1], Fan-pei Gloria Yang[1], Sachien Sharma[2], Ari Bernstein[2], Navid Khodaparast[2], Daniel C. Krawczyk[2,3]; [1]National Tsing Hua University, Hsinchu, Taiwan, [2]The University of Texas at Dallas, [3]UT Southwestern Medical Center at Dallas — A pun is a play on words that uses different meanings or similar sounds of words to cause deliberate confusion. Previous research on figurative language processing (metaphors, irony, jokes) often suggested right hemisphere (RH) plays a special role in non-literal language processing. Functional Magnetic Resonance Imaging (fMRI) research also reported RH involvement in anomalous sentence processing. The present study used event-related functional magnetic resonance imaging to investigate the brain region involved in processing puns and non-meaningful sentences. Furthermore, determined whether we can distinguish between pun and non-meaningful sentences using multivoxel pattern analysis (MVPA).Sixteen participants (10 females, 6 males) read either puns (Math teachers have lots of problems), literal (Math teachers have lots of students), or non-meaningful sentences (Math teachers have lots of door handles) and had to press buttons with both thumbs when they finished reading the sentences. All image processing was performed using SPM5. We used beta values of many ROIs involved in processing puns and non-meaningful sentences for training the classifier. We found that the combination of right superior medial frontal gyrus, right insula, left inferior temporal gyrus and left angular gyrus is distinguish the two kinds of sentence better than chance and other combinations of ROIs. This result supports the point that comprehension of puns and non-meaningful sentences are involved different regions. The 4 regions we selected finally might be the critical difference when subjects processed the two kinds of sentence.

## A94

### DIFFERENTIAL REPRESENTATION OF INFORMATION IN HIPPOCAMPUS AND VISUAL CORTEX DURING PERCEPTION AND RETRIEVAL

Sue-Hyun Lee[1], Dwight Kravitz[2], Chris Baker[1]; [1]National Institute of Mental Health, National Institutes of Health, [2]The George Washington University — Memory retrieval allows humans to re-experience previously experienced events or stimuli. Such retrieval is thought to evoke similar representations in sensory cortical areas to those elicited during the actual experience. Recent neuroimaging studies investigating neural activation in sensory cortex support this idea, showing that cortical responses can be used to decode the identity of retrieved items based on the activation observed during perception. However, it remains unclear whether hippocampus, which has been thought to bind together sensory features to create a unitary representation of the actual experience, also shows similar neural activation during retrieval and perception. To compare these representations in hippocampus and visual cortex, we performed a 7T fMRI experiment with a long-term memory task, comprising separate perception, learning and retrieval sessions. Using multi-voxel pattern analysis, we found that object-selective cortex represents item specific information during both perception and retrieval, whereas hippocampus represents the specific information during retrieval only and not during perception. Moreover, in object-selective cortex but not hippocampus, there was close correspondence between the representations during perception and retrieval. To clarify whether hippocampal representations during retrieval are long-term memory specific, we also conducted a similar fMRI experiment with a short-term memory task. During retrieval of short-term memory, object-selective cortex but not hippocampus showed item specific representations during retrieval. These results suggest that while reactivation of representations in visual cortex can occur immediately, hippocampal representations depend critically on a time-consuming consolidation processes.

## A95

### FEATURE-BASED OBJECT MEMORY RETRIEVAL IN RETIRED PROFESSIONAL ATHLETES AS MEASURED BY EVENT-RELATED POTENTIALS

Julie Fratantoni[1], Bambi DeLaRosa[1], Scott K.M. Shakal[1], John Hart Jr.[1,2]; [1]Center for BrainHealth, The University of Texas at Dallas, [2]Department of Neurology and Neurotherapeutics, The University of Texas Southwestern Medical Center — Semantic feature integration is a cognitive phenomenon requiring coordination between dispersed cortical regions; subsequently, in injured and diseased states these circuits are disrupted. To investigate the neural mechanisms underlying dysfunctional semantic memory retrieval we recorded scalp electroencephalography (EEG) during an object retrieval task in 5 retired professional athletes with traumatic brain injury (TBI), 4 retired professional athletes with mild cognitive impairment (MCI), and 5 healthy controls (HC). The task involves object retrieval when two visual words representing object features are presented. In some instances the word pairs facilitate retrieval (i.e. "desert" and "humps" normally elicits "camel") and in other trials word pairs do not (i.e. "desert" and "barks"). Previous studies have found that during this task there is a late EEG amplitude difference between retrieval and non-retrieval word pairs (Hsueh-Sheng et al., 2014). In the current study we found that athletes with MCI had longer reaction times (M=1974.20 ms, SD=162.71ms) compared to healthy controls (M=1507.46 ms, SD= 387.52 ms) for the non-retrieval word pairs ($t(7)=3.901$, $p=.006$). Consistent with previous findings we also found amplitude differences between retrieval and non-retrieval word pairs in healthy controls ($t(4)=2.972$, $p=.041$). There was no significant amplitude difference between the two conditions for both the athletes with TBI and athletes with MCI. Findings suggest altered performance and disrupted electrical signatures of semantic memory retrieval in individuals with TBI and MCI.

## A96

### EXTENDING KNOWLEDGE THROUGH MEMORY INTEGRATION: THE EFFECT OF LAG DURING ENCODING

Nicole L. Varga[1], Patricia J. Bauer[1]; [1]Emory University — Understanding how knowledge is acquired is essential to understanding cognition. New content can enter the knowledge base through direct experience, and also through self-generative processes resulting from integration of information acquired across separate learning episodes. Indeed, in everyday contexts, individuals are frequently faced with the task of sorting through the vast amount of information encountered, integrating it with previously learned content, and extending upon what is already known. We investigated the effect of lag between separate but related learning episodes on this integration process. Twenty-seven adults read 40 pairs of novel facts (Apple seeds are called pips; Cyanide is found in pips) which could be combined to create novel integration facts (Apple seeds contain cyanide). Half of the to-be-integrated sentences were presented in each of two conditions: short lag and long lag (with M = 5 and 60 intervening sentences, respectively). Following the encoding task, event-related potentials (ERPs) were measured while participants read each of 80 sentences: 20 short-lag integrations, 20 long-lag integrations, 20 well-known facts, and 20 novel facts. A main effect of condition was observed at central-parietal electrodes during the N400 time window, $F(3,78) = 13.62$, $p = .001$. Bonferroni-corrected comparisons indicated that integrated knowledge assumed an intermediate status between novel and well-known information, irrespective of lag. Thus contrary to findings of a benefit of long lags on subsequent memory for separate episodes, newly-integrated knowledge was processed similarly regardless of the distance between items. This suggests differential processes for integrating versus segregating separate episodes of experience.

## A97

### VMPFC DAMAGE REDUCES INFLUENCE OF SCHEMATIC MEMORY IN A RECOGNITION MEMORY TASK

Kelsey Spalding[1], Samuel H. Jones[1], Melissa C. Duff[1], Daniel Tranel[1], David E. Warren[1]; [1]University of Iowa — Schemas are memory representations of typical experiences or settings, and schematic memory enhances reconstructive memory for typical events. However, this benefit of schematic memory may come at the cost of episode-specific information. Recent research suggests that ventromedial prefrontal cortex (vmPFC) may be important for schematic memory. We used a neuropsychological approach to test whether individuals with vmPFC lesions (N=5) would show a reduced influence of schematic memory, compared to healthy normal comparisons (NC; N=10), in a recognition memory task that provided schematically congruent or incongruent contexts for studied items. At study, participants visualized specific objects in normatively congruent or incongruent contexts (e.g., "cactus": "desert" or "ice rink"). At test, participants indicated whether objects (without context) were studied,

similar but not studied, or completely new. Congruent study contexts were expected to increase false recognition (similar items called studied) relative to incongruent contexts in the NC group due to increased schema influence and corresponding reductions in memory specificity. Planned comparisons supported this prediction. The NC group demonstrated increased false recognition in congruent contexts ($t(9) = 3.921$, $p = .004$). Critically, there was no difference in performance between congruent and incongruent contexts for the vmPFC group ($t(4) = .024$, $p = .982$), suggesting that vmPFC damage reduced the influence of schematic memory. These preliminary results are consistent with the proposition that vmPFC plays an important role in integrating previous experience into ongoing memory processes, and support the idea that vmPFC may be part of a larger network of brain regions supporting memory processes.

### A98

### THE REPRESENTATION OF OBJECT-DIRECTED ACTION AND FUNCTION KNOWLEDGE IN THE HUMAN BRAIN

Quanjing Chen[1], Frank Garcea[1], Bradford Mahon[1]; [1]University of Rochester — The appropriate use of everyday objects requires the integration of action and function knowledge. Previous research suggests that action knowledge is represented in frontoparietal areas while function knowledge is represented in temporal lobe regions. Here we used multivoxel pattern analysis to investigate the representation of object-directed action and function knowledge while participants executed pantomimes of familiar tool actions. A novel approach for decoding object knowledge was used in which classifiers were trained on one pair of objects and then tested on a distinct pair; this permitted a measurement of classification accuracy over and above object-specific information. ROI analyses showed that object-directed actions could be decoded in tool-preferring regions of both parietal and temporal cortex, while no independently defined tool-preferring ROI showed successful decoding of object function. However, a whole brain searchlight analysis revealed that while frontoparietal motor and peri-motor regions are engaged in the representation of object-directed actions, medial temporal lobe areas in the left hemisphere are involved in the representation of function knowledge. These results indicate that both action and function knowledge are represented in a topographically coherent manner that is amenable to study with multivariate approaches, and that the left medial temporal cortex represents knowledge of object function.

## PERCEPTION & ACTION: Audition

### A99

### COMPLETION OF A MUSICAL TRAINING PROGRAM ENHANCES PROCESSING OF ACOUSTIC FEATURES FOR SPEECH

McNeel Jantzen[1], Rebecca Scheurich[1], Cliff Hare[1], Nathan Braks[1], Chelan Bressers[1], K.J. Jantzen[1]; [1]Western Washington University — Our previous research has found that musicians have enhanced selective attention and increased sensitivity to acoustic features of speech that is facilitated by musical training and supported, in part, by right hemisphere homologues of established speech processing regions of the brain (Jantzen, Howe, & Jantzen, 2014; Jantzen and Scheurich, 2014). In the current study, we sought to provide evidence that musical training would enhance the processing of acoustic information for speech sounds. We hypothesized that non-musicians would have improved discrimination and enhanced sensitivity of acoustic features for speech stimuli differing in voice onset time after completion of a musical training program. Fifteen subjects first performed a perceptual mapping procedure using a synthetic continuum that ranged from the American English voiced alveolar [d] to the voiceless alveolar [t]. Subjects identified the stimuli (2AFC) and judged how good the stimuli were as exemplars of each of the two categories. Next, subjects received 11 sessions (one/day) of an ear-training program. Finally, the perceptual mapping was repeated immediately following training. Musical training effects and organization of acoustic features were reflected in the EEG as observed by location and amplitude of the ERP's. Results show early neural response to the acoustic features was both faster and greater following musical training. In addition, behavioral results indicate that the pattern of performance on the perceptual mapping procedure differed as a function of initial perceptual capabilities.

### A100

### THE ROLE OF MOTOR FORCE PARAMETERS IN ACTION-RELATED AUDITORY ERP ATTENUATION

Janos Horvath[1]; [1]Research Centre for Natural Sciences, Hungarian Academy of Sciences — The processing of action-induced stimulation is often attenuated in comparison to that caused by external sources. Specifically, self-induced sounds result in reduced event-related potentials (ERPs), when these are compared to ERPs elicited by externally induced sounds. In paradigms measuring action-related auditory attenuation, the auditory ERP contribution to the action-sound coincidence- related ERP is often estimated by subtracting a "motor-related" ERP, that is, an ERP recorded when the action does not result in a sound. The present study assessed the validity of this procedure by measuring the force applied to the response device in a sound-initiation, and a "motor" condition. Healthy, young adult participants (N=19) squeezed a response device for 2 s intervals. In the Auditory-Motor condition, squeezing the device resulted in a tone as long as the participant maintained pressure, but no tone was generated in the Motor condition. The N1 and P2 estimated by subtracting the motor-related ERP was attenuated in comparison to the ERPs elicited by a replay of the self-induced sounds. Importantly, however, the squeeze force-profiles were different between conditions: participants applied more pressure in the Motor condition. Although separating trials by the applied force showed ERP differences, these could not explain the ERP attenuations found in the N1 and P2 time-range. This suggests that although the estimation of the auditory ERP in the action-tone ERP is flawed, N1 and P2 attenuation is not brought about by a motor-related confound.

### A101

### PREDICTIVE ADAPTATION TO CHANGE IN BASAL GANGLIA PATIENTS: ELECTROPHYSIOLOGY, STRUCTURAL IMAGING, LESION-SYMPTOM MAPPING

Michael Schwartze[1], Anika Stockert[2,3], Sonja A. Kotz[1,2]; [1]University of Manchester, School of Psychological Sciences, [2]Max Planck Institute for Human Cognitive and Brain Sciences, [3]University of Leipzig, Language and Aphasia Laboratory — Efficient use of regular inter-event-relations, e.g., probabilistic associations or temporal regularity, allows predicting future events. In turn, the ability to predict future events may spare cognitive resources and optimize adaptation to an ever-changing environment. In concert with cortical areas, the basal ganglia (BG) engage in the processing of temporal inter-event-relations (intervals). However, less is known about functional implications of this mechanism and its interaction with cognitive behavior. Here, we investigated the impact of BG lesions on auditory event-related potentials of the electroencephalogram (ERPs/EEG) obtained in temporally regular and irregular contexts. Patients (N=30) and matched controls counted infrequent deviants (N=90, 660 Hz) presented among frequent standard (N=360, 600 Hz) equidurational (300 ms) tones in regular (inter-stimulus-interval, ISI: 600 ms) and irregular (ISI: 200-1000 ms) "oddball" sequences. Cognitive behavior associated with deviance processing (change) was assessed by means of N1, N2, P3a, and P3b ERP (sub-) components. Structural MRI scans were used to generate binary lesion maps to perform complementary lesion-symptom mappings. In controls, temporal regularity and deviance processing modulated early components independently and started to interact in later components. In patients, early responses were selectively indifferent to temporal regularity, while later responses to deviants were reduced in amplitude in the regular context, suggesting impaired temporal processing and subsequent use of temporal predictability. Mappings of amplitude and variability measures derived from the respective ERPs substantiate these findings. Taken together, the results provide evidence for both, modulation of cognitive behavior by temporal predictability and a critical contribution of the BG to this mechanism.

### A102

### THE EFFECTS OF SELF-SELECTED EMOTIONAL MUSIC ON EEG AND PAIN MODULATION

Trevor C. J. Jackson[1], Christine R. Jimenez[1], Mark W. Geisler[1]; [1]San Francisco State University — Music has been shown to have an analgesic effect for pain when it is self-selected (Mitchell & MacDonald, 2006) or positively valenced (Roy, Peretz, & Rainville, 2008). The current study investigated whether an analgesic effect of positive music is stronger than negative music when both musical excerpts are self-selected. EEG was

collected at bands of interest that included alpha (8-13 Hz), frontal-midline theta (4-8 Hz), and beta (13-30 Hz), and was recorded from Fz, F3, F4, Cz, C3, C4, Pz, P3, and P4. Participants chose one song that was rated as most positive, and one song that was rated as most negative. Participants then listened to white noise (as a control) and each musical excerpt (in a counterbalanced order) for 45 seconds before placing their hand into a pain-inducing cold-pressor task (CPT) while the music played. Length of time in the CPT was recorded, along with subjective pain intensity ratings (11-point continuous Likert scale) and continuous EEG. Preliminary results indicated longer times in the CPT for negative music compared to positive music and white noise. Pain intensity ratings were nearly identical for both positive and negative music, but were lower than white noise. EEG measures showed that, for positive music and white noise, frontal-midline theta power was maximal during the time immediately preceding hand placement in the CPT, then power decreased during the painful stimulus. For negative music, frontal-midline theta power was minimal during the time immediately preceding hand placement in the CPT, then power increased during the pain stimulus.

## A103

### ABNORMAL AUDITORY-MOTOR INTEGRATION OF VOICE CONTROL IN TEMPORAL LOBE EPILEPSY

Hanjun Liu[1], Weifeng Li[1], Shaozhen Chen[1], Peng Liu[1]; [1]Department of Rehabilitation Medicine, The First Affiliated Hospital, Sun Yat-sen University — A growing body of literature has shown the neural substrates involved in auditory-motor integration through the intra-cranial recordings of brain activity from patients undergoing temporal lobe epilepsy (TLE). Whether those findings can be generalised to normal populations, however, remains unclear. In the present study, we sought to examine whether patients with TLE differed from healthy controls in the auditory-motor integration in voice control. Following the altered auditory feedback paradigm, all participants were required to produce sustained vowels while hearing their voice feedback pitch-shifted in real-time. Vocal and neurophysiological responses to pitch perturbations in voice auditory feedback were measured and compared between two groups. Behavioral results showed significantly larger vocal responses in the TLE group as compared to the control group, and a positive correlation between response magnitude and the mean baseline pitch was found only in the TLE group. Neurophysiological results revealed a significant decrease of P2 response in the TLE group relative to the control group. Furthermore, there was a negative correlation between disease duration and P2 amplitude. Taken together, this study provides the first evidence demonstrating the abnormal auditory-motor integration in voice control in TLE at the levels of behavior and cortex. This may be related to the dysfunction of auditory-vocal system caused by epileptic seizure, suggesting that cautions must be exercised in interpreting the results of auditory-motor integration obtained from patients with TLE.

## A104

### PARAMETRIC EFFECTS OF GLOBAL AND LOCAL PRECEDENCE IN AUDITORY PERCEPTION

Alex Brandmeyer[1], Jonas Obleser[1]; [1]Max Planck Institute for Human Cognitive and Brain Sciences — Global and local processes in the perception of complex stimuli have been dissociated based on biases in perceptual behavior and the underlying neurophysiology. In audition, 'global' and 'local' have been primarily considered with respect to different temporal scales. Instead, the present magnetoencephalography study used spectrotemporally complex stimuli, with parametric manipulations of both global and local features. We asked how relevant and irrelevant stimulus dimensions would interactively shape perception. Acoustic textures consisting of densely layered tone sweeps varying in the coherence of their slopes (upwards or downwards, local feature), and with different spectral centers (global feature) were presented in pitch and direction judgement tasks using a within-subject (N=20) design. The irrelevant stimulus dimension was found to bias perceptual judgments both for congruent and incongruent stimuli: A strong global precedence effect occurred in the (local) direction task. Local precedence effects were also observed in the (global) pitch task when global cues were weak. The impact of local/global stimulus congruence on behavioral performance corresponded to modulations of the M100 component of the evoked field at sensors over left fronto–temporal regions. Additionally, it was found that parametric changes in global features during incongruent trials differentially modulated evoked activity in the M300 time window, depending on task setting: strong global cues led to increased activity in the pitch task, and to reduced activity in the direction task. Together, these results suggest that the precedence effects associated with local and global levels of perceptual processing also shape the perception of complex spectrotemporal sound features.

## A105

### A NEW ACOUSTIC SPACE TO INVESTIGATE HEMISPHERICAL ASYMMETRIES IN SPEECH

Adeen Flinker[1], David Poeppel[1]; [1]New York University — The left and right hemispheres have been argued to have different sensitivities to temporal and spectral auditory information, but the underlying cortical mechanisms remain unknown. Two related models posit that asymmetries arise from a relative difference in temporal integration windows (i.e. AST, Poeppel 2003) or a difference in spectral versus temporal resolution (i.e. Zatorre et al. 2002). Here we examine a unifying scheme based on the modulation power spectrum (MPS) of speech, providing a novel framework to parametrically manipulate speech stimuli and test psychophysical and neurophysiological responses. In contrast with a spectrogram, which represents the signal's amplitude across time and frequency, the MPS is a second order representation that assesses how the time-frequency power is modulated across the spectral and temporal axes. We propose that the two hemispheres integrate different ranges of spectral and temporal modulations. In order to address this hypothesis, we implemented a new filtering technique and varied the degree of spectral and temporal modulations in the signal to produce new sentences materials. We characterized the modulation space as a function of intelligibility as well as pitch (here: gender) identification. Neurophysiological responses (MEG power 0.1-8 Hz) across sensors correlated significantly with the temporal and spectral modulation space. The spatial distribution of sensors was more left lateralized for the temporal modulation axis and more right lateralized for the spectral modulation axis. Behaviorally, the fine-graded parametric steps reveal a sharp intelligibility cutoff, a right ear dichotic advantage as well as an influence of spectral modulation on pitch perception.

## A106

### ALTERED SENSORIMOTOR INTEGRATION IN FEEDBACK CONTROL OF VOCAL PITCH IN ALZHEIMER'S DISEASE

Kamalini Ranasinghe[1], Naomi Kort[1], Alexander Beagle[1], Jeevit Gill[1], Danielle Mizuiri[1], Susanne Honma[1], Keith Vossel[1], John Houde[1], Srikantan Nagarajan[1]; [1]UCSF — A compelling example of speech-motor integration is the pitch perturbation reflex in which speakers respond rapidly to shifts of the pitch of their auditory feedback. In response to brief perturbations of pitch in the auditory feedback subjects alter their vocalization to oppose the direction of the applied pitch shift. Previous neurophysiological studies have linked these specific adjustments in vocal output to integration between sensory feedback error-detection and motor error-correction circuits of speech motor control system. Such network integrations become vulnerable targets in neurodegenerative diseases like Alzheimer's disease (AD), which are characterized by distributed patterns of atrophy and functional dysconnectivity. In this study we tested the hypothesis that AD patients will demonstrate altered pitch-perturbation reflex resulting from lack of modulation of distinct network components. We examined the neural and behavioral responses of pitch-perturbation reflex in AD patients (n=12) compared to an age-matched control group (n=11). Subjects phonated the vowel /a/ while a real-time signal processor briefly perturbed (±100 Cent for 400ms) pitch of their auditory feedback. We used magnetoencephalography and examined the high-gamma (50–150Hz) evoked response during the pitch altered feedback response. We documented the degree of compensation demonstrated behaviorally by each subject by changing their pitch in response to the pitch altered feedback. Behaviorally, AD patients demonstrated an elevated compensatory response compared to age-matched controls. Neural analysis revealed that, AD patients show a significantly enhanced high-gamma evoked activity compared to age-matched control subjects. These results implicate lack of sensory-motor network modulation during auditory feedback-based control of pitch in AD.

# PERCEPTION & ACTION: Multisensory

## A107

### AOA AND HOURS OF PRACTICE INDEPENDENTLY AFFECT BRAIN ACTIVITY IN ATHLETES: AN FMRI STUDY.

Arturo Hernandez[1], Madeleine Gorges[1], Maya Greene[1], Brandin Munson[1], Kelly Vaughn[1], Victoria Wagner; [1]University of Houston — The present study investigated the neural correlates associated with time spent playing (practice) and the age of initial learning (AoA) of a sport in a group of athletes. Although age of acquisition is known to play a key role in a number of domains, only recently have studies begun to explore its importance in sport. The present study tested a group of athletes on a kinesthetic and auditory imagery task for both sport and environmental sounds. Results from a multiple regression involving both AoA and hours of practice revealed distinct areas of increased activity for both. Across all stimuli, earlier AoA revealed increased brain activity in areas involved in visual imagery as well as motor planning. Greater practice was associated with brain activity in the BA 17/18. Less practice was associated with brain activity in bilateral cingulate, right inferior parietal and inferior frontal areas. When sport and environmental sounds were considered separately there was an effect of both practice and AoA. For sport sounds, less practice was associated with increased activity in the hippocampus (bilateral), thalamus, BA 17/18 and the precentral gyrus. Later AoA was associated with increased activity in the inferior occipital gyrus. Very small effects were observed for environmental sounds. These results suggest that AoA of sport influences imagery in general. However, the number of hours of practice may be more crucial in moderating brain activity related to sports. Thus AoA may have a general influence on imagery whereas hours of practice may be more specific to sports.

## A108

### THE MULTISENSORY (AV) REPRESENTATION OF NUMBER

Edward M. Hubbard[1], Danielle T. Day[1], Christina T. Tran[1], Jennifer C. Hathaway[1], Grace C. George[1], Cooper Siepmann[1]; [1]University of Wisconsin-Madison — To assess the degree to which number is represented independent of sensory modality, we asked naïve adults to make judgments about small quantities (in the range from 7-10) of auditory beeps or visual flashes sequentially presented quickly enough to discourage counting. Adults 1) estimated the number of flashes or beeps (n = 50), or identified which of two intervals contained the larger number (2-AFC; n = 16) when presented with beeps or flashes, within and between modalities. In the estimation paradigm, we find classic signatures of the approximate number system, including approximate responding and increasing variability with larger numbers. Estimates of visual and auditory number were highly correlated across individuals, but sensitivity was not. In the comparison paradigm, adults successfully compared numbers across modalities, but within modality comparisons were more accurate than between modality comparisons. These data support the hypothesis of a shared neural system for multisensory number, but also suggest that non-abstract sensory processes also play a role. We next showed that presentation of congruent numbers of flashes and beeps (n = 16) led to multisensory enhancement for number, as demonstrated by faster and more accurate responses for the multisensory comparison, suggesting neural convergence of signals for number. Finally, we found that audition dominated nearly entirely when presented with conflicting numerical information (n = 16). Participants were able to accurately estimate the number of auditory beeps, and estimates were not affected by visual number. Estimates of visual number, however, were strongly affected by the number of simultaneous beeps presented.

## A109

### PREDICTIVE VISUAL MOTION FACILITATES SPEECH PERCEPTION

David Brang[1,2], Satoru Suzuki[1], Vernon L Towle[2], Sasha Wu[2], James X Tao[2], Marcia Grabowecky[1]; [1]Northwestern University, [2]University of Chicago — Auditory speech is typically accompanied by multisensory cues that actively enhance the speed and accuracy of auditory perception and compensate for degraded auditory processing in the presence of environmental noise or auditory deficits. Research investigating multisensory influences on speech perception has primarily focused on lip articulations during lipreading (speechreading) providing contextual information for a heard phoneme. However, benefits from multisensory integration are not limited to speech stimuli or contextual processes, and visual facilitation of speech perception may utilize other multisensory mechanisms. Here we demonstrate a novel form of multisensory facilitation present in natural speech, in which preparatory lip movements enhance phoneme recognition by predicting the timing of speech-sound onset. Healthy participants (n=20) were presented with one of four spoken phonemes (/ba/,/ga/,/ka/,/pa/) embedded in noise and were instructed to report the heard phoneme. Participants experienced a significant benefit of seeing predictive visual motion relative to seeing non-predictive motion or hearing auditory speech alone, highlighting the benefit for speech perception of sound-onset prediction from anticipatory visual motion. In order to examine the role of predictive visual information on auditory neural processes, we acquired intracranial electrocorticographic (ECoG) recordings from three patients undergoing evaluation for intractable epilepsy who performed the task. Indices of local spiking activity were computed from electrodes neighboring auditory cortex. Each of the three patients showed significantly reduced activation of auditory cortex on the predictive-motion trials relative to the non-predictive-motion or auditory-alone trials, suggesting that predictive visual motion reduces auditory processing requirements through enhancing perceptual fluency.

## A110

### TOP-DOWN REGULATION OF PRIMARY SOMATOSENSORY CORTEX WHEN JUDGING LATERALITY OF HAND IMAGES

Bettina Forster[1], Simone Tüttenberg[1], Alejandro Galvez-Pol[1], Antonella Giallonardo[1], Valentina Comiti[1], Beatriz Calvo-Merino[1,2]; [1]City University London, London, UK, [2]Universidad Complutense de Madrid, Madrid, Spain — Neuroimaging studies consistently report activation of somatosensory areas when viewing body images. To investigate whether recruitment of somatosensory areas is automatic or regulated via top-down processes (task set) when viewing body images we recorded electrocortical activity while participants performed two tasks: a laterality judgement task of hand images, and, in another part, a gender judgement task of the same hand images. Importantly, we probed activity within the somatosensory system by presenting task irrelevant tactile stimuli to the fingers (evoking somatosensory event potentials - SEPs). Further, to control for any visual evoked effects ERPs on visual only trials (without tactile probe) were subtracted from touch trials. The resulting difference SEPs showed significantly enhanced amplitudes at the P45 component in the laterality compared to the gender judgment task while later latencies show task differences over sensorimotor areas (frontal and parietal cortex). As the P45 reflects activity within primary somatosensory cortex (S1), and given we controlled for possible visual carry over effects by visual condition subtraction, our results provide evidence for a top-down regulation of S1 when judging body images and, thus, a flexible, task driven contribution of S1 to embodied cognition.

# PERCEPTION & ACTION: Motor control

## A111

### FUNCTIONAL ROLE OF DELTA AND THETA BAND OSCILLATIONS FOR AUDITORY FEEDBACK PROCESSING DURING VOCAL PITCH MOTOR CONTROL

Roozbeh Behroozmand[1], Nadine Ibrahim[2], Oleg Korzyukov[2], Donald Robin[3], Charles Larson[2]; [1]Speech Neuroscience Lab, Department of Communication Sciences and Disorders, University of South Carolina, [2]Speech Physiology Lab, Department of Communication Sciences and Disorders, Northwestern University, [3]Research Imaging Institute, University of Texas Health Science Center San Antonio — Speech motor control in a highly complex task that requires neural communication between spatially-segregated but functionally-related areas in the brain. The present study investigated the neural correlates of speech motor control by studying the spectro-temporal dynamics of EEG responses when three groups of non-musicians (NM), relative pitch (RP) and absolute pitch (AP) musicians maintained steady vowel sound vocalizations and received pitch perturbations in their voice auditory feedback. We identified two neural response components that highlighted different aspects of auditory feedback processing during vocal pitch motor control. The first component appeared as a phase-synchronized (evoked) fronto-central theta band (5-8 Hz) activity that temporally overlapped with compensatory vocal responses and was significantly stronger in RP and AP compared with NM. The second component was a

non-phase-synchronized (induced) frontal delta band (1-4 Hz) activity that had longer onset latency, extended beyond the duration of vocalizations and was stronger in the NM compared with RP and AP. These findings suggest that the evoked theta reflects top-down mechanisms of auditory feedback processing for vocal pitch motor control, and is also a neurophysiological marker of enhanced cognitive ability for pitch processing in RP and AP musicians. However, delta band activity seem to reflect neural processes by which the current state of the sensory-motor networks is updated during an adaptive process that drives subsequent speech motor behavior in response to perturbed auditory feedback. These findings provide new insights to distinctly different neural mechanisms that process auditory feedback for online monitoring and control of vocal pitch during speaking.

# PERCEPTION & ACTION: Multisensory

## A112

### LOCATION-SPECIFIC ADAPTATION OF AUDITORY EEG RESPONSES IS AFFECTED BY CROSSMODAL INTEGRATION

Talia Shrem[1], Leon Y. Deouell[1]; [1]The Hebrew University of Jerusalem — Space is a dimension shared by all modalities, but at what stage spatial encoding is affected by crossmodal integration is not clear. In light of direct connections between primarily unimodal sensory cortices, it is conceivable that relatively early processing is sensitive to crossmodal effects. Previous studies have found attenuation of the N1-P2 auditory evoked response following repetition of sounds from the same location. We asked whether this effect will be modulated by audio-visual interaction. We presented pairs of sounds in free field. The test sound was presented at a fixed lateral location. The preceding adapter sound was presented from the same location or from a more medial location, and was accompanied by a simultaneous flash displayed orthogonally from one of the two locations. Behaviorally, the sound-flash congruency affected the perceived adapter sound location (the ventriloquism effect). Overall we found attenuation of the N1- P2 complex relative to the response to the first sound. The attenuation of the N1 response was not affected by adapter sound location, but was affected by the location of the preceding flash, possibly due to spatial cueing. In contrast, attenuation of the P2 response was affected by the adapter sound location, being stronger when the adapter sound appeared at the same rather than different location. Importantly, this effect interacted with sound-flash congruency, such that spatially incongruent flashes reduced the location specificity effect. We conclude that spatial encoding in auditory cortex is not entirely unimodal and that it may be susceptible to crossmodal perceptual illusions of space.

## A113

### PREPARATORY PROCESSES OF MOTOR IMAGERY AND EXECUTION IN ADULTS WITH AND WITHOUT HAZARDOUS DRINKING PROBLEM: AN ERP STUDY

John Shing-Yu Chan[1], Yi Jin[1], Jin Hong Yan[2]; [1]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, 100875, China, [2]Institute of Affective and Social Neuroscience, Shenzhen University, Shenzhen, 518060, China — Alcohol intake has been shown to impair both cognitive and motor functions. In previous studies, alcohol drinking is related to a reduction in motor preparation and the impairment is dosage dependent. In this study, we examined if such a reduced capability can be extended to motor imagery in adults with and without hazardous drinking problem. Sixteen hazardous drinkers (HD, 25.73±3.06 years) and 16 control subjects (CON, 23.94±3.09 years) were recruited. HD scored 8 or more on the Alcohol Use Disorders Identification Test (AUDIT). Event-related potentials were recorded with an S1-S2 paradigm which elicits contingent negative variation (CNV). Participants had to physically execute a sequential finger movement (PE), or imagine producing it visually (VI) or kinesthetically (KI) when they heard the imperative signal 3 seconds after the corresponding visual warning signal. Results showed that HD and CON had comparable early (800-1300ms post-S1) and late CNV (2500-3000ms post-S1) amplitude. PE and VI elicit similar early and late CNV amplitudes, which are significantly larger than those of KI. The findings suggest normal arousal level and preparatory processes preceding motor execution and imagery in HD. In addition, PE and VI may share similar motor preparatory processes, requiring greater arousal and preparatory efforts than KI.

## A114

### VISUAL AND HAPTIC CONTRIBUTIONS TO THE DEVELOPMENT OF HAND PREFERENCE FOR GRASPING

Kayla Stone[1], Claudia Gonzalez[1]; [1]University of Lethbridge — Studies on the development of handedness have demonstrated a right-hand preference for grasping by age five. But what factors contribute to the development of this right-hand preference? Since grasping an object requires processing visual and haptic information, sensory feedback must play a pivotal role in the establishment of hand preference. Recent studies on right-handed adults have shown a right-hand preference for visually-guided grasping, but an increased preference for the left hand during haptically-guided grasping. These findings have been attributed to a right-hand/left-hemisphere specialization for visually-guided grasping and a left-hand/right-hemisphere specialization for haptically-guided object recognition. However, little is known about the development of such specializations. Are children, who inarguably have less experience grasping and manipulating objects, affected by sensory changes prior to grasping? We asked children (5-8 years old) to replicate 3D models from a tabletop of building blocks under different sensory (visual or haptic) conditions and recorded the hand selected to grasp each block. Results showed clear differences in hand preference for grasping when hapsis or vision was occluded: a right-hand preference for visually-guided grasping, and a significant increase in left-hand use for haptically-guided grasping. The results support a hemispheric division of labour for visually- and haptically-guided actions, which is fully developed by age five. Moreover, the results suggest that hand preference for grasping develops from an interplay of the visual and haptic systems.

## A115

### RECENT FINDINGS REGARD EEG MEASURES OF MENTAL LOAD IN 3D AND 2D INTERFACES

Alex Dan[1], Miriam Reiner[1]; [1]Technion, Israel Institute of Technology, [2]Technion, Israel Institute of Technology — A - Synchronous interaction, especially in learning, became embedded in everyday educational systems and basic instruction needs of the public. In this study, we look at the role of interface in remote learning and what are the properties of an optimal ome for enhanced learning. 2D representations are perceptually less loaded compared to 3D. 3D representations are more precise are more easily recognizable. We hypothesize that in 3D, patterns are easily recognized compared to 2D corresponding patterns, and therefore reduce the extraneous mental load of the learner. This research compares the mental load in a task learned either with a 3D Human Realistic Avatar and a 2D video. In the study, we used an origami task with motor and cognitive components. The dependent variables were the mental load as measured by EEG; students' perceived mental load based on questionnaires and a posttest exam. We measured the spectrum EEG using two channels. Our research question is that multisensory integration of visual cues that exhibit biological motion of the 3D Human Realistic Avatar, result in automatic and, therefore, effortless embodiment of a mental motor plan. From a learning perspective, this reduces the mental load, by leaving more working memory capacity available for processes such as elaboration or reflection on intentions of actions. The results of the will are showed. Results show that there are some other EEG measures that may be associated with the mental load, and the correlation between the learning method and the different dependent variables.

# PERCEPTION & ACTION: Vision

## A116

### HIGHER RESPONSE GAIN IN SUSTAINED STATE VISUAL EVOKED RESPONSE IN INDIVIDUALS WITH AUTISM SPECTRUM DISORDERS

Yukari Takarae[1], Savanna Sablich[1], John Sweeney[1]; [1]Center for Autism and Developmental Disabilities, University of Texas Southwestern — Sensory abnormalities are frequently reported in Autism Spectrum Disorders (ASD) and have been newly added to the ASD diagnostic criteria for the DSM-V. Hypersensitivity to sensory stimuli is a common form of such sensory abnormalities in ASD and warrants further examination. We used high density EEG to investigate biological correlates of sensory hypersensitivity in ASD individuals. Fifteen high functioning adolescents and adults with ASD and 10 age-matched typically developing individuals participated in

the current study. Sinewave gratings (2 cycles/deg) were presented with an on/off frequency of 4Hz at 10 different contrast levels (5, 10, 20, 30, . . . 90%). Evoked stimulus power increased with an increase in stimulus contrast at a much higher rate in the ASD group than the TD group. The observed group difference was greatest at the highest contrast, consistent with a change in response gain, rather than stimulus gain. Response gain in neural response has been known to increase with administrations of glutamate agonist or gamma-aminobutyric acid (GABA) antagonists and thus is sensitive to alterations in cortical excitability. The observed data pattern also resembles those previously reported in epilepsy patients, a population known for cortical hyperexcitability. Thus, the result suggests cortical hyperexcitability in the ASD group and corroborates sensory processing differences seen clinically in individuals with ASD.

## A117

### NEURAL GENERATORS OF CHILDREN'S EVENT-RELATED POTENTIALS TO STANDARD, TARGET, AND NOVEL VISUAL EVENTS

Anthony Herdman[1], Jelena Obradović[2], W. Thomas Boyce[3]; [1]University of British Columbia, [2]Stanford University, [3]Uinversity of California San Fancisco — The main goal of this study was to determine the underlying neural generators of children's event-related potentials (ERPs) evoked during a visual novelty oddball task. ERPs were recorded from 62 children (8 to 10 years old) while they performed a visual selective-attention task of detecting tilted triangles (target, 10% probability) among upright triangles (standard, 75% probability) and novel photos (novel, 15% probability). Discrete-dipole modeling (BESA) and distributed-source imaging (LCMV beamformer) methods were used to localize the neural generators of the visual evoked potentials: P1, N1, P2, N2c, and P3b. As would be expected based on previous research, generators for children's visual ERPs evoked by standard and target stimuli were mostly localized to bilateral occipital (P1 and N1), inferior temporal (P1), and occipital-parietal cortices (P2). Interestingly though, the children's N1 response had an additional source in the frontal mid-line for both discrete-dipole and distributed-source models. Target P3b generators were mainly localized to mid-line parietal cortices with additional frontal activity being evident in the beamformer images. Most surprisingly, children's generators of the N2c evoked by novel visual stimuli were primarily localized to bilateral occipital and inferior temporal cortices with no evidence of frontal sources from either discrete-dipole or distributed-source results. This later finding is inconsistent with previous research in adults that suggested the N2c reflects recruitment of frontal-posterior networks for orienting to novel events.

## A118

### UPRIGHT FACE-PREFERENTIAL HIGH-GAMMA RESPONSES IN LOWER-ORDER VISUAL AREAS: EVIDENCE FROM INTRACRANIAL RECORDINGS IN CHILDREN

Eishi Asano[1,2], Naoyuki Matsuzaki[1,2], Rebecca Schwarzlose[2], Masaaki Nishida[1,2], Noa Ofen[2]; [1]Children's Hospital of Michigan, [2]Wayne State University — Behavioral studies demonstrate that a face presented in the upright orientation attracts attention more rapidly than an inverted face. Saccades toward an upright face take place in 100-140 ms following presentation. The present study using electrocorticography determined whether upright face-preferential neural activation, as reflected by augmentation of high-gamma activity at 80-150 Hz, involved the lower-order visual cortex within the first 100 ms post-stimulus presentation. Sampled lower-order visual areas were verified by the induction of phosphenes upon electrical stimulation. These areas resided in the lateral-occipital, lingual, and cuneus gyri along the calcarine sulcus, roughly corresponding to V1 and V2. Measurement of high-gamma augmentation during central (circular) and peripheral (annular) checkerboard reversal pattern stimulation indicated that central-field stimuli were processed by the more polar surface whereas peripheral-field stimuli by the more anterior medial surface. Upright face stimuli, compared to inverted ones, elicited up to 23% larger augmentation of high-gamma activity in the lower-order visual regions at 40-90 ms. Upright face-preferential high-gamma augmentation was more highly correlated with high-gamma augmentation for central than peripheral stimuli. Our observations are consistent with the hypothesis that lower-order visual regions, especially those for the central field, are involved in visual cues for rapid detection of upright face stimuli.

## A119

### SYMBOLIC REPRESENTATIONS OF ACTION IN THE POSTERIOR MIDDLE TEMPORAL GYRUS

Lorna Quandt[1], Yune-Sang Lee[1], Diana Rosa-Leyra[2], Anjan Chatterjee[1]; [1]University of Pennsylvania, [2]Brandeis University — Action information can be conveyed in a variety of formats, which may vary in how abstract or concrete they are. This study investigated how different symbolic representations of action (e.g., action pictograms and action verbs) are processed in the brain, particularly in the posterolateral middle temporal gyrus, which is thought to represent actions across varying levels of abstraction. While prior work has shown that the posterior middle temporal gyrus (pMTG) is involved in processing abstract action concepts, no existing work has compared schematic action pictograms to action verbs. We predicted that while both action pictograms and action words would recruit pMTG, the pictograms would result in greater pMTG activation, since they contain more perceptual detail and may be more evocative of motion. Nineteen healthy participants viewed action pictograms (AP), action words (AW), object pictograms (OP), and object words (OW) in a sparse event-related design while fMRI data was collected. Univariate fMRI analyses revealed that BOLD activity was greater for AP than AW in occipital regions, bilateral fusiform, and bilateral pMTG, and greater for AW than AP in bilateral caudate. Activation was greater for AP than OP in bilateral pMTG and the posterior inferior temporal cortex. Overall, activation was greater for Actions (AP+AW) than for Objects (OP+OW) in bilateral pMTG and surrounding inferior temporal cortex. All comparisons are significant at $p<.001$ with cluster correction. Our findings suggest that the pMTG is selective for action concepts across symbolic presentation formats. A representational similarity analysis demonstrates commonalities in action processing across different formats.

## A120

### HIGH ROAD OR LOW ROAD? DISSECTING THE CONTRIBUTION OF CORTICAL AND SUBCORTICAL VISUAL PATHWAYS TO THREAT ENCODING IN AN AVERSIVE CONDITIONING STUDY

Yuqi You[1], Wen Li[1]; [1]University of Wisconsin-Madison — Prevailing accounts hold that a subcortical pathway to the amygdala ("a low road") mediates fast threat processing, but accruing evidence implicates additional mechanisms. By pairing Gabor patches with highly aversive pictures and sounds, we contrasted aversive associative learning for Gabors primarily activating the cortical pathway (isoluminant red/green in high spatial frequencies/HSFs) versus those dominantly activating the subcortical pathway (gray-scale in low SF; N=52). Before, immediately after and 2 weeks after the conditioning phase, subjects performed a perceptual discrimination task to judge whether the CS+ or CS- Gabor had the same or different orientation from a following Gabor patch (0-12 degree offset) while high-density EEG was acquired. Behavioral analysis revealed a significant Gabor-type-by-Time-by-Anxiety interaction ($F(1, 50)= 6.86$, $p = 0.01$): high trait anxiety was associated with improved discrimination (d') for CS+ (vs. CS-) from before to immediately after conditioning , but in gray-scale CS+ only ($r = 0.28$, $p = 0.04$). Comparing before and 2 weeks after conditioning, we observed a significant Time-by-Anxiety interaction ($F(1, 40)= 3.41$, $p = 0.07$): a general speed up in perceptual discrimination for both gray-scale and chromatic CS+ (vs. CS-) in high versus low anxious subjects. Together, current findings indicate both immediate and long-lasting perceptual learning as a result of aversive associative learning while specifying the low road (subcortical visual pathway to amygdala) in mediating immediate perceptual gain. ERP analysis is underway to confer additional insights into the visual pathways supporting threat encoding and their respective patterns of short-term and long-term plasticity via aversive associative learning.

## A121

### NATIVE READING DIRECTION INFLUENCES VISUAL EXPLORATIONS AND PREFERENCES OF LATERALLY LIT IMAGES

Austen K. Smith[1], Lorin J. Elias[1]; [1]University of Saskatchewan — Although perceptual and spatial asymmetries are often biased towards the left in neurologically normal individuals, known as pseudoneglect, lighting (Sun & Perona, 1998), spatial location (Nicholls, Bradshaw, & Mattingley, 1999), and native reading direction (Fagard & Dahmen, 2004) have been found to influence attention and perception. Smith and Elias (2013) compared left-to-right (LtoR) and right-to-left (RtoL) readers on an image comparison task and

found LtoR readers' scanning distributions to be significantly more leftward as well as a preference for leftward-lit images among LtoR readers. Whereas Smith and Elias (2013) presented 2 images simultaneously, the current study examines scanning distributions of a single image and compares preference ratings at time 1 and 2. Eighty images with a clear left or right source of illumination were presented in block 1 and eighty mirror images were presented in block 2. Image presentation was limited to 2000 msec. and a preference score was recorded directly after viewing each image. The overall distribution of fixations across all images (regardless of lighting direction) was not significantly biased in any way for either reading direction group, however, when lighting direction of the image was considered differences between reading direction groups were found. Additionally, image preference ratings interacted with reading direction. Differences in fixation patterns were found and the degree to which images are visually explored like directional (left-to-right or right-to-left) text is discussed.

### A122

### TYPICALITY SHARPENS OBJECT REPRESENTATIONS IN OBJECT-SELECTIVE CORTEX

Marius Cătălin Iordan[1], Michelle R. Greene[1], Diane M. Beck[2], Li Fei-Fei[1]; [1]Stanford University, [2]University of Illinois at Urbana-Champaign — The purpose of categorization is to identify generalizable classes of objects whose members can be treated equivalently. Within a category, however, some exemplars are more representative of that concept than others. This typicality effect manifests as increased speed of recognition and lower error rates for verifying category membership for the more typical items (Rosch, 1973; Rosch & Mervis, 1975). Despite these behavioral effects, little is known about how typicality influences the neural representation of objects from the same category. To address this question, we performed an fMRI experiment where participants were shown color photographs from 64 subordinate-level object categories grouped into 8 basic-level categories (4 animals and 4 vehicles). Typicality for each subordinate within its basic category was assessed behaviorally. We analyzed neural responses in early visual areas and object-selective areas: V1, V2, V3v, hV4, LOC. For each brain area, we computed separate similarity matrices (Kriegeskorte et al., 2008) for the most and least prototypical halves of the category set. We show that in object-selective cortex LOC, but not in early visual areas, typical categories distinguish significantly better between basic-level categories than less typical ones, suggesting that typicality enhances within-category similarity (cohesion) and between-category dissimilarity (distinctiveness). Furthermore, in LOC, typical categories capture the category central tendency as it's encoded in the neural activity patterns. This suggests that real-world objects show neural reference to a prototype representation and that typicality may be correlated to neural distance between categories in LOC, with highly typical members maximizing dissimilarity to instances of other categories.

### A123

### A ROLE FOR STRIATAL DOPAMINE IN VISUAL CONSCIOUSNESS: EVIDENCE FROM EYE-BLINKS

Filip Van Opstal[1], Tom Verguts[2], Esther De Loof[2]; [1]Center for Research in Cognition & Neurosciences, Université Libre de Bruxelles, Belgium, [2]Department of Experimental Psychology, Ghent University, Belgium — In two experiments the relation between striatal dopamine and visual consciousness was investigated. The spontaneous eye-blink rate (EBR) was used to measure striatal D2 receptor density. Visual consciousness was measured with breaking continuous flash suppression (b-CFS). In a first experiment (n = 15), the EBR was measured by the vertical electro-oculogram, which recorded the voltage difference between two electrodes placed above and below the right eye of the participants. Linear regression analysis revealed a significant relation between the EBR and b-CFS ($p = .0397$), and thus confirmed the relation between striatal dopamine and visual consciousness. Contrary to what would be expected, no relation between the moment of an eye-blink and the point at which the visual information broke through suppression was observed. A second experiment (n = 21) replicated this result with a simplified method to measure the EBR. EBR was now measured prior to the experiment by letting subjects look at a monitor while their eye-blinks were recorded on video for three minutes. The EBR was defined by counting the number of blinks. Results of this experiment closely matched the results of the first experiment by showing a close to significant relation between EBR and b-cfs ($p = .0905$). A regression analysis on both experiments together showed a significant effect of EBR on b-cfs ($p = .0172$). These results convincingly show a relation between the EBR and visual consciousness, in line with recent results that argued for a similar relation with positron emission tomography.

## THINKING: Decision making

### A124

### COGNITIVE ENGAGEMENT IN THE PREPARATION AND EXECUTION OF MORALLY-RELEVANT DECEPTION

Nolan O'Hara[1], William Gehring[1]; [1]University of Michigan — Acts of deception require a number of unique and cognitively demanding processes that facilitate personal understanding of what is lie and what is truth. Unfortunately, the vast majority of neuroimaging research that attempts to deconstruct these processes has explicitly instructed subjects to lie or has otherwise morally sanctioned the act of lying. Such studies fail to observe the motivational and ethically-relevant processes that make deception so important in the real world. We report on an event-related potential (ERP) analogue of Joshua Greene and Joseph Paxton's fMRI study in which subjects are not told to lie, but rather choose to lie of their own volition after realizing that the experimental structure can be exploited for dishonest monetary gain. Subjects who were willing to act deceptively in this morally accountable context showed distinctive ERP responses preceding potential lies. Specifically, stimuli about which a dishonest participant was able lie elicited more negative feedback-related negativities and less positive P3 waveforms. The extent of these effects further varied as a function of a deceptive subject's preceding behavior, suggesting an ongoing process of self-monitoring uniquely associated with morally-relevant deception. The observed patterns of activity may point to the importance and detectability of ethical and motivational processes that precede real-world deception, rather than processes that underlie the actual execution of deceptive acts. Such findings can enrich both our interpretation of past studies investigating instructed deceit and also our temporal understanding of ethical decisions more generally.

### A125

### NEURAL SUBSTRATES OF RETROSPECTIVE AND PROSPECTIVE CONFIDENCE JUDGMENTS IN PROBABILISTIC CATEGORIZATION

Timothy Kelley[1], Benjamin England[2], Michael Serra[1], Nadia Sari-Sarraf[1], Tyler Davis[1]; [1]Texas Tech University, [2]Missouri Western State University — Although current literature on neuroimaging of metacognition is sparse, converging research from a number of domains, including perception and metamemory, has implicated the right lateral prefrontal cortex (rlPFC) in confidence judgments. One key distinction that has not been fully investigated in neuroimaging is the distinction between prospective and retrospective confidence judgments. In terms of cognitive processing, prospective judgments involve predictions about future events whereas retrospective judgments involve evaluations of past performance. To examine whether these cognitive differences translate to differences in neural processing, we scanned participants as they learned a probabilistic categorization task and made prospective and retrospective confidence judgments about their performance. Consistent with the previous literature, we found significant activation in rlPFC when comparing prospective confidence judgments to retrospective judgments, after removing the effect of the categorization cue from each. Contrastingly, retrospective judgments were associated with activation in the ventral striatum. This result converges with previous categorization research implicating the ventral striatum in uncertainty processing and suggests that activation in this region may reflect post-decisional evaluation. Together these results suggest that different types of metacognitive judgments can have different neural substrates and future neural models will need to take into account their unique processing characteristics.

### A126

### ACUTE STRESS EXPOSURE AND EXPRESSION OF INSTRUMENTALLY CONDITIONED FINANCIAL PREFERENCES: AN FMRI STUDY

William McCuddy[1], Stephanie Potts[1], Anthony J. Porcelli[1]; [1]Marquette University — Recent research suggests acute stress exposure is associated with increased habit-based over goal-oriented decision making (e.g., Schwabe & Wolf, 2011). We examined whether acute stress promoted expression of simple financial preferences "overtrained" to the point of

habit in the face of a changing environment where said preferences were later rendered non-optimal. Over three days participants (current N = 19) learned to discriminate between visual stimuli probabilistically associated with monetary gains or losses and made decisions between stimuli with real financial outcomes. On the fourth day after exposure to either an acute stressor or control procedure participants performed the same tasks during fMRI scanning, including additional learning and decision tasks where monetary values associated with the same stimuli were altered. Choice and fMRI data, psychophysiological measures (e.g., blood pressure, skin conductance, and EKG), and salivary cortisol were collected. Participants in both groups successfully made optimal decisions between stimuli on Days 1 to 3 (reaching asymptote on Day 2). Preliminary analysis of Day 4 data revealed significantly increased sympathetic nervous system activation and salivary cortisol levels in acutely stressed participants only. During fMRI scanning after stimuli values were altered stressed participants made significantly more decisions consistent with original stimuli values, although these decisions were now financially detrimental, than did non-stressed participants. Thus, stressed participants made decisions more consistent with their overtrained (i.e., habit-based) preferences. It is expected that at the neural level during decision making a shift will be observed from prefrontal and dorsomedial striatal towards dorsolateral striatal processing.

## A127

## MODEL-BASED AND MODEL-FREE PAIN AVERSION LEARNING

Oliver Wang[1,3], Ben Seymour[2,4], Sangwan Lee[5], John O'Doherty[5], Wako Yoshida[3]; [1]Stanford University, [2]University of Cambridge, [3]Advanced Telecommunications Research Institute International, [4]Center for Information and Neural Networks, [5]California Institute of Technology — There has been accumulating neural evidence for multiple action systems underlying human reward learning, in particular a cognitive "model-based" system, and computationally simpler "model-free" (akin to 'habits'). However, whether a comparable distinction exists for avoidance has been relativity unexplored, and indeed the very nature of avoidance learning has been much less clearcut. Here, we implemented a behavioral task to look for evidence of two distinct systems during physical pain avoidance learning, mirroring a paradigm and modelling approach recently developed for a financial reward task (Lee et al.,2014). The experiment, performed by 16 healthy subjects, involved a two-step instrumental paradigm with probabilistic pain outcomes of varying magnitude (0-4 electrical pain stimuli), and with the delivery of outcomes contingent on signals indicating the trial type (to provide a form of outcome devaluation). Analysis by computational model fitting strongly suggested that a model-free system could not adequately account for task performance, and that a dual model-based and model-free system provided the best account of the data. Interestingly, in comparison to reward, we found a significantly greater tendency for subjects to divert from model-free to model-based controllers in the face of uncertainty. Overall, the data supports a dual-system model of pain avoidance, similar too, but much more 'conservative' than reward acquisition.

## A128

## NEURAL CORRELATES TO RULE-BASED AND EXEMPLAR-BASED MATHEMATICAL MODELS OF JUDGMENT

Sara Stillesjö[1,2], Johan Eriksson[1,2], Peter Juslin[3], Lars Nyberg[1,2], Linnea Karlsson[1,2]; [1]Umeå center for Functional Brain Imaging (UFBI), Umeå University, Sweden, [2]Umeå University, Sweden, [3]Uppsala University, Sweden — Cognitive modeling has repeatedly revealed that both rule-based and similarity-based (exemplar-based) models can predict human judgment data quite well. We tested key assumptions of such models by investigating neural correlates to both instructed and spontaneously adopted strategies using fMRI. In a between-group design, participants made judgments of a continuous criterion in a multiple-cue judgment task. Some participants were taught to explicitly rely on rule-based or exemplar-based strategies, whereas other participants spontaneously adopted rule-based or exemplar-based strategies in response to outcome feedback. After learning, all groups were scanned with fMRI while doing judgments without feedback. Using cognitive modeling we verified which participants had relied on rule-based or exemplar-based models and an ANOVA tested for differences in evoked brain responses between the strategies. Rule-based strategies evoked relatively more activity than exemplar-based strategies in premotor areas, dorsolateral prefrontal, middle temporal, and inferior and superior parietal cortices. Exemplar-based strategies evoked relatively more activity than rule-based strategies in left precuneus/cuneus and left inferior parietal cortex. Our results suggest that both instructed and spontaneous rule-based models of judgment taxes regions important for executive functions and explicit verbal memory to a larger degree than exemplar-based models. Moreover, both instructed and spontaneous exemplar-based models taxes regions important for episodic memory retrieval and selective attention to a larger degree than rule-based models. By combining the approaches of cognitive modeling and fMRI our results complement previous findings from the categorization literature, focusing on instructed strategies, and confirm some of the key assumptions of cognitive models of human judgment.

## A129

## INDIVIDUAL DIFFERENCES IN NEURAL PROCESSING OF PERSUASIVE MESSAGES: IMPLICATIONS FOR MESSAGE TAILORING

René Weber[1], Benjamin O. Turner[1], Richard Huskey[1], J. Michael Mangus[1]; [1]University of California Santa Barbara - Media Neuroscience Lab — Neuroimaging studies show that multiple functional networks are recruited when processing persuasive messages and that activation in these networks is predictive of behavior change (Falk et al., 2012). These studies typically rely on group level investigations of neural activity and its correlation with a small number of behavioral variables. However, mounting evidence suggests that activation patterns for identical behavioral outcomes are modulated by individual differences in attitudes or traits including cognitive style, sensation seeking (SS), and personal involvement (among many others), in addition to demographic and anatomical differences (Miller et al., 2009). Consequently, if neuroimaging is to be used to help tailor messages to individuals with the goal of improving message effectiveness, then the multiple dimensions along which individuals may differ must also be considered. This study seeks to isolate a selection of theoretically-relevant factors that explain individual differences in neural processing above and beyond what might be expected based on self-reported message effectiveness and anatomical differences. Anti-drug public service announcements (PSAs) were shown to 28 participants while undergoing fMRI (Weber et al., 2014). We also collected participants' ratings of the PSAs, drug-use risk, and scores on other scales including SS. We found extensive individual variability in neural processing of these PSAs, a significant proportion of which could be explained by examining how individuals differed along these other measures. We suggest that using neuroimaging for improving individual message tailoring (e.g. within social media sites) is only effective when considering the many ways in which individuals' neural responses differ.

## A130

## GENETIC INFLUENCES ON EXPLORATORY BEHAVIOR IN HUMANS

Hans Melo[1], Daniel Müller[1,2], William Cunningham[1], Adam Anderson[3]; [1]University of Toronto, [2]Center for Addiction and Mental Health, [3]Cornell University — When confronted with making a choice in an uncertain environment, humans must decide whether to exploit a known option or explore a less familiar but potentially more rewarding option. Previous work on this exploitation-exploration dilemma reveal that orbitofrontal cortex (OPFC) and interparietal sulcus are associated with explorative behavior, whereas activation of regions in the striatum and ventromedial prefrontal cortex (vmPFC) are related to exploitative behavior. The aim of this study was to examine dopamine-related genetic influences on exploratory behavior. Bearing in mind regions of the brain implicated in this phenomenon, we focused on single nucleotide polymorphisms (SNPs) associated with striatal dopamine function (DAT1/SLC6A3, DRD2 C957T, DRD4) and frontal dopamine function (COMT Val158Met). Functional Magnetic Brain Imaging (fMRI) activity was collected from 74 healthy individuals (38 male; mean age 21) using a 3T GE MRI scanner while participants performed a four-arm bandit gambling task. Saliva samples were collected from all participants for genomic DNA extraction and analyzed. Analysis of fMRI data using single-trial beta analysis revealed significant interactions between COMT genotype and BOLD activity in the vm-PFC and OPFC. Specifically, increased activation in vmPFC and OPFC predicted choice for Val-homozygous individuals but not for Met-carriers. Our work shows that dopamine-related polymorphisms influence the neural mechanisms underpinning exploration in humans.

## A131

### A MULTIMODAL STUDY OF DISGUST IN THE ULTIMATUM GAME

Filippo Rossi[1], Veerle van Son[2], Ian Fasel[3], Marian Bartlett[1,3], Alan Sanfey[2]; [1]Institute for Neural Computation, University of California, San Diego, [2]Donders Institute for Brain, Cognition and Behavior, Radboud University, [3]Emotient, Inc., San Diego — We present a novel approach to study neural activity associated with the experience of disgust. Moreover, we show an application of this methodology to the Ultimatum Game (UG), an economic task where players seem to experience moral disgust in response to small financial offers. Using state-of-the-art computer vision techniques, we detected the facial expression of disgust from 26 participants while they played the UG and the Pictures Game (PG) in an fMRI scanner. In the PG, participants saw neutral, positive or disgusting pictures from the International Affective Picture System. The purpose of this task was to identify a distributed pattern of voxel activity associated with the emotion of disgust, which was assessed using Emotient facial expression recognition software. We then tested whether small financial offers in the UG activated the same neural "fingerprint." First, we were able to predict whether a picture was disgusting or not from a combination of voxels in the anterior insula, amygdala, and caudate (cross-validation accuracy = 66%, $p < 0.0001$). Second, we showed that the same multi-voxel pattern could accurately predict when participants received small financial offers in the UG (cross-validation accuracy = 64%; $p< 0.0001$). These results suggest that the experiences of visual and moral disgust share a common neural substrate, which can be identified using our approach. In the future, we will try to isolate multi-voxel patterns associated with several emotions in order to investigate their role in decision-making processes.

## A132

### ACTION SELECTION AS A CONTINUOUSLY BIASED PROCESS: EVIDENCE FROM A RAPID REACHING TASK

Cristian Buc Calderon[1], Tom Verguts[2], Wim Gevers[1]; [1]Centre for Research in Cognition and Neurosciences, ULB Neuroscience Institute, Faculté de psychologie et sciences de l'éducation, Université Libre de Bruxelles, [2]Department of Experimental Psychology, Ghent University — When selecting an action, traditional theories suggest a cognitive architecture made of serial processing units. Other authors have suggested instead that action selection emerges from the parallel implementation of and competition between multiple action plans. To disentangle between these two hypotheses, we created a reaching task allowing to assess the temporal dynamics of action selection. Crucially, contrary to previous reaching task studies, our design did not force action selection processes to operate in parallel, thus allowing an informative comparison between the two theories. We manipulated the probability of congruence between a cue and a delayed upcoming target reach go signal. This allowed us to assess in an unbiased way if this congruence probability interacts with a subsequently selected reach trajectory (i.e. whether there is co-activation of cognition and action). We show that reach trajectories are modulated by the probability of congruence between cue and target. Our results suggest that action selection emerges from a competition between multiple afforded action plans, in parallel biased by relevant task factors (e.g. probability of reach).

# Poster Session B

## ATTENTION: Development & aging

### B1

**AGE DIFFERENCES IN THE ATTENTION NETWORK TEST: EVIDENCE FROM BEHAVIOR AND ERPS** Julia Spaniol[1], Ryan S. Williams[1], Anna L. Biel[2], Pete Wegier[1], Leann K. Lapp[1], Kathleen M. Lyons[3], Benjamin J. Dyson[1]; [1]Ryerson University, [2]Ludwig Maximilian University of Munich, [3]University of Western Ontario — The Attention Network Test (ANT; Fan et al., 2002) is widely used to examine the contributions of alerting, orienting, and executive control to attention. Behavioral studies comparing younger and older adults on RT measures of attentional networks have suggested that age deficits are more pronounced in executive control than in alerting or orienting, but no prior studies have examined the neural basis of age differences in the ANT. In the current study, we obtained behavioral responses and ERPs in the ANT from 24 healthy younger adults (mean age: 21.4 years) and 24 healthy older adults (mean age: 65.1 years). Compared with younger adults, older adults showed a reduced alerting effect on RT. Posterior cue-evoked N1 amplitude, as well as target-evoked N1 and P3b amplitudes, showed similar alerting effects in both age groups, but the effect of alerting on P3b latency was reduced in older adults. In contrast, older adults showed a larger orienting effect on RT and on the posterior cue-evoked N1, compared with younger adults. Orienting effects on target-evoked N1 and P3b components were similar in both groups. Finally, age deficits in executive control were expressed behaviorally (greater slowing in the presence of incongruent flankers) as well as neurally (increased flanker-based modulation, and more anterior distribution, of P3b). In summary, these findings suggest that attentional networks show differential sensitivity to normal aging. Older adults' enhanced posterior orienting response, seen as early as 100ms post-cue, may reflect an over-reliance on spatial cues to compensate for age-related decline in executive control.

### B2

**COGNITIVE TRAINING IMPROVES MOBILITY IN HEALTHY OLDER ADULTS** Lindsay Nagamatsu[1], Nathan Medeiros-Ward[1], Michael Kranz[1], Pauline Baniqued[1], Cher Wee Ang[1], Anya Knecht[1], Kathryn Johnson[1], Arthur Kramer[1]; [1]University of Illinois at Urbana-Champaign — With the number of adults aged 65 years and older expected to triple by the year 2050, developing effective interventions to promote healthy and successful aging is an increasing priority. Improving mobility is especially relevant, given its role in functional independence and quality of life. While mobility may be improved via physical training, an alternative approach is to target cognitive functioning; indeed, cognition is known to be critical for balance and mobility, and impaired cognitive functioning is a risk factor for falls in older adults. Hence, we conducted a five-week cognitive intervention on older adults aged 60-80 years (n = 100) aimed at improving cognition and consequently, improving mobility. Participants completed cognitive and physical assessments at baseline and trial completion, and were randomized into two groups: 1) a training group that played computer games known to highly correspond to working memory and reasoning abilities; or 2) a training group that played computer games that did not reliably tap working memory and reasoning, but were related to performance on attention and perceptual speed tasks. All participants completed a total of 15 hours of training. Mobility was assessed via gait speed. We found that participants in the attentional/perceptual group significantly improved their gait speed, in comparison to the working memory/reasoning group. This suggests that attention and perceptual speed may be particularly critical for mobility in older adults. Our results may inform future intervention strategies to improve mobility in older adults by providing evidence that cognitive training can positively impact physical outcome measures.

### B3

**INCREASED EARLY PROCESSING OF TASK-IRRELEVANT AUDITORY STIMULI IN OLDER ADULTS** Erich Tusch[1], Anne Fox[1], Fabio Porto[1], Brittany Alperin[2], Phillip Holcomb[3], Kirk Daffner[1]; [1]Brigham and Women's Hospital, Harvard Medical School, [2]Oregon Health and Science Univeristy, [3]Tufts University — Age-related increases in N1 amplitude to task-irrelevant auditory stimuli have been interpreted as reflecting diminished inhibitory capacity. If so, one might predict that N1 amplitude would be augmented by increasing task demands and attenuated in individuals with high executive capacity (EC). ERPs were measured in young, middle aged, young-old, and old-old adults, divided into high and average EC groups. Subjects were exposed to auditory (repetitive pure tone, rare pure tone, rare novel) and visual (repetitive letters, infrequent letters) stimuli. Under the auditory-ignore (visual-attend) condition, subjects ignored auditory stimuli and responded to rare target letters under low and high task load. Under the auditory-attend condition, subjects ignored visual stimuli and responded to rare target tones. N1 amplitude to novel and repetitive auditory stimuli was larger under the auditory-ignore condition for all age groups except young adults. There was an age-related increase in N1 amplitude under the auditory-ignore but not auditory-attend condition. EC modulated the pattern of response only among old-old subjects. Increasing target number under visual-attend was associated with a reduced N1 to task-irrelevant auditory stimuli in all groups. In summary, the study's findings do not neatly fit the inhibitory-deficit hypothesis of cognitive aging. Augmenting visual task load led to decreased, not increased N1 to task-irrelevant auditory events. Executive capacity played a limited role in modulating the N1 response. Older adults did not simply fail to suppress the N1 amplitude to auditory stimuli in the task-irrelevant modality; they actually generated a larger response than to identical stimuli in the task-relevant modality.

### B4

**ERP CORRELATES OF PROACTIVE AND REACTIVE ATTENTIONAL CONTROL IN PRESCHOOL AND MIDDLE CHILDHOOD** Sarah Elke[1], Tyler Harrison[1], Aishah Abdul Rahman[1], Sandra A. Wiebe[1]; [1]University of Alberta — The engagement of cognitive control can occur in two forms: reactive control, where cognitive control is engaged as needed, and proactive control, where cognitive control is engaged in anticipation of upcoming demands. This study used event-related potentials to investigate the neural correlates of these strategies in children. Younger children (n = 18, 4 and 5 year olds) and older children (n = 21, 7 and 8 year olds) completed a cued task-switching paradigm. On each trial, children were presented with a cue indicating whether to sort by colour or shape followed by a stimulus to be sorted by the cued dimension, which children indicated on a touch-screen. Upon cue presentation, the task allowed children to prepare for the upcoming trial (i.e., a proactive strategy) or wait until stimulus presentation to do so (i.e., a reactive strategy). The P3 was analyzed after both the cue and the stimulus. Older children had better task performance and their stimulus-evoked P3s had faster latencies than those of younger children. Both age groups had larger stimulus-P3s in trials requiring a task switch than in trials where the same task was performed consecutively. This difference may reflect increased working memory load on switch trials that might have been avoided had children used a proactive strategy. Together, these results suggest that both 4 and 5 year olds and 7 and 8 year olds used a reactive strategy, with older children doing so more efficiently.

### B5

**SELECTIVE ATTENTION AS A PROTECTIVE FACTOR FOR NONVERBAL INTELLIGENCE IN LOWER SES CHILDREN: AN EVENT-RELATED POTENTIALS STUDY** Elif Isbell[1], Amanda Hampton Wray[2], Helen Neville[1]; [1]University of Oregon, [2]Michigan State University — Selective attention is the ability to enhance the processing of particular input while suppressing the information from other concurrent sources and has been postulated to be a foundational skill for learning and academic achievement. The neural mechanisms of this foundational ability are both vulnerable and

enhanceable in children from lower socioeconomic status (SES) families. Here we assessed the protective role of this malleable brain function for nonverbal cognitive abilities in lower SES children. We recorded event-related potentials (ERPs) during a dichotic listening task and administered nonverbal IQ tasks to 124 lower SES children (77 females) between the ages of 40 and 67 months. The attention effect, i.e. the difference in ERP mean amplitudes elicited by identical probes embedded in stories when attended versus unattended, was significantly correlated with nonverbal IQ scores. Overall, larger, more positive attention effects over the anterior and central electrode locations were associated with higher nonverbal IQ scores. Our findings provide initial evidence for prominent individual differences in neural indices of selective attention in lower SES children. Based on these findings, we propose that selective attention acts as a protective factor for the development of nonverbal cognitive abilities in children from lower SES families.

## B6

### DON'T PAY ATTENTION! PARADOXICAL EFFECTS OF MONETARY INCENTIVE ON ATTENTIONAL PERFORMANCE IN OLDER ADULTS.

Ziyong Lin[1], Cindy Lusitg[1]; [1]University of Michigan — Monetary incentives are often used to increase attention and performance, presumably by increasing motivation. We examined how these effects vary across age groups and types of attentional control. Young (M age = 20.2 yrs) and old (M age = 70.7 yrs) adults were tested on the Continuous Temporal Expectancy Test with video distractor, which allows independent assessment of focused attention, the ability to sustain that focus over time, and the ability to resist distraction (Berry et al., 2014; Berry et al., in press). Within each age group, half the participants were tested under standard conditions, and half were tested under an incentive condition. In the incentive condition, participants could earn up to $20, with $.20 deducted for every error. Replicating our previous studies, although both distraction and time-on-task effects reduced performance, the effects of distraction did not systematically increase with time-on-task. Older adults were more vulnerable to distraction but not to time-on-task effects. The monetary incentive tended to improve the performance of young adults, but significantly reduced the performance of older adults. Incentive had its primary effects on focused attention and overall performance rather than specific effects on either sustained attention or distraction control. Age and incentive condition also influenced correlations between performance and self-report measures of boredom, mind-wandering, and distractibility. Overall the effects suggest that manipulations of motivation via monetary incentive have general rather than ability-specific effects on attentional control, and these effects may be paradoxical for older adults.

## B7

### AGE-RELATED DIFFERENCES IN IMPLICIT SEQUENCE LEARNING

Rebecca J. Campbell[1], Alison Colbert[1], Jin Bo[1]; [1]Eastern Michigan University — Motor learning occurs both implicitly, without awareness of knowledge being acquired, and explicitly, in which individuals are aware that learning is taking place. The "invariance learning hypothesis" (Reber, 1993) suggests that the ability for implicit learning generates early and is impervious to age effects. However, there have been inconsistent findings in the literature. Some studies have found little to no age effect on implicit sequence learning (e.g. Meulemans et al., 1998), while others have found a strong age effect (e.g. Maybery et al., 1995). Such discrepancy could result from task difficulties of learning sequence and explicit awareness. Thus, the current study examined age-related differences on implicit sequence learning in thirteen typically developing children (aged 6 to 12). A serial reaction time task was employed with ten blocks. Blocks 1, 2, 8 & 10 contained a baseline sequence whereas Blocks 3 to 7 and 9 contained a 12-element learning sequence with a different predictive structure than the baseline sequence. Learning was measured as the response time (RT) differences between Block 7&8, Block 8&9, and Block 9&10. One sample t-tests revealed positive learning on RT difference between Block 8&9 ($t = 1.95$, $p < 0.05$). No significant age effects were found on RT differences in Block 7&8 ($r = .01$, $p = 0.35$) and Block 9&10 ($r = .51$, $p = 0.42$). However, age effect on the RT difference on Block 8&9 was approaching significance ($r = .26$, $p = 0.08$). The preliminary analysis supports the "invariance learning hypothesis". Future research will include a larger sample and children with motor difficulties such as autism.

## B8

### THE INFLUENCE OF EXECUTIVE CAPACITY AND AGE ON ATTENTION TO NOVEL AUDITORY STIMULI

Anne M. Fox[1], Erich Tusch[1], Fabio Porto[1], Brittany Alperin[2], Phillip Holcomb[3], Kirk R. Daffner[1]; [1]Brigham and Women's Hospital, Harvard Medical School, [2]Oregon Health and Science University, [3]Tufts University — There is evidence that adults with higher executive capacity (EC) pay more attention to novel visual stimuli. The role of EC in processing novel auditory stimuli, however, has not been carefully examined. This study measured ERPs at frontocentral sites in young, middle-aged, young-old, and old-old subjects, who were divided into high and average EC groups based on neuropsychological testing. The P3a served as an index of the allocation of attentional resources. Subjects were exposed to both auditory (repetitive pure tone, rare pure tone, rare novel) and visual (repetitive letters, infrequent letters) stimuli. Under the auditory-attend condition, subjects were instructed to respond to rare target tones and ignore visual stimuli. Under the auditory-ignore condition, subjects were instructed to respond to rare visual target letters and ignore auditory stimuli. Results showed that the P3a to novel auditory stimuli was larger for subjects with high than with average EC. At frontal sites, the magnitude of this effect did not differ across age groups, while at central sites the EC effect was much more robust in older subjects. An age-related linear decline in the amplitude of the novelty P3a was observed at fronto-central sites under the ignore, but not under the attend, condition. In summary, higher EC was associated with increased appropriation of attentional resources to novel auditory stimuli, a pattern of response preserved or even augmented across the adult lifespan. These findings extend prior observations about enhanced sensitivity to novelty of high EC individuals to include not only visual, but also auditory, stimuli.

## B9

### A LONGITUDINAL INVESTIGATION OF ATTENTION NETWORKS IN CHILDREN 6-11 YEARS OF AGE.

Frances Lewis[1], Katherine Johnson[1], Robert Reeve[1]; [1]School of Psychological Sciences, University of Melbourne — Attention is critical for everyday functioning, and consists of several neural networks. The alerting network is involved in arousal, the orienting network is involved in selecting a modality and shifting attention, while the executive network is involved in top-down control of attention. The Attention Network Task (ANT) is a cued flanker task to assess these networks. Forty-one 6-year-olds, 30 8-year-olds and 43 10-year-olds performed a modified adult version of the ANT three times over 12 months, at 6-monthly intervals. Ten-year-olds performed with a more efficient alerting network than both 6- and 8-year-olds for mean response time (RT), and a more efficient alerting network than 6-year-olds for errors and omissions at the first time point. The orienting network showed no difference between age groups at any time point. 10-year-olds performed with a more efficient executive network than 6-year-olds at the first two time points in terms of errors, and at all time points in terms of omissions. Eight-year-olds performed with a more efficient executive network than 6-year-olds for standard deviation of RT, and at the first two time points for errors and omissions. Eight- and 10-year-olds performed with a more efficient reorienting network than 6-year-for both errors and omissions at all time points. Results indicate that the alerting network develops earlier than previously suggested. The executive network shows minimal development past 7 years of age. Results support findings of an early development of the orienting network. Six to 8 years of age is a critical period in attention development.

## B10

### VISUAL REPRESENTATIONS ACROSS MEMORY SYSTEMS AND AGING

Sarah Reaves[1], Shekinah Phillips[2], Audrey Duarte[1]; [1]Georgia Institute of Technology, [2]Agnes Scott College — Visual short term memory (VSTM) is a capacity-limited system that represents visual information after it is no longer available via sensory input. Studies manipulating retrospective attention (attention directed to previously viewed stimuli) have shown that the contents of VSTM can be modulated by attentional control in younger adults. Only one study has manipulated retrospective attention in older adults while monitoring an event related potential (ERP) related to working memory maintenance known as contralateral delay activity (CDA) . Results from this previous study using a blocked design suggested

that older adults could use retrospective cues to reduce working memory demands, but older adults did not show behavioral benefits. The present study manipulated retrospective attention pseudo-randomly across trials while monitoring the CDA. Different from previous studies which used colored squares as stimuli, the present study used images of real-world objects, which was a novel stimulus class for detecting the CDA. This allowed for testing the effects of retrospective attention on both VSTM and long-term memory. Results revealed a benefit at both working memory and long-term memory for retrospectively cued items. Contrary to previous evidence, this suggests that older adults' behavioral performance can be improved via retrospective attention. The present study also detected a CDA using complex images. This suggests that the CDA can index complex representations held in visual working memory. Additionally, the fact that retrospective attention influenced both working memory and long-term memory suggests that memory systems may be more interactive than previously thought and that this interaction persists with aging.

# ATTENTION: Multisensory

## B11

### AGE-RELATED DIFFERENCES IN EARLY AND LATE HAND PROXIMITY EFFECTS ON VISUAL EVOKED POTENTIALS

Catherine Reed[1], Abigail Kramer[2], Summer Clay[3], David Leland[4], Alan Hartley[5]; [1]Claremont McKenna College, [2]Pitzer College, [3]Claremont Graduate University, [4]University of Wisconsin, Eu Claire, [5]Scripps College — The present study examined age-related differences in the influence of hand location on visual processing. For young adults, previous research has shown that by the time stimuli are categorized as relevant/irrelevant for action, the proprioceptive effects of the hand on visual attention are selective for goal/task-related stimuli. At the same time, hand proximity appears to bias attention early, starting with a facilitation of processing for perhaps any visual stimuli near the hand, and continuing with enhancements that are selective to those stimuli categorized as task-relevant. Here we examined age-related changes in this multisensory integration by comparing event-related potentials (ERPs) between younger (average age~ 19) and older (average age~ 70) adults. We used a visual detection task in which the hand was placed near or kept far from target and non-target stimuli that were matched for frequency and visual features. The presence of the hand near the stimuli produced faster response times in both age groups. However, the hand's influence on ERPs was different for younger and older adults. Younger adults showed increased amplitudes for visual stimuli early in processing but older adults only showed hand effects later in processing. In addition, for older adults activity was distributed not only in contralateral parietal regions but also in frontal regions. This neural pattern suggests that older adults may integrate hand position and visual inputs using top-down mechanisms to a relatively greater extent than younger adults.

## B12

### SALIENT SOUNDS ELICIT SLOW POTENTIAL SHIFTS PARALLELED BY ALPHA RHYTHM DESYNCHRONIZATION IN CONTRALATERAL VISUAL CORTEX

Viola S. Störmer[1], Wenfeng Feng[2], Antigona Martinez[3,4], John J. McDonald[5], Steven A. Hillyard[3]; [1]Harvard University, USA, [2]SooChow University, Jiangsu, China, [3]University of California San Diego, USA, [4]Nathan Cline Institute for Psychiatric Research, USA, [5]Simon Fraser University, Canada — We previously showed that sudden sounds activate human visual cortex automatically. By recording the brain's electrophysiological responses using EEG, we found that peripheral, task-irrelevant sounds triggered a contralateral positive deflection over visual cortex (termed the ACOP), even in purely auditory tasks (McDonald et al., 2013). Importantly, the magnitude of the ACOP predicted improved perceptual processing of a subsequent visual target, revealing its functional significance for cross-modal effects of attention (Feng et al., 2014). Here, we examined whether task-irrelevant sounds also modulate alpha-band (9-14Hz) oscillatory activity over visual cortex, and discovered a relative decrease in alpha power contralateral to the sound. These data suggest that sounds prepare the visual system for the potential processing of subsequent visual targets by biasing the alpha-band oscillatory activity in the visual processing pathways in a spatially specific manner. Importantly, we observed these lateralized changes in alpha-band activation in tasks that were purely auditory, demonstrating the reflexive nature of this effect. Interestingly, these lateralized changes in alpha power correlated with the ACOP magnitude in a trial-by-trial manner, such that trials with larger ACOPs were associated with stronger decreases in contralateral alpha power. These changes in alpha-band oscillatory activity are strikingly similar to lateralized changes in alpha-band power previously reported in studies of voluntary attention. Thus, the present data reveal an important link between the neural mechanisms underlying voluntary and involuntary attention.

## B13

### LEVELS OF PROCESSING DIFFERENTIALLY INFLUENCE VISUAL AND AUDITORY MEMORY DISTORTIONS

Ryan Brigante[1], Kristen Deupree[1], Eric Slinker[1], Bart Rypma[1]; [1]University of Texas at Dallas — Boundary extension (BE) is a function of visuospatial cognition in which scenes are remembered with extra content in the periphery. However, auditory memories tend to become truncated at the boundaries, so listeners are unaware of changes in the beginning and end of an auditory stream. Boundary restriction (BR) is considered normal in the auditory domain, but like visuospatial BE, there is much variability in the data. An open question is, does BE/BR occur at the perceptual or semantic representational level? We conducted two separate experiments (one visual and one auditory) with levels-of-processing manipulations during initial encoding of stimuli and examined the rate of memory distortions that emerged in a recognition task. In the visual experiment, encoding tasks were judging colorfulness (perceptual) and personal relevance (semantic). In the auditory experiment, the tasks were counting beats (perceptual) and judging conveyed emotion (semantic). In the recognition phase, half of all stimuli were manipulated at the boundaries. Participants had to judge whether each stimulus was extended, restricted, or the same. In the visual experiment, there was a main effect of error type, as BE was significantly more frequent than BR. Critically, there was an interaction of error type and encoding task; BE was more frequent with conceptually-encoded stimuli, but BR was more frequent with perceptually-encoded stimuli. In the auditory experiment, we found the opposite pattern; BE was more frequent with perceptually-encoded stimuli, but BR was more frequent with conceptually-encoded stimuli. These results suggest that visual and auditory BE arise from different cognitive mechanisms.

## B14

### SHALL I STAY OR SHALL I GO? RAPID DECISION TO ALLOCATE ATTENTION – OR NOT – TO INCOMING STIMULI IN THE VENTRO-LATERAL PREFRONTAL CORTEX: AN INTRACEREBRAL EEG STUDY

Anne Claire Croize[1,2], JR Vidal[3,4], M Baciu[3,4], M Petton[6,7], L Minotti[1,2,5], P Kahane[1,2,5], JP Lachaux[6,7], M Perrone-Bertolotti[3,4]; [1]Inserm, U836, F-38000 Grenoble, France, [2]Univ. Grenoble Alpes, GIN, F-38000 Grenoble, France, [3]CNRS, LPNC, UMR 5105, F-38040 Grenoble, France, [4]Grenoble Alpes University, LPNC, F-38040 Grenoble, France, [5]Grenoble Alpes University, LPNC, F-38040 Grenoble, France, [6]Service de Neurologie, CHU de Grenoble, Hôpital Michallon, F-38000 Grenoble, France, [7]INSERM, U1028, CNRS, UMR5292, Lyon Neuroscience Research Center, Brain Dynamics and Cognition Team, Lyon F-69000, France, [8]University Lyon 1, Lyon F-69000, France — In the brain, the decision to allocate attention to an incoming stimulus - and to trigger the cascade of high-level processes which follow - must be taken carefully as it creates transient windows of unavailability to subsequent stimuli. In this study, we set to identify brain regions which carry out such decision, based on the following set of constraints : a) such "gate-keepers" should react to a stimulus earlier than 250 ms, that is before the classic divergence between attentive vs inattentive processing in high-level brain regions (i.e., Broca or Wernicke for text stimuli); b) they should be part of a flexible memory system in the prefrontal cortex where rules differentiating between context-dependent relevant vs. irrelevant items are known to be maintained (Sakai, 2008). To have the sufficient time and spatial resolution to test those criteria, we used intracranial EEG in epileptic patients implanted in the frontal lobes as they performed several tasks, including a reading task contrasting to-be-attended vs. to-be-ignored words, a visual oddball task, a visual search, and working memory tasks. From the combination of those tasks, and the measure of High-Frequency Activity [50-150 Hz] as a proxy of population-level spiking activity (Lachaux et al., 2012), we identified neural populations in

the left and right Ventro-Lateral Prefrontal Cortex (VLPFC) as the best possible candidates for an "attentional gate-keeper", within the so-called ventral attentional network (Corbetta et al, 2008).

# EMOTION & SOCIAL: Emotion-cognition interactions

## B15

### BIPOLAR DISORDER: ANALYSIS OF SUBCORTICAL STRUCTURES INVOLVED IN EMOTIONAL AND REWARD PROCESSING AND THE EFFECTS OF WIDELY PRESCRIBED MEDICATIONS.

Christopher R. K. Ching[1,2], Derrek P. Hibar[2], Neda Jahanshad[2], Adam Mezher[2], Joshua Faskowitz[2], Benson Mwangi[3], Jair Soares[3], Paul M. Thompson[2]; [1]University of California Los Angeles, [2]Imaging Genetics Center, University of Southern California, [3]University of Texas Medical School — Few studies have compared neuroimaging measures across bipolar subtypes I and II (BD1, BD2) and not otherwise specified (BD NOS). In a large cohort scanned with magnetic resonance imaging (MRI), we hypothesized that bipolar subtype would be associated with volumetric differences in subcortical structures involved in emotional and reward processing and that commonly prescribed treatments might affect subcortical volumes. Brain T1-weighted MRI data were segmented using FreeSurfer to compute 8 subcortical volumes including the nucleus accumbens, amygdala, caudate, hippocampus, putamen, pallidum, thalamus and lateral ventricles. After quality control, 479 subjects were analyzed (BD1=185; BD2=67; BD NOS=44; Control=183). We assessed the relationship of diagnosis to subcortical volumes using multiple linear regression, correcting for age, sex and intracranial volume. Effects of lithium, anticonvulsants, antidepressants, atypical antipsychotics and benzodiazepines were also tested in a subgroup of medicated subjects. BD2 youths (<21yrs) had nominally smaller thalamic and ventricular volumes compared to controls. BD NOS youths showed a trend toward smaller putamen volumes compared to BD1 and smaller right thalamus volumes compared to BP2. For medicated subjects, smaller putamen, pallidum, left amygdala and right thalamus volumes were associated with use of antipsychotics. Subjects on benzodiazepines had nominally smaller putamen and right pallidum volumes compared to non-medicated subjects. Our study revealed both bipolar subtype specific volume differences and associations between medication and subcortical volumes. To combat patient heterogeneity, our ENIGMA Bipolar Working Group is extending this analysis to over 4,000 subjects and is examining disease subtype and medication interactions with increasing power.

## B16

### PREFRONTAL CORTEX ACTIVATION DURING AN EMOTIONAL STROOP TASK: A NEAR INFRARED SPECTROSCOPY (NIRS) STUDY

Keara Kangas[1], Robert Torrence[1], Joshua Carlson[1]; [1]Northern Michigan University — Near-infrared spectroscopy (NIRS) research measuring prefrontal cortex (PFC) activity during emotional processing has been limited. Studies showed cortical activation during an attention task measuring affective picture processing in the occipital lobe using NIRS, EEG, and fMRI, but little is known about visuospatial attention during an emotional Stroop task, which measures selective attention to emotional stimuli. The present study used NIRS to measure the temporal dynamics of the PFC during an emotional Stroop task. This task consisted of threating/fearful and neutral images from the International Affective Picture System. The images had either a red, green, or blue border, in which the participant was instructed to respond too by using a colored keypad. An increased hemodynamic response is expected during emotional trials, bilaterally in the PFC, due to prefrontal interference processing during this condition. We also expect to see slower response times during the emotional trials. The current NIRS data suggest that the PFC is differentially involved in interference processing during affective and neutral conditions. The neural affect was correlated with the behavioral aspect, which was accompanied by slower reaction times for emotional compared to neutral stimuli. Thus suggesting the PFC is involved in emotional processing of visuospatial attention to emotional stimuli, showing stronger brain activation during emotional trials due to interference.

## B17

### INDIVIDUAL DIFFERENCES IN THE DOWN-REGULATION OF SUFFERING

Spencer Reuter[1]; [1]Edgewood College — Pain is a complex, multidimensional event and recent research has attempted to dissociate the sensory and affective components of pain; the latter often regarded as suffering. It is possible to dissociate pain from suffering because suffering can be subject to cognitive and affective reappraisal. The purpose of this study is to understand individual differences in the regulation of suffering by correlating physiological measures of distress with self-report measures designated to assess self-regulation and perceived self-control. Physiological measures collected include heart rate (HR), facial movements, skin conductance response (SCR) and body temperature. Participants were exposed to 20 thermal pain stimuli from a Medoc Neurosensory Analyzer, a device that heats water up to 48C. After each pain stimulus, participants used a sliding scale to report pain intensity and unpleasantness and answered a portion of the Attributional Style Questionnaire (ASQ) to assess learned helplessness. Variables of interest for assessing individual differences included locus of control, learned helplessness, pain catastrophizing and meditation experience. Preliminary data suggest a negative correlation between rate of down-regulation after a painful stimulus and learned helplessness. Slower down-regulation of pain is also associated with a more externalized locus of control. Overall, these findings suggest that suffering is modified by an individual's sense of control. Future studies should investigate whether self-regulation techniques such as mindfulness meditation or therapeutic interventions such as mindfulness based cognitive therapy (MBCT) can modify the affective components of the pain response.

## B18

### EFFECTS OF CUEING ON SEMANTIC MEMORY IN PARKINSON'S DISEASE WITH COMORBID DEPRESSION

Anisa Marshall[1], Michelle Fenesy[2], Kathleen Poston[1]; [1]Stanford University, [2]UCLA — Semantic memory impairment is common in Parkinson's disease (PD) patients. Several studies have reported PD patients improve memory with cueing compared to free recall, and similar cueing improvements have been shown in people with depression. Because depressive symptoms are prevalent in PD, clarifying the relationship between PD-associated semantic memory impairment and PD-associated depression is critical in interpreting neuropsychological testing. In this study, we aimed to determine if differing depression severity in PD patients influenced improvement in semantic memory during cued recall (CR) compared to free recall (FR). We administered the California Verbal Learning Test Second Edition (CVLT-II) to 59 PD patients with differing depression severity. We used the Beck Depression Inventory-II to determine depression severity according to published criteria: non-depressed 0-13 (n=41), mildly depressed 14-19 (n=9), and moderately-to-severely depressed > 19 (n=9). The three groups were age-and education-matched. We compared the CVLT-II short-delay FR, short-delay CR, long-delay FR, and long-delay CR between groups. We also compared memory improvements with cueing compared to free recall (CR minus FR) between groups. Using one-way ANOVA, there were no between group differences in performance on individual tests; however, we found between group differences during long-delay CR minus FR ($p=.007$). On post-hoc Tukey HSD analysis cueing improved performance only in the mildly depressed PD patients, compared to the non-depressed ($p=0.008$) and the moderately-to-severely depressed PD patients ($p=.018$). Our results help elucidate the effects of depression in PD on semantic memory, allowing for a more accurate interpretation of standard neuropsychological assessments.

## B19

### A MEG STUDY ON THE BRAIN ACTIVITY IN PROCESSING FACES WITH EMOTIONAL EXPRESSIONS

Pei-Shu Tsai[1], Ming-Chun Lee[2], Daisy L. Hung[4,5], Ovid J.-L. Tzeng[5,6], Denise H. Wu[4,7], Shih-tseng Tina Huang[2,3]; [1]Graduate Institute of Translation and Interpretation, National Changhua University of Education, [2]Department of Psychology, National Chung-Cheng University, [3]Center for Cognitive Sciences, National Chung-Cheng University, [4]Institute of Cognitive Neuroscience, National Central University, [5]Institute of Neuroscience, National Yang-Ming University, [6]The Institute of Linguistics, Academia Sinica, [7]Laboratories for Cognitive Neuroscience, National Yang-Ming University — The present

research attempted to examine the brain activation in processing faces with emotional expressions. Twenty adults (10 males and 10 females, age ranged from 19 to 29) with normal or corrected normal vision and reported no abnormal neurological history participated. In the study, faces of seven basic emotions were tested in separate blocks and presented in pairs. The participants were asked to judge if the two faces in each trial were identical as in the same emotion or as from the same person. Results found the brain activation of person identity task was significant higher than those of the emotion task in premotor cortex and supplementary motor cortex (BA6), somatosensory association cortex(BA7) and right cerebrum at 60-90ms after onset of the stimuli. The activation of the second faces were higher than those of the first faces in insular cortex, supramarginal gyrus, and right Cerebrum at 240-290ms. We found early activation at 60-90ms in processing female faces were higher in BA7, V2, and dorsal posterior cingulate cortex, whereas processing male faces were higher in fusiform gyrus, anterior prefrontal cortex, and right cerebrum. Further analysis found at 240-275ms in processing female faces higher than in male faces in BA6 and insular cortex. The results suggested that a non-conscious perception of male and female emotional expressions which is implemented at early stage of processing. Furthermore, it was found that higher activation in processing female facial expressions in motor and insular cortex than in male faces in later stage.

### B20

### OVARIAN HORMONE LEVELS PREDICT INTRINSIC CONNECTIVITY BETWEEN SALIENCE AND DEFAULT MODE NETWORKS

Joseph Andreano[1,2,3], Alexandra Touroutoglou[4,2,3], Nicole Betz[5], Bradford Dickerson[4,2,3], Lisa Feldman Barrett[1,2,3,5]; [1]Massachusetts General Hospital, Department of Psychiatry, [2]Athinoula A. Martinos Center for Biomedical Imaging, [3]Harvard Medical School, [4]Massachusetts General Hospital, Department of Neurology, [5]Northeastern University, Department of Psychology — Converging evidence suggests that ovarian hormone fluctuations over the course of the menstrual cycle can influence susceptibility to mood disorders in women. Similarly, ovarian hormone fluctuations also influence the modulation of memory by affect. Mood disorders and affective memory modulation have each separately been associated with the strength of intrinsic connectivity between nodes within two of the brain's intrinsic networks, the salience network and default mode network. This raises the possibility that changes in ovarian hormone levels may influence the degree of intrinsic connectivity between these two networks. To test this hypothesis, we investigated whether there are brain regions within the default mode network whose intrinsic connectivity with the amygdala (a node of the salience network) is correlated with estrogen and progesterone levels. The same procedure was used to identify regions of the salience network whose connectivity with the hippocampus (a node of the default mode network) was correlated with estrogen and progesterone levels. The results indicated that amygdala connectivity with default mode structures was correlated with both estrogen and progesterone levels. Similarly, hippocampal connectivity with salience network structures was also correlated with estrogen and progesterone. These findings indicate that ovarian hormone levels modulate the degree of communication between intrinsic networks involved in affect and memory. This ovarian modulation of connectivity may explain menstrual cycle effects on susceptibility to mood disorders.

### B21

### PERCEPTUAL AND PHYSIOLOGICAL DIFFERENCES BETWEEN GENUINE AND POSED EMOTIONAL VOCALIZATIONS

Sinead HY Chen[1], Samuel Evans[1], César Lima[1,2], Naiara Demnitz[1], Sophie Scott[1]; [1]Institute of Cognitive Neuroscience, University College London, [2]Faculty of Psychology and Education, University of Porto — In social interactions, the ability to understand whether emotional expressions are genuinely felt is important for understanding the social intentions of others. In this study, twenty-four adult participants (twelve female) passively listened to recordings of genuine and posed emotional expressions (40 laughs (positive emotion), 20 genuine and 20 posed; 40 cries (negative emotion), 20 genuine and 20 posed) while pupil diameter was measured. In a separate session, participants were asked to rate the emotional sounds on a 7-point Likert scale for the degree to which they perceived the sounds as authentic, contagious, arousing, and the degree to which the speakers were in control of their emotional expression. Participants' pupils dilated significantly more when they were listening to authentic as compared to posed emotional expressions ($p<.001$), and showed significant pupil dilation for authentic emotional expressions two to five seconds after sound onsets($p<.001$). In behavioural testing, authentic emotional expressions were rated to be higher in authenticity, arousal and show less control than posed ones ($p<.001$), and positive expressions were rated as more authentic and arousing, and show less control than negative ones ($p<.001$). In addition, authentic positive expressions were rated to be higher in arousal, contagious, and less in control than negative ones ($p<.001$). Our results suggest that listeners are indeed able to differentiate genuine from posed positive and negative emotional expressions, consistent with pupillometry results. However, the absence of an emotion difference in pupil responses shows a discrepancy between overt behavioural ratings and physiological process.

## EMOTION & SOCIAL: Other

### B22

### EMOTIONAL AND MOVEMENT-RELATED BODY POSTURES MODULATE VISUAL PROCESSING

Khatereh Borhani[1], Caterina Bertini[1], Martin Maier[1,2], Alessio Avenanti[1,3], Elisabetta Làdavas[1]; [1]University of Bologna, [2]Catholic University of Eichstätt-Ingolstadt, [3]IRCCS Fondazione Santa Lucia — Human body postures convey useful information to understand others' emotions and intentions. To investigate at which stage of visual processing emotional and movement-related information conveyed by observed bodies is discriminated, we examined event-related potentials (ERPs) elicited by laterally-presented images of bodies with static postures, and implied-motion bodies with neutral, fearful or happy expressions. At the early stage of visual structural encoding (N190), we found a different sensitivity of the two hemispheres to observed body postures. Specifically, the right hemisphere showed a N190 modulation both for the motion content (i.e., all the observed postures implying body movements elicited greater N190 amplitudes compared to static postures) and for the emotional content (i.e., fearful postures elicited the largest N190 amplitude), while the left hemisphere showed a modulation only for the motion content. In contrast, at a later stage of perceptual representation, reflecting selective attention to salient stimuli, an increased early posterior negativity (EPN) was observed for fearful stimuli in both hemispheres, suggesting an enhanced processing of motivationally relevant stimuli. The observed modulations, both at the early stage of structural encoding and at later timing, suggest the existence of a specialized perceptual mechanism tuned for emotion and action-related information derived by human body postures.

### B23

### SEX DIFFERENCES IN NEURAL RESPONSE TO MONETARY LOSS DURING ADOLESCENCE

Catherine Fassbender[1], Cynthia Krafft[1], Daniel Hawes[2], Ana-Maria Iosif[1], Wouter van den Bos[3], Stephen Hinshaw[4], Amanda Guyer[1], Samuel McClure[2], Julie Schweitzer[1]; [1]UC Davis, [2]Stanford University, [3]Max Planck Institute, Berlin, [4]UC Berkley — Risk taking is increased during adolescence compared to childhood and adulthood. Moreover, males are more likely to display adolescent risk taking than females. One potential basis for risk taking is differential responsiveness to rewards and punishments generally, independent of explicit risk considerations. We measured neural activity following unpredictable monetary gains and losses in adolescent males and females to determine whether brain responses to reinforcers differ by sex. For 49 adolescents (ages 12-18; 24 males, 25 females) we investigated neural activity in the nucleus accumbens (NAcc) during the evaluation of probabilistic outcomes from a well-studied number-guessing task (Delgado, 2000). The NAcc was chosen as the primary region of interest because of its strong association with value-based decision-making, including risk assessment. Both sexes exhibited sustained increases of NAcc activity after gains, with no significant difference between them. However, there was a significant difference between males and females in response to loss feedback, $t(47)=2.64$, $p=.011$: only females exhibited the expected pattern of decreasing NAcc activity. Adolescent males, on the other hand, exhibited reduced neural sensitivity to losses during the evaluation of probabilistic punishment, which was also supported by behavioral performance in a separate risk-taking task (Lejeuz et al., 2002). For the latter, the sexes did not differ in overall amount of risk-taking, but females took significantly lower risks than males on trials immediately following losses, $t(47)=2.67$, $p=.01$.

Overall, differential increases in risk-taking behaviors for male and female adolescents may be rooted in reduced sensitivity of adolescent males to the experience of undesirable outcomes.

## B24

### VERBAL INSTRUCTIONS VERSUS ACTUAL EXPERIENCE: TWO DIFFERENT NEURAL PATHWAYS TO THE ACQUISITION OF FEAR

Senne Braem[1], Jelle Demanet[1], Raffael Kalisch[2], Jan De Houwer[1], Marcel Brass[1]; [1]Ghent University, [2]Johannes Gutenberg Universität — In this fMRI study, we aimed at uncovering the brain regions that mirror the acquisition of merely instructed versus experienced fear. To this end, we administered a fear conditioning paradigm where participants were instructed that two out of three visual stimuli could be followed by an electric shock. However, during the training phase, participants were told that electric shocks following one of these two stimuli would be replaced by a placeholder — under the false pretense that this would allow them to gradually adjust to the aversive task conditions. In contrast, the other stimulus was occasionally paired with a shock. In the test phase, participants were re-instructed that now both stimuli could be followed by a shock, while in fact, no more shocks were distributed. We replicate earlier findings by demonstrating that fear ratings during the test phase were initially higher for the experienced versus merely instructed fear stimulus. Furthermore, the imaging data document a differential recruitment of the striatum being more active during the acquisition experienced fear, and the inferior frontal sulcus which was most active during merely instructed fear. Moreover, we demonstrate how the activity in the inferior frontal sulcus during instructed fear in the training phase correlated with fear ratings for the same stimulus in the later test phase. Our results demonstrate how different neural pathways are involved in the acquisition of experienced versus merely instructed fear associations.

## B25

### FOOD BRAND PREFERENCES MODULATE NEURAL RESPONSES TO ADVERTISEMENTS IN MEDIAL PREFRONTAL CORTEX

Kristina Rapuano[1], Andrea Wosham[1], James Sargent[1,2], Todd Heatherton[1], William Kelley[1]; [1]Dartmouth College, Hanover NH USA, [2]Dartmouth-Hitchcock Medical Center, Lebanon NH USA — Despite the ubiquity of food advertisements, little is known about how the brain represents brand preferences (e.g., McDonalds vs. Burger King) across individuals. The current study sought to investigate (1) the strength of individuals' brand preferences on brain responses to food advertisements, and (2) whether the strength of this modulation predicts individual differences in body fat. While undergoing fMRI, participants viewed food and non-food (control) advertisements and performed an unrelated incidental judgment task (indoor/outdoor discriminations). Following scanning, participants rated their preferences for each brand on a scale from 1 to 7. Body fat measurements were obtained with a Tanita bioelectric impedance scale. Subjects' brand preferences were included in a multiple regression to identify brain regions whose activity increased with increasing brand preference. Several regions were found to track with food brand preferences, including the mPFC, dorsal striatum, and visual perception and attention areas. In order to identify whether activity in these regions influence adiposity, activity in regions specific for food brand preference was correlated with subjects' body fat measurements. The mPFC was the only brain region to predict individual differences in body fat— individuals with strong brand-preference activity in the mPFC were those individuals with higher body fat measurements. These results suggest that the mPFC, a region involved in self-referential processing, may represent the personal salience of reward cues and may reflect an additional motivational signal that contributes to unhealthy eating behavior.

## B26

### IMPACT OF CONTEXT AND AFFECTIVE QUALITY ON THE REPRESENTATIONAL STRUCTURE OF VISUAL IMAGES IN BRAIN AND BEHAVIOR

Marcie King[1], Dwight Kravitz[1,2], Chris Baker[1]; [1]Laboratory of Brain and Cognition, National Institute of Mental Health/NIH, [2]The George Washington University — fMRI has revealed brain regions selective for certain concrete categories of visual stimuli (e.g. faces, scenes, and objects). However, this work has largely focused on how these regions represent object identity or category and typically use images of isolated objects in the absence of any context. The current study extends our understanding of how complex visual stimuli are represented in the brain and in behavior by examining how context and the affective quality of the object modulate these representations. Participants viewed 144 diverse images, spanning a wide range of concrete categories and varying in affective quality (e.g. images of smiling people, broken dishes, rainy landscape, etc.), while they were scanned on a 7T MRI scanner. Following the scan, participants completed a one-hour behavioral session in which they spatially arranged all 144 images according to their general perceived similarity. We directly compared the neural space of the images (determined by similarities in neural responses in different brain regions between individual stimuli) with the perceived similarity of the images (determined as a measure of the distance between any pairs of individual stimuli in the behavioral data). Our results show that the representation of complex images is stable across independent sets of stimuli with the same affective quality, and that the neural representation of these images in visual cortex is predictive of behavioral grouping. Importantly, however, the precise representational structure is strongly modulated by the affective quality of the images, both in brain and behavior.

## B27

### MODULATING THE INTENTIONAL STANCE THROUGH NONINVASIVE BRAIN STIMULATION OF THE ANTERIOR PARACINGULATE CORTEX

Eric J. Blumberg[1,2], Raja Parasuraman[1,2], Amanda Hanelli[1], Eva Wiese[1,2]; [1]George Mason University, [2]Center of Excellence in Neuroergonomics, Technology, and Cognition (CENTEC) — Attending to where others look (i.e., gaze cueing) is a fundamental mechanism of social cognition and has been shown to be modulated by beliefs about whether changes in gaze direction are caused by an agent with a mind (e.g., human) or by an agent without a mind (e.g., robot) – a mechanism commonly referred to as adopting the intentional stance. Previous studies have shown that taking the intentional stance in social interactions is associated with activation in the anterior paracingulate cortex (PCC; Gallagher & Frith, 2003). Therefore, stimulating this brain region with transcranial direct current stimulation provides a unique method to investigate the causal role of the PCC for modulating low-level mechanisms of social cognition, such as gaze cueing. Electrodes were placed on EEG scalp location FZ (anode) and F9 (cathode) following current model predictions of optimal current flow through the PCC. Participants (N=14) were randomly assigned to one of two conditions while they performed a gaze cueing task: active stimulation at 2mA for 30 minutes or a sham control (2mA ramp-up and immediate ramp-down). Each participant completed 404 trials (202 trials with each agent type; human- or robot-face) during both baseline and stimulation blocks. Anodal stimulation significantly increased the gaze-cueing effect (average invalid reaction time minus average valid reaction time) for the human face but not for the robot face. Sham stimulation did not affect gaze-cueing performance in either agent. The results provide compelling evidence that the PCC plays a causal role in modulating basic mechanisms of social cognition.

## B28

### NEURAL UNDERPINNINGS OF DISTINCT DEPRESSIVE PHENOMENA IN NEURODEGENERATIVE DISEASE

Kelly A. Gola[1], Babu Adhimoolam[1], Brianne M. Bettcher[1], Virginia E. Sturm[1], Suzanne M. Shdo[1], Joel H. Kramer[1], Bruce L. Miller[1], Katherine P. Rankin[1]; [1]University of California, San Francisco — Though depression has been associated with neurostructural abnormalities, few studies have shown causal effects of focal brain damage on specific depressive phenomenology, and fewer differentiate cortical from subcortical contributions. To disambiguate how specific depressive symptoms arise from focal patterns of gray matter volume loss, we examined 223 neurodegenerative and healthy subjects [51 Alzheimer's Disease (AD), 66 behavioral variant frontotemporal dementia (bvFTDs) patients, 106 Healthy Controls (NCs)]. Depressive symptoms were assessed using the Geriatric Depression Scale (GDS). Grey matter correlates of symptoms were assessed using voxel-based morphometry (VBM) analysis using age, gender, disease severity, scantype and total intracranial volume as covariates. Depressive symptoms were elevated in ADs and bvFTDs relative to controls. Dysphoria predicted volume loss in the right superior temporal lobe (T=4.99), hopelessness predicted left cerebellum Crus 1 and left thalamus volume loss (T=5.08), and apathy predicted left cerebellum Crus 1 volume loss (T=4.93; $p<0.05$, FWE corrected). Our findings are consistent with emerging evidence that the cerebellum plays an important role in motivation and emotion regulation. Additionally, they inform existing

neurobiological models of depression that implicate dysfunctional cortical-subcortical circuitry. We found that cortical and subcortical regions differentially predicted distinct depression symptoms, thus highlighting the importance of careful phenotypic quantification in understanding brain contributions to neuropsychiatric syndromes.

## B29

### STRUCTURAL AND FUNCTIONAL NEURAL CORRELATES OF COMMUNICATION IMPAIRMENT IN CHRONIC TRAUMATIC BRAIN INJURY

Arianna Rigon[1], Michelle W. Voss[1], Melissa C. Duff[1]; [1]The University of Iowa — Although impairment in interpersonal communication is common following traumatic brain injury (TBI), techniques to characterize the neural systems involved in the impairment have lagged behind. We used the LaTrobe Communication Questionnaire to assess communication quality in individuals with TBI (N=20) as perceived by the patients themselves (Self-Report; LCQ-S) and by a close other (Other-Report LCQ-O). As two dimensions measured by the LCQ are sensitivity to the partner's need and ability to inhibit impulsive behaviors during conversation, we examined the correlation between LCQ scores and fMRI measured resting-state functional connectivity (RS-FC) in the Mentalizing Network (MN), important for inference of mental states, and in the Executive Network (EN), which has been found to support executive functioning. TBI patients' communication quality measured by LCQ-O correlated negatively with RS-FC between dorsal anterior cingulate cortex (dACC) and right (r=-.748, p<.01) and left (r=-.842, p<.01) insulae; these regions are thought to collaborate in mediation and switching between internally and externally oriented large scale brain networks, skills necessary to successfully navigate the social environment. Conversely, TBI individuals with higher self-perceived communication abilities had more RS-FC between the MN and dACC (r=.669, p<.01). Additionally, we used diffusion tensor imaging to measure axonal damage, and we found that global white matter integrity negatively correlated with the difference between LCQ-S and LCQ-O scores, a measure of TBI patients' awareness of the quality of their social communication (r=-.74, p<.01). Our findings suggest that DTI and RS-FC might prove useful in identifying biomarkers for predicting communicative outcomes following TBI.

## B30

### RELATIONS BETWEEN ANXIETY SENSITIVITY AND EVENT-RELATED POTENTIALS FROM A GAMBLING FEEDBACK TASK

Nicholas Allan[1], Adreanna Massey[2], Brian J Albanese[1], Carson A Sutton[1], Matthew Bachman[2], Brad Schmidt[1], Edward M Bernat[2]; [1]Florida State University, [2]University of Maryland — Anxiety sensitivity (AS), or the fear of anxiety and the accompanying anxious arousal, is a multifaceted risk factor for anxiety pathology. AS comprises a general factor as well as more specific physical, cognitive, and social concerns dimensions. In recent years, efforts have been made to investigate neurophysiological mechanisms underlying processes associated with AS. The current study assesses individual differences in AS in relation to event-related potential (ERP) activity collected during a common gambling feedback task (Gehring and Willoughby, 2002). Recent work from our group has delineated a response in theta which is increased to losses (consistent with the feedback-negativity [FN]) from a response in delta which is increased to gains (e.g. Bernat et al., 2011). The current study was designed to examine the relations between general and specific self-reported AS factors (Taylor et al., 2007) and time-frequency principal components indexing theta and delta gambling feedback ERP activity in a sample of 70 participants (M age = 36.4 years, SD = 15.92; 43.4% male) with elevated risk status for anxiety (data collection is ongoing). Results indicated that AS was positively associated with delta-gain as well as theta-loss parameters. Importantly, some degree of specificity was detected in the relations between specific AS dimensions and delta and theta parameters. The current study presents an important step in understanding neurophysiological systems associated with self-report AS parameters.

## B31

### ANXIETY AND DEPRESSION MODULATE BRAIN ACTIVITY TO MEANINGFUL AND EMOTIONAL WORDS

Lowri Hadden[1,2], Debra Mills[1]; [1]Bangor University, [2]Liverpool University — The maintenance of anxiety and depressive disorders is related to cognitive and emotional biases. Yet, the relative contribution of semantics and emotion in sustaining these biases remain entangled. The current study used event-related potentials to address how people who score low versus high on scales of anxiety/depression (AD) process valenced semantic and emotional words. Semantic and emotional processing were examined separately using written word pairs in a priming paradigm. Emotionally valenced targets (positive, negative or neutral) were primed to be semantically and affectively related, semantically unrelated, or affectively unrelated. When all participants were considered together, semantic and affective conditions modulated brain activity differentially; with an N400 effect for semantics and a Late Positive Potential (LPC) for emotion. However for participants who scored high on AD, interactions with valence significantly influenced both semantic and emotional processing. We propose that an LPC to semantic incongruencies is a neurophysiological marker for anxiety/depression indexing abnormal processing of positively valenced stimuli. Difficulty integrating positive meaning is consistent with low positive affect, negative schemas and could be associated with maintaining the disorders.

## B32

### INDIVIDUAL REWARD RESPONSIVENESS PREDICTED BY RESTING-STATE CONNECTIVITY OF BASAL GANGLIA AND ORBITOFRONTAL CORTEX

Nicholas Angelides[1], Jayesh Gupta[1], Timothy Vickery; [1]University of Delaware — Based upon behavioral and psychometric research, a Behavioral Activation System (BAS) has been proposed to underlie reward responsiveness and appetitive motivation. However, neural mechanisms corresponding to the proposed constructs of BAS are still poorly defined. The basal ganglia (BG) and orbitofrontal cortex (OFC) are implicated in subserving reward-related functions that are also associated with the BAS. In this study, we examined whether functional connectivity between these regions predicts a component of dispositional BAS proposed to reflect reward responsiveness. We employed resting-state functional connectivity and BAS-reward scores assessed by a personality questionnaire. Participants (N=52) in several different fMRI studies completed a standard resting state run and the Gray's Behavioral Inhibition and Activation Systems (BIS/BAS) Questionnaire following their primary tasks. Using resting-state BOLD, we assessed correlations between anatomically-defined BG ROIs (caudate and putamen) and bilateral orbitofrontal ROIs. We calculated mean connectivity between orbitofrontal ROIs and BG ROIs to establish single subject connectivity summary scores. Correlation analyses showed that BAS-reward functioning was positively correlated (r=0.28, p<0.04) with mean functional connectivity scores between BG and middle OFC. BAS-reward was not correlated with the connectivity scores between BG and a control region (precentral gyrus, r=0.13, p<0.35), nor was this connectivity associated with a different subscale of the BAS system (BAS-drive, r=0.03, p<0.83). These results demonstrate a novel correlation between BAS-reward responsiveness and resting-state connectivity, implying that spontaneous synchrony between reward-processing regions may play a role in defining personality characteristics related to motivation.

## B33

### GENDER-SPECIFIC EFFECTS OF EARLY LIFE STRESS ON NEURAL ASPECTS OF REWARD PROCESSING

Sara Bergman[1], Maddie Pollack[1], Natalie Colich[1], Ian Gotlib[1]; [1]Stanford University — A major risk factor for the development of reward-related disorders is early life stress (ELS; e.g., childhood maltreatment). Previous research indicates that ELS is associated with decreased activation in reward brain regions (e.g., striatum and insula) during anticipation, and increased activation during reward receipt. This research has investigated effects of stressful life events many years after they have occurred; consequently, it is unclear when neural deficits emerge. Moreover, there is evidence suggesting that ELS has divergent sex-specific effects on the neurodevelopment of reward function. We measured the effects of ELS on neural responses during the anticipation and receipt of rewards in children, and we examined whether gender would interact with ELS. Trained interviewers assessed 58 children so far (ages 10-13 years) for severity of ELS. Participants completed a modified monetary incentive delay task while being scanned with functional magnetic resonance imaging. ELS severity was entered into higher-level whole-brain analyses to examine correlations between ELS and neural activity during anticipation and receipt of reward. Although ELS did not moderate anticipatory activation, ELS severity was positively correlated with activation

in right nucleus accumbens (NAcc) and insula during receipt of gains. We extracted parameter estimates from these regions and obtained a significant interaction of ELS and gender in NAcc. Whereas females demonstrated greater activation with increasing ELS during gain > no gain in NAcc, males showed a negative correlation. Our findings underscore the differential effects of both stress and gender on neural activations during the different phases of reward processing.

# EXECUTIVE PROCESSES: Goal maintenance & switching

## B34

### THE IMPACT OF A MATCH BETWEEN GLOBAL AND LOCAL INCENTIVES ON CATEGORIZATION RULE SWITCHING IN INDIVIDUALS WITH PARKINSON'S DISEASE AND HEALTHY OLDER ADULTS

Lauren Szymula[1], W. Todd Maddox[2], Shawn W. Ell[1]; [1]University of Maine, [2]University of Texas at Austin — Recent data suggest that performance on rule-based classification tasks (i.e., tasks that emphasize between-category representations which facilitate the differentiation of members of contrasting categories) can be modulated by manipulating the extent to which global and local incentives match. This is thought to depend, in part, on increased cognitive flexibility that facilitates categorization rule switching. The present study investigated whether Parkinson's disease patients (PDs) and healthy older adults (OAs) would benefit from a match. Experiment 1 manipulated global incentive by placing participants in a promotion (gain sensitive) or prevention (loss sensitive) regulatory focus. The local incentive was to maximize trial-by-trial gains (i.e., a match with the promotion condition). Participants were trained on a rule-based task where successful performance required learning a rule on a relevant stimulus dimension while ignoring irrelevant dimensions. Once a learning criterion was met, the rule was switched (i.e., a previously irrelevant dimensions became relevant). Following the rule switch, a match facilitated the performance of OAs, but had no effect on the performance of PDs. Experiment 2 investigated if this match benefit for OAs would generalize to a loss-oriented local incentive that emphasized minimizing trial-by-trial losses (i.e., a match with the prevention condition). In contrast to Experiment 1, a loss-oriented match had no effect on the performance of OAs. These data suggest that the benefit of a match between global and local incentives on categorization rule switching may be restricted to gains-oriented situations and may depend on the frontal-striatal networks disrupted in PD.

## B35

### VARIABILITY IN TASK CONCEPTUALISATION DRIVES PERFORMANCE-G CORRELATIONS

Peter Bright[1], Ellen Carroll[1,2]; [1]Anglia Ruskin University, Cambridge UK, [2]University of Cambridge — Research indicates that the requirement to withhold a prepotent response tendency is a crucial risk factor for the engagement of Spearman's g, and that impaired response inhibition and low fluid intelligence are disproportionately associated with frontal lobe damage (Bright, 1998). We have shown that recruitment of g is driven, not so much by task demands per se, but by the modelling of instructions prior to execution (Duncan et al., 2008; Carroll & Bright, 2013). To further clarify the relative contributions of task conceptualisation versus real time execution demands to the recruitment of g, participants undertook a novel speeded response task requiring prepotent response inhibition (Bright, 1998; Duncan et al., 2008) and the Dot Pattern Expectancy (DPX) task (MacDonald et al., 2005) in which the impact of different cognitive demands (updating, maintenance, prepared response inhibition) was explored. Findings showed that performance-g correlations were strengthened by the presence (vs. absence) of requirements to inhibit prepotent and prepared response tendencies irrespective of overall task difficulty, and by increased maintenance and updating demands on working memory. Crucially, however, these effects were observed only when the same body of task instructions was presented as four, and not two, distinct rules (Carroll & Bright, submitted). Reconceptualisation of task requirements towards greater representational efficiency was also associated with g. Together, these experiments indicate that recruitment of Spearman's g is largely determined by the relational complexity of task components, and that the effort required for optimal modelling of a task largely determines the strength of performance-g correlations.

## B36

### BENEFITS OF DANCE MOVEMENT TRAINING FOR PEOPLE WITH PARKINSON'S DISEASE: A PILOT CLINICAL TRIAL

Maria I. Ventura[1,2], Jessica M. Ross[3], Karen A. Sigvardt[2], Elizabeth A. Disbrow[4]; [1]University of California, San Francisco, [2]University of California, Davis, [3]University of California, Merced, [4]Louisiana Stata University, Shreveport — Parkinson's disease (PD) is a chronic and progressive neurodegenerative disease which can result in disruption to a number of motor and cognitive functions. We investigated the benefits of dance movement training (DMT) on motor and cognitive functioning and explored how DMT may impact quality of life. Participants were recruited from PD support groups and Dance for PD®, a DMT program for people with PD. The Intervention group (N=8) completed a battery of neuropsychological testing at time point 1, participated in 10 DMT intervention sessions (1.25 hours once per week), then completed the same neuropsychological assessment at time point 2. The Control group (N=7) completed a battery of tests identical to the one given to the Intervention group at time points 1 and 2, but did not receive the DMT intervention. After study completion, Control participants were invited to enroll in Dance for PD® classes. In the motor domain, the Intervention group experienced a greater decline in fear of falling (group-by-time interaction, p=.02) and significantly improved gait speed (group-by-time interaction, p=.02) relative to the Control group. In the cognitive domain, the Intervention group had significantly faster set-switching completion times (group-by-time interaction, p=.04). In the quality of life domain, the Intervention group reported significantly greater improvements in quality of life (group-by-time interaction, p=.02) and in activities of daily living (group-by-time interaction, p=.01). Our findings indicate that DMT interventions like Dance for PD® can significantly improve motor function, cognitive function and quality of life for people with PD.

## B37

### EARLY PRACTICE EFFECTS IN INSTRUCTED TASKS REFLECT LEARNING OF THE DYNAMIC STRUCTURE OF A TASK

Apoorva Bhandari[1], Ryan Fugate[1], David Badre[1]; [1]Brown University — Humans are unique in that they are able to perform complex tasks with relatively little practice after being verbally instructed. In previous research, a common finding is that of an early practice effect wherein the first few trials after instruction show a rapid decline in response time. As task rules are instructed, such 'learning curves' have been interpreted as reflecting a process of transfer from symbolic to pragmatic rule representations (Ruge & Wolfensteller, 2010). We suggest that the process of implementing novel tasks from instruction involves not just adopting the rules of the task, but also learning its dynamic structure. Therefore, early practice effects may reflect adaptation of a rule to the task's dynamic structure. In two behavioral experiments, we directly tested this idea by examining the transfer of dynamic structure between tasks. We found that subjects indeed show both positive (same task structure) and negative (different task structure) transfer of task dynamic structure, independent of the novelty of task rules. Our results identify a novel cognitive process that may underlie early practice effects in instructed tasks.

## B38

### TASK SWITCHING, INHIBITION, AND ALPHA OSCILLATIONS

Russell Costa[1], Benjamin Cohen[1], Chrono Nu[1], Lesa Ellis[1]; [1]Westminster College, Salt Lake City, UT — Numerous theoretical cognitive models of task switching propose that inhibition, particularly of recently performed task information, plays a critical role in switching one's attention between multiple tasks. At the neural level, recent work in selective attention has examined the role of alpha-band (8-14 Hz) cortical oscillations as a mechanism for suppressing goal- or task-irrelevant information. In this study, we explored whether such alpha-band activity can be extended beyond spatial suppression and selection to examine inhibitory processes involved in switching attention between non-spatial tasks. Participants switched their attention between the color, shape, or motion of a series of visual stimuli presented in the middle of the visual field that contained features of only two (i.e., color

and motion, color and shape, or shape and motion) of the three possible perceptual dimensions. An instructional cue was presented prior to each target, indicating which feature of the upcoming stimulus the participant should attend and respond to. Results suggested that increased cue-locked alpha-band power, observed during the pre-stimulus interval, was associated with task repetition trials compared with task switches. Additionally, during task switch trials, increased alpha-band activity was observed when the previous (n-1) trial's goal-relevant information was presented as distracting information on the current trial. These results support the notion that alpha-band activity may underlie inhibitory processes involved in task switching beyond spatial tasks; moreover, such activity may play a role in both pre-stimulus, proactive cognitive control as well as in stimulus-driven, reactive suppression of task-irrelevant perceptual information.

## B39

### NEURAL MECHANISMS OF SWITCHING BETWEEN PROCEDURAL AND DECLARATIVE CATEGORIZATION

Matthew Crossley[1], Benjamin Turner[2], F. Gregory Ashby[2]; [1]UC Berkeley, [2]UC Santa Barbara — A number of current theories assume that human category learning is governed by the interaction of multiple qualitatively distinct systems. A popular assumption is that these hypothesized category-learning systems map onto broadly defined memory systems. In this view, procedural memory is used to form many-to-one stimulus to response mappings (i.e., S-R associations), whereas declarative memory is used to apply explicit rules and test hypotheses about category membership. The multiple systems framework has been successful in motivating and accounting for a broad array of empirical observations over the last 20 years. Even so, little is known about how these systems interact to coordinate control of limited motor resources. Here, we report neuroimaging results suggesting that the brain networks recruited by rapid trial-by-trial switching between procedural and declarative categorization tasks include and extend those found in classical task switching brain networks. In particular, by comparing activity on trials within a particular system based on the type of the preceding trial—for instance, whether a trial designed to be solved procedurally (indicated to the participant by means of a cue) was preceded by another procedural trial (a "stay" trial) or a declarative trial (a "switch" trial)—we identified several areas in prefrontal and inferior temporal cortex whose activity was reliably different across trial types. We propose that these regions comprise a network whose activity is critically involved in initiating the switch between systems—a result which has implications for both the category learning and task-switching literatures.

## B40

### EFFECTS OF TRIAL PREPARATION TIME AND TRIAL TYPE PROBABILITY ON PERFORMANCE OF ANTISACCADES AND PROSACCADES

Jordan Pierce[1], Jennifer McDowell[1]; [1]University of Georgia — In saccade tasks, individuals must make a rapid eye movement towards (prosaccade, PS) or away from (antisaccade, AS) a peripheral target. When these saccade types are intermixed in a single run, cues are provided to indicate to the participant which task to perform on the subsequent trial. The probability of a certain trial type occurring within a run, time between trials, and duration of the cue may all impact the participant's ability to prepare for the trial and, thus, the saccade reaction time (RT) and number of errors committed. In the current study, 111 participants performed 5 runs of mixed trials with 10, 25, 50, 75, or 90% probability of an AS (vs. PS). Participants were assigned to one of four timing conditions with a long vs. short intertrial interval and long vs. short trial type cue. Results for RTs showed that when the cue period was short, RTs increased for both saccade types when the probability of that trial type occurring was low. For the long cue conditions, the 50% AS run had the longest RTs for both AS and PS. Results for error rate also indicated an effect of trial type cue, with short cue conditions eliciting nearly twice as many AS errors as long cue. These findings indicate that in the context of mixed saccade trials with varying probability of AS, performance is more strongly influenced by the amount of time to prepare for the specific saccade type than by the amount of time between trials.

## B41

### MINDFULNESS TRAINING IMPROVES ATTENTIONAL PERFORMANCE IN ELITE COLLEGE ATHLETES

Joshua Rooks[1], Alexandra Morrison[1], Merissa Goolsarran[1], Scott Rogers[1], Amishi Jha[1]; [1]University of Miami — Elite athletes strive for peak performance. Yet the stress and anxiety of high stakes, high demand athletic training may impede performance. We investigated the impact of offering mental conditioning programs to a Division I NCAA football team (N=105). Performance on the sustained attention response task (SART), self-reported stress (PSS) and anxiety (STAI) were examined before (T1) and after (T2) the mental conditioning programs. Over 4 weeks, the team attended a mindfulness training course (MT) or a relaxation and visualization course (RV). Both courses involved 4, 45 minute group sessions with a trainer, 4 weekly proctored practice sessions, and 12 minutes of assigned daily homework listening to guided recordings. Assignment to MT vs. RV was determined via a matched randomization procedure. Because homework compliance was highly variable, each training group was median split by self-reported minutes of homework practice. A repeated measures ANOVA examining time (T1 vs. T2) x training type (MT vs. RV) x homework compliance (high vs. low) on SART performance (A') demonstrated a significant 3-way interaction. At T2, A' was greater for high vs. low MT, while high and low RV did not differ from each other. High MT also outperformed RV at T2. When practice time was considered as a continuous variable, greater time spent engaging in homework corresponded with greater improvements in A', as well as greater reductions in self-reported stress and anxiety for MT but not RV. Thus, MT course participation and better homework compliance enhanced attention and psychological health.

## B42

### PREFRONTAL CORTEX AND UNCERTAINTY DURING SEQUENTIAL TASKS

Theresa M. Desrochers[1], Anne GE. Collins[1], David Badre[1]; [1]Brown University — Every day we perform sequences of tasks that require monitoring the performance of individual sub-goals to reach a final end goal. This process often occurs in the absence of external cues indicating the amount of progress made towards the overarching goal. In such situations, one must internally monitor progress through the sequence. In previous fMRI and TMS experiments, we found that activation in the rostrolateral prefrontal cortex (RLPFC) progressively increased its activity over the course of a sequence of tasks. Specifically, participants repeatedly performed a sequence of four simple categorization tasks (e.g.: color, shape, shape, color). Further, single pulse TMS delivered to the RLPFC during the task sequences increasingly disrupted performance as the sequence progressed, mirroring the activation pattern. These results suggested that RLPFC may be necessary to resolve accumulated uncertainty at each position in the sequence, rather than representing serial position itself. We designed an experiment to explicitly test this hypothesis by breaking the confound between uncertainty and sequence position. Specifically, we provided "clues" to the participants as to the identity of the task they should be performing on approximately one third of the trials across positions. The clues serve to reduce the uncertainty on those trials. We used computational modeling to infer from subjects' trial-by-trial choices their uncertainty about the task sequence. Preliminary results from fMRI participants suggest that RLPFC preferentially represents this uncertainty instead of a signal that simply monotonically increases through each position in sequence.

## B43

### NEURAL EVIDENCE FOR STIMULUS AND RESPONSE-SPECIFIC TASK PREPARATION

Savannah Cookson[1], Richard Hazeltine[2], Eric Schumacher[1]; [1]Georgia Institute of Technology, [2]University of Iowa — Cognitive control refers to the set of processes by which we direct our actions toward a specific goal based on present situational context. One of these processes includes our ability to use incomplete information to aid performance in an upcoming task; this process allows us to narrow our future actions to a subset of options, reducing selection and/or preparation time. However, it is unclear how these processes are instantiated at the neural level. Here, we used an event-related fMRI design to understand the activation patterns that were elicited by a partial-information cue indicating either the upcoming stimulus type (face/place) or response hand (left/right). Stimulus-response (S-R) mappings segregated stimulus types by response hand,

such that the two dimensions were perfectly confounded. We hypothesized that cues would allow for the activation of coherent subsets of S-R pairs via sensorimotor region biasing; thus, in addition to the activation of general control-related processing areas, we expected cues to activate both the explicitly related sensorimotor processing regions and those implied by the overlap in the mapping structure. Whole-brain analyses of cued versus uncued trials at the cue event showed significant activation in frontoparietal regions for cued versus uncued trials at the cue. In addition, both stimulus- and response-related regions showed separable activation for both types of cues in a regions-of-interest analysis. These results suggest that, when a salient S-R subgroup is indicated by a cue, control processes bias activation in both stimulus- and response-relevant regions in preparation for future response selection and execution.

# EXECUTIVE PROCESSES: Other

## B44

### WHITE MATTER DIFFERENCES IN MONOLINGUAL AND BILINGUAL YOUNG ADULTS

Ashley Chung-Fat-Yim[1], Laura Mesite[2], Buddhika Bellana[3,4], Gigi Luk[2], Ellen Bialystok[1,4]; [1]York University, [2]Harvard Graduate School of Education, [3]University of Toronto, [4]Rotman Research Institute, Baycrest Centre for Geriatric Care — Previous research has reported behavioral differences between monolingual and bilingual participants in executive control but the brain structures underlying those differences are largely unknown. We compared fractional anisotropy (FA) of young adults who were unbalanced but proficient bilinguals and monolinguals who had minimal use of a second language. Participants performed a verbal and nonverbal switching task in fMRI and we used diffusion tensor imaging (DTI) to measure white matter integrity. Fourteen monolingual and 17 English-French bilingual young adults participated. Groups differed in French proficiency, (Bilingual = 90.2%, Monolingual = 19.8%, $t = 18.72$, $p < .001$) and French usage (Bilingual = 30.9%, Monolingual= 0.40%, $t = 6.69$, $p < .001$). Behavioral results showed equivalent group performance on the nonverbal task but slower performance by bilinguals in the verbal task, consistent with previous research. Analysis of DTI data showed that bilinguals had higher FA than monolinguals in association tracts in the left hemisphere, specifically in superior longitudinal fasciculus, inferior longitudinal fasciculus and inferior fronto-occipital fasciculus (corrected $p < .05$). No area showed higher FA in monolinguals than bilinguals. The higher FA values for bilinguals in these regions are similar to those found in a study with older adults (Luk et al., 2011) and with a meta-analysis of functional activity during language switching in which bilinguals showed significant activation in these left temporal and parietal regions across studies (Luk et al., 2012). These results contribute to our understanding of the brain basis of performance differences shown between monolinguals and bilinguals.

## B45

### THE INFLUENCE OF PREVIOUS CONCUSSIONS ON RETURN-TO-PLAY RECOVERY TIME

Brian R. Johnson[1], Christopher D'Lauro[1], Craig A. Foster[1], Marie Rossillon[1], Michelle Ferguson[1], Gavin O'Neil[1], Jonathan Jackson[1], C. Dain Allred[1], Gerald McGinty[1], Darren Campbell[1]; [1]U.S. Air Force Academy — Concussions have long been treated as an ephemeral injury leaving no lasting damage; however, recent evidence indicates neural effects may persist even after cognitive function has apparently returned to normal. At the Air Force Academy, cadets must complete required military training and sport participation that increases their susceptibility to concussions. Military command structure and free inclusive healthcare afford more complete concussion follow-up for return-to-play protocols than at civilian schools. Our goal is to use our integrated concussion care and high-risk population to better understand how prior concussion history effects return-to-play determinations. We have collected a two-year comprehensive database (N=307) cataloguing these assessments including: days until normalized neurocognitive assessment, source of concussion, prior concussion history, days until symptom free, days until completed return-to-play protocol, and others. These data indicate dramatically longer recovery times for anyone with a prior concussion history when compared to those experiencing their first concussion. For example, first time concussion sufferers reported being symptom free in a shorter time (M=28.0 days) than those with a previous concussion history (M=74.3 days; $F(1, 75)=5.90$, $p < .05$). When taking a neurocognitive battery (e.g., Stroop task, visual search task, working memory, etc.), first time concussion sufferers returned to their baseline earlier (M=25.2 days) than those with a previous concussion history (M = 53.0 days; $F(1, 75)=4.67$, $p < .05$). Taken together, these data support the idea that concussions cause latent neural damage that persist even with apparently normal cognitive performance.

## B46

### NEURAL SUBSTRATES OF JUDGMENTS OF LEARNING

Andre Lindsey[1], Pradeep Ramanathan[1], Katie Bessette[2], Michael Stevens[2]; [1]The University of Connecticut, [2]The Institute of Living Hartford Hospital — A key type of meta-memory, judgment of learning (JOL), is an individual's evaluation of the extent to which information has been learned. JOLs frequently take the form of Likert scale ratings of the likelihood that currently or recently studied information will be successfully recalled at a later time. The few extant neuroimaging studies have employed visual images of faces and scenes, rather than the traditional word pair learning task used in behavioral studies. Furthermore, these studies have not investigated the neural underpinnings of the well-documented "delayed JOL effect", the finding that JOLs made after a short delay (e.g., 2 minutes) are far more accurate than those made immediately after study. Here we used event-related fMRI to test the hypothesis that JOLs made immediately after stimulus encoding involve primarily fronto-executive networks subserving inferential processes, while those solicited after a delay will also include medial temporal networks reflecting the additional recruitment of long term recall processes. In this study, eighteen participants studied unrelated word pairs and made immediate and delayed JOLs. Distinct but overlapping regions of activation were observed, with immediate JOLs associated with differentially greater activation of fronto-executive networks and delayed JOLs associated with differentially greater activation of medial temporal networks. These results suggest that when JOLs are made immediately after encoding vs. after a delay of several minutes, distinct cognitive processes are engaged. Cognitive processing models of JOLs must therefore take into account the elapsed time between encoding and judgment.

## B47

### DOES CORTISOL IMPAIR CONTROLLED COGNITIVE PROCESSING DURING ACUTE STRESS? A META-ANALYSIS OF THE EFFECTS OF CORTISOL ADMINISTRATION ON EXECUTIVE FUNCTION AND CONTROLLED ATTENTION.

Grant S. Shields[1], Joseph C. Bonner[1], Wesley G. Moons[1]; [1]University of California, Davis — The hormone cortisol is often believed to play a pivotal role in mediating the effects of stress on human cognition. This meta-analysis is an attempt to determine the effects of cortisol administration on controlled cognitive processes, namely, executive function and selective attention. We hypothesized that cortisol administration would produce significant impairments in executive function and controlled attention. Surprisingly, however, the results contradicted our hypothesis: the effect of cortisol administration on executive function and controlled attention was negligible, $g=0.03$, $t(24.3)=0.77$, $p=.45$, 95% CI [-0.051, 0.112]. Fine-grained analyses revealed that, after separating the rapid, nongenomic effects of cortisol from the slow, genomic effects of cortisol, the rapid effects of cortisol significantly enhanced response inhibition but impaired working memory. However, while these effects paralleled the effects of stress on the same cognitive processes, the effects of cortisol on both response inhibition and working memory were much smaller in magnitude than the effects of stress, suggesting that cortisol is not wholly responsible for the effects of stress on those cognitive processes. Thus, we found little support for the idea that increases in cortisol is the primary pathway through which acute stress impairs executive function and alters selective attention.

## B48

### A COMPARISON OF TRADITIONAL AND TABLET-DELIVERED TRAILS A&B IN THREE SAMPLES

Sean Mullen[1], Tiffany Bullard[1], Jason Cohen[1], Daniel Palac[1], Andrew Hua[1], Aaron Johnson[1], Raksha Mudar[1]; [1]University of Illinois at Urbana-Champaign — There are many advantages to adopting mobile, digital cognitive assessments—for research purposes, clinical practice, and personal use—provided that they are accurate, valid, sensitive to change, and easy-to-use. Paper-based Trails A&B (TrAB) has been used as

a global measure of executive functioning for decades, but it is susceptible to methodological effects and is cumbersome to administer. The purpose of this study was to examine initial evidence for the usability and validity of multiple iPad versions of TrAB. Participants were recruited from Central Illinois from three, independent randomized controlled trials. Sample 1 (n=14) involved young adults, sample 2 (n=12) involved middle-aged adults with mild cognitive impairment (MCI), and sample 3 involved older adults (n=6) without depression or MCI. As part of a large assessment battery, participants received paper and iPad TrAB, in randomly counter-balanced order, as well as biometric (e.g., blood pressure [BP]), neuropsychological, psychosocial, and physical functional assessments. Results indicated significant ($p < .01$) positive correlations between TrA reaction time [RT] ($r = .794$) and TrB RT ($r = .594$) which attenuated slightly after accounting for age. The correlation between cost measures (TrB-TrA RT) was not significant ($p = .51$). Better performance via a new cost algorithm (based on the difference between novel iPad-delivered TrAB moving modes and original stationary modes) was associated with lower BP ($r = -.375$). Discussion will highlight differences between the modes of delivery, advantages and disadvantages of iPad data collection, as well as age-related challenges. Future directions for the utility of iPad-delivery will also be discussed.

### B49

### NETWORK PROPERTIES ASSOCIATED WITH TASK-BASED CHANGES IN FUNCTIONAL CONNECTIVITY

Caterina Gratton[1], Timothy O. Laumann[1], Evan M. Gordon[1], Babatunde Adeyemo[1], Steven E. Petersen[1]; [1]Washington University in St Louis — Recent studies suggest that resting functional connectivity (FC) of large-scale networks is altered when completing a variety of tasks. However, it is less clear which areas exhibit these alterations. We propose two hypotheses regarding how FC may change during a task: (1) FC will change for regions activated by a task or (2) FC will change at hub regions that interact with many networks (measured with participation coefficient, PC). Here, we analyzed fMRI FC from 29 participants during rest and three visual tasks varying substantially in their processing and control demands: a semantic task, a mental rotation task, and a coherence discrimination task. Task-residuals from a mixed block/event-related (FIR) GLM model were used for FC analysis to minimize the influences of frank task-evoked signals. FC was analyzed by taking time-series correlations between 264 predefined gray-matter regions. Although largely similar, FC during tasks and rest varied systematically and consistently across individuals. Visual regions decreased FC within their own network, but increased FC with subsets of control regions. Changes in connectivity, especially between networks, were positively correlated with the activation of regions during tasks and with the PC of regions at rest. These effects were independent, and regions that consistently showed both high PC and activation localized to control networks. These findings suggest that task-activation and network hub characteristics separately predict which regions change their FC in a task and may shed light on how processing and control locations are flexibly coordinated in the service of a variety of complex goals.

### B50

### 'FROM STARTUP-TO-CEO:' GUIDED EXPERIENTIAL LEARNING OF GOAL-ORIENTED ATTENTION REGULATION THROUGH GAME-ASSISTED TRAINING FOLLOWING BRAIN INJURY.

Fred Loya[1,2,3], Deborah Binder[1,2,3], Nicholas Rodriguez[1,2,3], Michelle Madore[4], Bruce Buchanan[3], Audrey Kossman[1,2], Michael Sapiro[1,2], Tatjana Novakovic-Agopian[1,2,3], Anthony J.-W Chen[1,2,3]; [1]VA Northern California Health Care System, [2]San Francisco VA Medical Center, [3]University of California, Berkeley and San Francisco, [4]Palo Alto VA Health Care System — Attentional control processes are amongst the most commonly disrupted cognitive functions following brain injury. Improved training methods and tools that support the systematic and intensive strengthening of these 'gateway' functions would be highly valuable for clinical rehabilitation and neuroscience. We designed and developed a training system that consists of interactive 'game' scenarios that unfold in a narrative arc (starting and building a multi-component service business), integrated into a trainer-led coaching protocol, with goals of (a) promoting experiential learning of attention regulation skills by providing opportunities for skill application across a range of calibrated cognitive contexts requiring goal-directed functional cognition, and (b) enhancing generalization by fostering the application of skills learned in the 'game-world' to personal life goals. We assessed the process and effects of training for six participants with history of TBI (> 6 months post-injury) and chronic mild-to-moderate executive dysfunction who completed 7 individual training sessions in-person or by tele-video and approximately 30 minutes of daily practice over 6-8 weeks. Participants reported increasing success with applying skills and strategies in both 'game' and personal contexts over the course of training, and self-perceived improvements in cognitive abilities after training. Quantitative changes in neuropsychological test performance were observed. These findings suggest that a training system that incorporates game experiences can provide valuable opportunities for the guided experiential learning of attention regulation skills that will be applicable in personal life. This training system may provide a valuable method for studying neural mechanisms of improvements in cognitive functioning.

## LANGUAGE: Lexicon

### B51

### EVIDENCE OF A DISSOCIATION IN ERP REPETITION PRIMING EFFECTS BETWEEN DEAF SIGNERS

Katherine J. Midgley[1], Phillip J. Holcomb[1], Jonathan Grainger[2], Karen Emmorey[1]; [1]San Diego State University, [2]CNRS & Université de Provence — Numerous studies demonstrate an attenuation of the N400 component to a meaningful stimulus that is repeated compared to when it is presented for the first time. For words this effect is interpreted as reflecting the decreased difficulty associated with integrating lexico-semantic representations (smaller N400s reflecting easier integration). We report a study with two groups of participants who viewed a series of ASL signs in a repetition priming paradigm. Sixteen ASL deaf signers performed a go/no-go semantic categorization task (press to occasional signs for people, e.g., policeman) to 200 video clips of ASL signs. Fifty items were repeated on the next trial. Sixteen non-signing hearing participants also viewed the same stimuli, but because they did not know the meaning of the ASL signs their task was to press to occasional signs that contained a dot superimposed at different locations near the face of the signer. The ERP data revealed a significant attenuation of the N400 component (350-600 ms) for repeated compared to unrepeated signs in the deaf group. This N400 effect had the typical central-parietal distribution and a very similar time course to that seen in previous studies using words from spoken languages. The hearing participants revealed a very different pattern -- instead of an attenuation of the N400, they showed a significant increase in negativity in the N400 latency range for repeated compared to unrelated signs. This is first study to show this pattern, which suggests that repeated items are unexpected for non-signers but are more easily recognized for signers.

### B52

### MORPHEME-BASED COMBINATORIAL PROCESSING OF ENGLISH COMPOUNDS: EVIDENCE FROM MAGNETOENCEPHALOGRAPHY AND LEXICAL DECISION

Robert Fiorentino[1], Stephen Politzer-Ahles[2], Ke Liao[3]; [1]University of Kansas, [2]New York University, Abu Dhabi, [3]University of Kansas Medical Center — The extent to which the processing of complex words such as compounds (e.g., teacup) makes recourse to morpheme representations (e.g., tea/cup) remains a matter of debate. One factor argued under some models to preclude morpheme-based processing is limited semantic transparency. The current study (N=20) thus examines the processing of semantically transparent and opaque compounds using magnetoencephalography (MEG) and lexical decision, testing transparent compounds (e.g., shoebox), opaque compounds (e.g., honeymoon), monomorphemic words with a word-initial pseudomorpheme (e.g., stampede), and monomorphemic words with a word-final pseudomorpheme (e.g., crimson), matched on a number of lexical properties. If both transparent and opaque compounds are processed via morphemes, we predict faster response times (RT) for compounds than monomorphemic words; if transparency affects but does not preclude morpheme-based processing, we also predict faster RT for transparent than opaque compounds. Using MEG, we probe for effects that distinguish transparent and opaque compounds from monomorphemic words, and effects distinguishing the transparent and opaque compounds. RTs were faster for both transparent and opaque compounds compared to their monomorphemic counterparts, and for transparent than opaque compounds. False Discovery Rate corrected MEG source

waveform analysis revealed emerging effects distinguishing transparent and opaque compounds from their monomorphemic counterparts; these responses emerged on similar timecourses for transparent and opaque compounds and were evident across left entorhinal, fusiform, and inferior temporal cortex from approximately 280-450ms post-stimulus onset. A right-hemisphere entorhinal effect distinguished transparent and opaque compounds at approximately 375-460ms. These findings are consistent with word recognition models positing across-the-board morpheme-based processing of complex words.

### B53

### LANGUAGE AND SPEECH-MOTOR REPRESENTATIONS IN THE HEALTHY ADULT LEFT HEMISPHERE: A NAVIGATED TMS - VOICE REACTION TIME ANALYSIS

Noriko Tanigawa[1], Theresa Hauck[2], Florian Ringel[2], Bernhard Meyer[2], Sandro M. Krieg[2]; [1]University of Oxford, [2]Technical University of Munich — The present study investigated spatial distributions of language and speech-motor representations in the healthy adults' left hemisphere (LH) by analyzing the variations in object naming voice reaction times (vRTs) caused by navigated TMS. Nine right-handed native German speakers were asked to name 100 familiar objects. For each trial, a 5-Hz 10-pulse train started at the picture presentation onset and vRT was measured from the onset of the first pulse to the onset of the first phoneme of the object name. At each of the 46 stimulation sites pre-defined along the gyri in LH, three trials were given. vRTs were percentile-ranked. The stimulation sites that received the longest 25% vRTs 2 out of 3 times for 4 out of 9 participants were designated disrupted sites. When only 22 sites along the core language pathways (IFG, STG, MTG, SMG, AnG) were included, two disrupted sites emerged in mMTG and opIFG, implicated in semantic retrieval and speech planning respectively. When all 46 sites were included, opIFG dropped and 3 disrupted sites emerged, presumably at the origins of the corticospinal tract for articulatory control (dorsal premotor/PrG) and of the corticobulbar tract for respiratory regulation (ventral premotor/PrG). For 3 of the 9 participants, a set of disrupted sites emerged in SFG and opIFG, presumably associated with the frontal aslant tract for verbal fluency. The vRT analysis showed that delayed responses may reflect systematic disruptions of 5 different sources, with nTMS impact greater on speech-motor control pathways and semantic retrieval area than on speech planning area.

### B54

### LOOK HERE: AN EVENT-RELATED BRAIN POTENTIAL (ERP) INVESTIGATION OF THE OPTIMAL VIEWING POSITION (OVP) IN WORD RECOGNITION

Wen-Hsuan Chan[1], Thomas P. Urbach[1], Marta Kutas[1,2]; [1]University of California, Cognitive Science, San Diego, [2]University of California, Neurosciences, San Diego — Visual word recognition strongly depends on where in a word the eye fixates. Isolated word recognition is fastest and most accurate when the eye fixates the word left of center; this is known as the optimal viewing position, OVP, which is commonly assumed to be a word phenomenon. We investigated the effect of fixation position on word processing by recording event related brain potentials (ERPs) to letter strings (words and nonwords) of varying lengths presented either centered at fixation or at the OVP. The frequency distribution over our word stimuli was matched to the CELEX English corpus. Occipital P100 amplitudes were larger for longer than shorter words and for longer than shorter nonwords, regardless of fixation condition. By contrast, there was a reliable effect of fixation at the right occipital site but for words only: P100 amplitudes were smaller for words positioned at the OVP than positioned at the word's center. This difference was not seen for nonwords! Moreover, this early sensory processing -- P100 amplitude -- difference between the two fixation positions for words was correlated with word length, suggesting a role for early perceptual processing (~ 100 ms) in the OVP. However, the finding that the fixation point differences are observed for words only indicates that the OVP effect cannot be explained by a single visual perceptual mechanism that does not take language into account.

### B55

### FAST LMTG ACTIVATION (AT AROUND 100MS) REFLECTS RAPID LEXICAL-SEMANTIC ACCESS DURING READING

Jian Huang[1,2], Suiping Wang[1], Hsuan-Chih Chen[2]; [1]South China Normal University, [2]Chinese University of Hong Kong — Lexical-semantic access is one of the core components of reading comprehension. Evidence from fMRI studies on patients and normal adults has consistently shown that lexical access is related to the left middle temporal gyrus (LMTG), but it is still unclear when this process occurs. Most ERP studies show that lexical-semantic access occurs in the N400 time window (300-500 ms post-stimulus onset), but behavioral and eye movement studies provide evidence that it can occur within 250 ms. Given this controversy, we traced the time course of the LMTG activation to verify the time point of lexical-semantic access by using the Event-Related Optical Signal (EROS) technique with both high spatial and temporal resolution. In Experiment 1, prime-target pairs were presented for lexical decision on the target noun, which was either semantically related or unrelated to the prime. The unrelated targets increased the activation in the LMTG from 128 mspost-stimulus onset. In Experiment 2, verb-noun phrases were presented for lexical decision on the final noun, which was either semantically congruent or incongruent with the verb. The incongruent targets enhanced the activation in the LMTG from 128 ms post-stimulus onset. In Experiment 3, sentences with high-or low-constraint context were presented for semantic plausibility judgment. The final target nouns following the low-constraint context increased the activation in the LMTG from 98 ms post-stimulus onset. These highly consistent results across experiments using words, phrases, or sentences as stimuli, clearly suggest that lexical-semantic access can occur very rapidly during reading comprehension.

### B57

### NEURAL DYNAMICS OF TOP-DOWN CONTROL IN VISUAL WORD RECOGNITION

Caroline Whiting[1], Elisabeth Fonteneau[1], William Marslen-Wilson[1]; [1]University of Cambridge — Behavioral and neuroimaging evidence suggests that an early stage in visual word recognition is the strictly bottom-up segmentation of the visual input into candidate linguistic substrings (words and morphemes), where this process is blind to the lexical properties of the strings being generated. The goal of this study, using combined electro- and magneto-encephalography (EMEG), was to investigate whether these early segmentation processes could be modulated by top-down semantic constraints. Participants saw morphologically complex and simple English words preceded by a semantically related or unrelated word, with no associated response task. We asked whether these contextual semantic constraints would modulate the initial interpretation of a letter-string as containing a root and suffix (e.g. farm-er), and in particular, affect incorrect bottom-up segmentations (e.g. corner as corn + -er), contrasting these complex (farmer) and pseudo-complex (corner) strings with morphologically simple forms (pebble). Source analyses of the EMEG data, using L2 minimum norm estimates (MNE), showed no priming effects in the earliest stages of visual word recognition (up to 250 ms post-onset), and no effects in posterior occipito-temporal sites. Significant semantic priming was seen from 250-500 ms in left anterior temporal and fusiform regions, showing decreased activity when targets were preceded by a semantically-related word. These late effects, in brain regions associated with access to lexical representations, showed spatially distinct patterns for complex and pseudo-complex targets. The overall spatiotemporal distribution of top-down effects is consistent with a strong morpho-orthographic account of the neurobiological substrate for visual word recognition.

## LANGUAGE: Other

### B58

### MEASURING MUSICAL AND LINGUISTIC PREDICTION IN COMPARABLE WAYS

Allison Fogel[1], Gina Kuperberg[1,2], Jason Rosenberg[3], Dillon Bowen[1], Martin Rohrmeier[4], Aniruddh Patel[1]; [1]Tufts University, [2]MGH/HST Athinoula A. Martinos Center for Biomedical Imaging, [3]Yale-NUS College, [4]Technische Universität Dresden — Music, like language, involves complex hierarchical structures and predictive listening (perceivers actively and implicitly predict upcoming information). Also similar to language, predictions are based on the interaction of different sources of information present in the

sequence. As a first step in studying relations between predictive mechanisms in music and language, we have developed a musical version of the well-known linguistic cloze probability task, in which listeners are asked to complete a sentence fragment with the first word that comes to mind. Listeners were presented with the beginning of tonal melodies and were asked to sing the note they expected to continue the melody. Half of the melodies had an underlying harmonic structure designed to constrain expectations for the next note. Each such 'high constraint' (HC) melody was matched to a 'low constraint' (LC) melody matched in terms of rhythm and melodic contour, but differing in harmonic structure. Data from 44 participants revealed much greater consistency in the notes sung following HC vs. LC melodies, as predicted. Human performance was compared to that of a n-gram model based on statistical learning of melodic structure. The model successfully predicted participants' responses for LC melodies but not HC melodies. This suggests that prediction of pitch information in music is more complex than can be captured with simple statistical learning model, and involves the interplay of at least two different levels of structure: a 'surface' level (sequences of scale degrees and durations) and an 'abstract' level (underlying harmonic structure).

## B59

### VISUAL FEATURE PROCESSING DURING WORD RECOGNITION: A MASKED ERP STUDY

He Pu[1], Katherine J. Midgley[2], Phillip J. Holcomb[1,2], Jonathan Grainger[3]; [1]Tufts University, [2]San Diego State University, [3]CNRS and Aix-Marseille University — According to the Bi-Modal Interactive Activation Model (BIAM) of word processing, brain areas that are responsible for early visual feature processing should be specialized for the rapid mapping of the primitive components of letters onto higher level whole letter representations. Support for this prediction comes from studies that have reported effects of visual similarity between prime and target letters during masked letter priming. While previous studies have manipulated some aspects of similarity between prime and target words (e.g., font), the present study is the first to manipulate the similarity of the constituent letter features within words in order to test whether the early feature mapping found during letter perception also occurs during word recognition. Fifty-six Native English speakers completed a no/no-go semantic categorization task in a masked repetition priming ERP paradigm. We manipulated letter shape similarity across 5-letter prime-target pairs based on results from a previous norming study. Similar pairs shared visual features across lower and upper case (e.g. cusp – CUSP) while dissimilar pairs had low visual feature overlap across lower and upper case (e.g. bald – BALD). We found a significant repetition effect on the N/P150 for visually similar prime-target pairs while visually dissimilar prime-target pairs did not reveal any evidence of an N/P150 effect. These findings support one prediction from the BIAM which specifies an early interactivity in the brain system responsible for fast bottom up feature processing during word recognition.

## B60

### LANGUAGE LATERALIZATION OF BIMODAL BILINGUALS: A FUNCTIONAL TRANSCRANIAL DOPPLER SONOGRAPHY (FTCD) STUDY OF SPEECH AND SIGN PRODUCTION.

Eva Gutierrez-Sigut[1], Richard Daws[1], Heather Payne[1], Chloe Marshall[1], Mairead MacSweeney[1]; [1]University College London — We investigate how bimodal bilingualism influences responses on fluency tasks, in particular how knowing a sign language might affect brain lateralization patterns during word generation. Although fMRI studies show that signed languages are processed in similar neural regions as spoken languages (MacSweeney et al., 2008) behavioural (Marshall et al., 2013) and ERP studies (Gutierrez et al., 2012) suggest that lexical access during sign language processing may be more influenced by the interplay between semantics and phonology, than during spoken language. We use Functional transcranial Doppler sonography (fTCD), a noninvasive way to measure cerebral blood flow, to investigate lateralization during British Sign Language (BSL) and speech production. We examine phonological and semantic production in hearing adult BSL/ English bilinguals (Children Of Deaf Adults: CODAs) in both languages. Results showed that participants were predominantly left lateralized for English (84%) and BSL (97%) production. There were no differences in strength of lateralization between phonological and semantic tasks in any of the languages. However, participants exhibited a stronger pattern of lateralization during the BSL task than during English generation. This result is consistent with our recently collected data which suggest stronger lateralization during sign generation in native deaf signers than during English generation in hearing non signers. This pattern, alongside the current results, implies that differences in lateralization between BSL and English are driven by language modality rather than by deafness itself. We discuss whether this effect is due exclusively to the higher motoric demands of sign production in comparison with speech production.

## B61

### THE PERCEPTUAL RELATIONSHIP BETWEEN CONSONANT VOICING AND VOWEL PITCH

Sara Catlin[1], Marie Huffman[1], Ellen Broselow[1], John Drury[1]; [1]Stony Brook University — Pitch skip is a cross-linguistic phenomenon in which vowel pitch after a voiced obstruent starts low and rises, while vowel pitch after a voiceless obstruent starts high and falls. In English (and other languages) this voicing-pitch association is active both in production (Hombert 1978; Kingston 2004; Hanson 2009) and in perception (Abramson & Lisker 1984; Whalen et al. 1992), and listeners use pitch skip to identify obstruent voicing with ambiguous voice onset time (VOT). However, the nature of the (neural) mechanisms underlying this vowel-pitch/consonant-voicing connection is unknown. For example, it is unclear whether this plays a functional role in early/pre-attentive auditory processing, or only later (i.e., in a possibly higher-level post-perceptual/attention-regulated way). We used event-related potentials (ERPs) in an attended oddball paradigm manipulating obstruent-voicing (pa/ba) and vowel-pitch (High/Low) yielding four types of rarely occurring deviants (pa-H/pa-L/ba-H/ba-L) which were tested in four separate blocks. Standard stimuli contrasted in voicing with all deviants, but realized an intermediate/mid-range (M) vowel pitch between the H/L values of the deviants (i.e., paM/baM). ERP results showed: (i) a mismatch-negativity (MMN) for both types of consonants, but larger for voiced deviants, (ii) N2b effects for both types of consonants, but larger for voiceless, and (iii) a P300 voicing/pitch interaction due to the fact that the voiced/low-pitch deviant demonstrated a smaller amplitude than the other three conditions. That a voicing/pitch interaction emerged only in the later (P300) but not the earlier (MMN/N2b) measures is consistent with a post-perceptual/attention-regulated locus for the relationship between these features in auditory processing.

## B62

### WHY DOESN'T NEGATIVE LANGUAGE BEHAVE? INFERENCES FROM EMOTIONAL LANGUAGE

Adriana Ariza[1], Connie Shears[1], Maisy Lam[1], Amy Cohen[1], Melissa Bond[1], Mackenzie Smith[1], Erika Sam[1], Jay Kim[1]; [1]Chapman University — Emotional language appears to support the inference process in a hierarchical nature (Shears, et al., 2011). However, Nasrallah, Carmel and Lavie (2009) suggest that the negative valence should be primary in supporting inferences because it is survival based. Further, Gygax, Garnham and Oakhill (2004) claim the importance of context is critical when readers are processing emotional language. Here, we extend previous findings using two sentence pairs, by examining longer, more natural story contexts. Similarly, we hypothesized that if emotional language supports the formation of causal inferences, then positive stories should cause more false alarms to inference-related target words than negative stories. Participants made key press responses to words either in the story (control) or words related to the inferred information (experiment). Both accuracy and reaction time data were used to measure the formation of inferences across valences. Results suggest readers formed inferences equally from positive and neutral stories, but did not form inferences from negative emotional stories. These findings imply a unique quality of negative emotional language that resists typical comprehension processes of knowledge-based inferences.

## B63

### THE NEURAL NETWORK OF READING: SIMILARITIES AND DIFFERENCES BETWEEN READING NETWORKS IDENTIFIED VIA TASK-BASED FMRI AND RESTING-STATE FMRI

Gali Ellenblum[1], Jeremy J. Purcell[1], Brenda Rapp[1]; [1]Johns Hopkins University — Resting-State functional Magnetic Resonance Imaging (RS-fMRI) allows acquisition of fMRI data without task performance during scanning. RS-fMRI provides certain advantages relative to task-based fMRI, including easier and faster data acquisition, reduction of task-irrelevant differences between groups

(e.g., differences related to effort, error, etc.), and use with individuals who cannot perform certain tasks (e.g., because of paralysis). However, the correspondence between RS and task-based fMRI networks has not been well-established in many cognitive domains. In reading, the limited available research lacks statistical rigor, and has suffered methodological shortcomings. We examined 11 healthy adults during rest (RS-fMRI) and during reading (task-based fMRI). Participants looked at a fixation cross during rest, and looked at alternating blocks of words and checkerboards during reading. The task-based reading network was identified via a contrast of word and checkerboard conditions. The RS reading network was identified using an area of the left fusiform gyrus (the Visual Word Form Area) as a seed region, with time-series correlations computed between this region and all other voxels. Comparisons of RS and task-based networks were carried out using conjunction and other analyses. Results show: (1) the RS reading network is highly consistent both across participants and within participants (across scan sessions); (2) there are greater similarities between the task-based reading network and the RS reading network than between the task-based reading network and non-reading RS networks (e.g., the Default Mode Network). These findings indicate that the RS reading network may provide a good and robust estimate of the task-based reading network.

### B64

### THE FUNCTIONAL NEUROANATOMY OF REGULAR AND IRREGULAR MORPHOLOGY: A NEUROANATOMICAL META-ANALYSIS

Rachael E. Campbell[1], Goldie Ann McQuaid[1], Kaitlyn M. Tagarelli[1], Peter E. Turkeltaub[1], Michael T. Ullman[1]; [1]Georgetown University — Regular and irregular morphology has been the focus of intense study as a model of the neurocognitive bases of language. Numerous studies have examined the regular/irregular distinction with functional neuroimaging. However, a clear picture has yet to emerge, due to apparent inconsistencies in findings. We therefore conducted a comprehensive quantitative meta-analysis of the functional neuroanatomy of regular and irregular morphology. We used Activation Likelihood Estimation (ALE), a probabilistic method for quantifying spatial reproducibility in neuroimaging studies. Seven studies examining both regular and irregular morphology qualified for ALE analysis. Analyses revealed that only left BA 44 showed reliable activation ($p < .001$), and only for regulars. The seven contributing studies actually reported more activation foci for irregulars, but these were more broadly distributed. Eight additional studies examining only regular morphology were then identified. This "replication" dataset also yielded reliable activation only in left BA 44, and only for regulars. Across the two datasets, the contributing studies showed diversity in language/language family (e.g., English, Spanish, Japanese, Korean, Finnish), inflection and derivation (e.g., tense and agreement, nominal and verbal derivation), and task (e.g., expressive and receptive), underscoring the generalizability of the results. The findings indicate that regulars, like syntax, are reliably tied to left BA 44, while irregulars fail to show this pattern. The study provides a fine-grained analysis of the functional neuroanatomy of regular/irregular morphology that dissociates regulars and irregulars, and links only regulars to the rule-based processing of syntax, consistent with "dual system" models of language.

## LANGUAGE: Semantic

### B65

### NETWORK ANALYSIS OF ABSTRACT AND CONCRETE WORD PROCESSING IN HEALTHY AGING AND APHASIA

Chaleece Sandberg[1]; [1]The Pennsylvania State University — Normal subjects and persons with aphasia exhibit a 'concreteness effect' during a variety of lexical tasks. Recent evidence from neuroimaging studies suggests possible dissociable neural correlates for processing abstract versus concrete words. However, this work has focused largely on healthy younger adults. Only one study has examined neural correlates of the concreteness effect in both neurologically healthy older adults (NHOA) and persons with aphasia (PWA), but this study had a limited number of subjects in each group (N=3) and did not explore functional connectivity within the abstract and concrete word processing networks (Sandberg & Kiran, 2013). The current study used graph theoretical analysis to explore abstract and concrete word processing in NHOA and PWA to shed more light on the concreteness effect. Thirteen (6 M) NHOA aged 50-67 and ten (7 M) PWA, in the chronic stage of post-stroke recovery, each completed a word judgment task during fMRI. Both NHOA and PWA showed differences in both node degree and betweenness centrality between abstract and concrete network regions (e.g., higher betweenness centrality in left inferior frontal cortex for abstract than concrete). Additionally, differences between NHOA and PWA were also noted for both abstract and concrete networks (e.g., higher node degree in left angular gyrus for PWA than NHOA). These results indicate that graph theoretical analysis of functional connectivity for concrete versus abstract networks in NHOA versus PWA may help identify neural correlates of the concreteness effect in both aging and language disordered populations, to help inform theories of the concreteness effect.

### B66

### TAXONOMIC AND THEMATIC ASSOCIATIONS IN THE BRAIN: AN MEG STUDY

Gwyneth A. Lewis[1], David Poeppel[1], Gregory L. Murphy[1]; [1]New York University — Converging evidence from behavioral and neuroimaging studies of human concepts indicate distinct neural systems for taxonomic and thematic knowledge. A recent study of naming in aphasia found involvement of the anterior temporal lobe (ATL) during taxonomic (feature-based) processing, and involvement of the temporoparietal junction (TPJ) during thematic (function-based) processing. We conducted an online magnetoencephalography (MEG) study to examine the spatio-temporal nature of taxonomic and thematic relations. We measured participants' brain responses to words preceded by either a taxonomically or thematically related item (e.g., cottage-castle, king-castle). In a separate experiment we collected "relatedness" ratings of the word pairs from participants. We examined effects of relatedness and relation type on activation in ATL and TPJ regions of interest (ROIs) using permutation t-tests to identify differences in ROI activation between conditions as well as single-trial correlational analyses to examine the millisecond-by-millisecond influence of the stimulus variables on the ROIs. Taxonomic relations strongly predicted ATL activation, and both kinds of relations influenced the TPJ. These effects occurred over a time window similar to that of lexical access. Our results further strengthen the view of the ATL's importance to taxonomic knowledge. Moreover, they provide a nuanced view of thematic relations as involving taxonomic knowledge.

### B68

### PATTERNS OF NEURAL ACTIVITY IN THE RESIDUAL TISSUES PREDICT PICTURE-NAMING PERFORMANCE- A CASE FMRI STUDY ON APHASIA USING MULTIVOXEL PATTERN ANALYSIS (MVPA)

Yune-Sang Lee[1,2], Jihad Zreik[1,2], Roy Hamilton[1,2]; [1]Department of Neurology, University of Pennsylvania, [2]Center for Cognitive Neuroscience, University of Pennsylvania — Despite some degree of spontaneous language recovery occurs over time in patients with aphasia after stroke, object naming often remains a challenging task for these individuals. This could be due to the possibility that the reorganized compensatory language network may include components that are inefficient to language processing. We hypothesized that unreliable neural processing could be instantiated by patterns, rather than the amplitude of neural activity within the compensatory language system. We recruited a chronic aphasic patient (KL; 66 year-old male) who showed a semantic deficit (e.g., "milk" for "cow"), and whose naming performance fell within the moderate range of impairment on the Western Aphasia Battery. Over the course of five behavioral sessions involving a naming task in a mock scanner, we identified seven visual objects that yielded an approximately 50% naming success rate. We then conducted two fMRI sessions where the patient performed a naming task for those 7 object categories. Multivoxel pattern-analysis (MVPA) revealed that right fusiform gyrus yielded differential activity patterns associated with correct or incorrect trials. Notably, this region has been implicated in the intermediate stages of object recognition processing, as reflected by the propensity for patients with lesions to this area to make semantic errors. By contrast, conventional fMRI analysis failed to identify this region. To our knowledge, this is the first fMRI study to predict naming performance based upon neural activity patterns within intact cortical tissue, and also the first to demonstrate useful application of MVPA in studies of language disorders.

### B69

### GETTING AHEAD OF YOURSELF: PARAFOVEAL WORD EXPECTANCY MODULATES THE N400 DURING SENTENCE READING

Mallory C. Stites[1], Brennan R. Payne[2], Kara D. Federmeier[2]; [1]State University of New York at Binghamton, [2]University of Illinois at Urbana-Champaign — One of the biggest debates in the reading literature is whether readers can extract semantic information from the parafovea (i.e., the next word in the sentence). Eye-tracking findings are mixed, but emerging evidence using event-related brain potentials (ERPs) suggests that semantic anomalies can be detected parafoveally (Barber, van der Meij, & Kutas, 2013). We use ERPs to ask whether the expectancy of a parafoveal word can affect the processing of the currently fixated word. In a flanker-word RSVP paradigm, sentences were presented word-by-word, flanked 2° bilaterally by the previous and upcoming words. Stimuli were high constraint sentences that were identical up to the target word, which could be expected (cloze>.9), unexpected but plausible (cloze=0), or anomalous (cloze=0). We predicted that if readers accessed the semantics of the target in the parafovea, an N400 congruency effect would be observed to the identical, always congruent pre-target word. Results supported our predictions: anomalous parafoveal words elicited more negative N400s than expected words did. Additionally, unexpected parafoveal targets elicited significantly larger N400s than expected targets, but were facilitated relative to anomalous words. Our findings show that semantic processing as indexed by the N400 component can take place for parafoveal words, supporting previous ERP work (Barber et al., 2013) and challenging eye-tracking findings that readers only process the orthography of parafoveal words (Rayner, Schotter, & Drieghe, 2014). However, other aspects of processing, including positivities related to the revision of predictions and explicit appreciation of semantic anomalies, are delayed until the word is fixated.

### B70

### BETA OSCILLATIONS REFLECT MEMORY AND MOTOR ASPECTS OF SPOKEN WORD PRODUCTION

Vitoria Piai[1], Ardi Roelofs[2], Joost Rommers[3], Eric Maris[2]; [1]UC Berkeley, [2]Radboud University Nijmegen, [3]University of Illinois at Urbana-Champaign — Two major components form the basis of spoken word production: the access of conceptual, lexical, and phonological information in long-term memory, and motor preparation and execution of an articulatory programme. Whereas the motor aspects of word production have been well characterised as reflected in beta (15-25 Hz) desynchronisation, the memory aspects have remained poorly understood. Using magnetoencephalography, we investigated the neurophysiological signature of not only motor but also memory aspects of spoken-word production. To probe the involvement of the memory component, we manipulated sentence context. Participants named or judged pictures after reading sentences. Sentence contexts were either constraining or nonconstraining towards the final word, presented as a picture. In the judgment task, participants indicated with a left-hand button press whether the picture was expected given the sentence. In the naming task, they named the picture. Naming and judgement were faster with constraining than nonconstraining contexts. Beta desynchronisation was found for constraining relative to nonconstraining contexts pre-picture presentation. For the judgment task, beta desynchronisation was observed in left posterior brain areas associated with conceptual processing and in right motor cortex. For the naming task, beta desynchronisation was found in the same left posterior brain areas, but also in left anterior and posterior temporal cortex (associated with memory aspects), left inferior frontal cortex, and bilateral ventral premotor cortex (associated with motor aspects). Our results suggest that both memory and motor components of spoken word production are reflected in overlapping brain oscillations in the beta band.

### B71

### FIGURATIVE LANGUAGE IMPAIRMENT IN PRIMARY PROGRESSIVE APHASIA

Marguerite McQuire[1], Eileen E.R. Cardillo[1], Michael F. Bonner[1], Murray Grossman[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — Previous research indicates patients with focal lesions in the left hemisphere can have metaphoric comprehension impairments in the absence of literal language difficulty. This pattern suggests figurative language abilities may be especially vulnerable to brain injury. We test this possibility by considering metaphoric and literal language comprehension in patients with a progressive loss of language function. Specifically, we compared the performance of 5 patients with the logopenic variant of primary progressive aphasia (lvPPA) to 20 healthy, age- and education-matched controls on a metaphor multiple choice task. Stimuli consisted of unfamiliar metaphors and closely matched literal sentences with the same base term (The stepmother was a wrecking ball / The hanging metal was a wrecking ball). Sentences were presented visually, followed by four adjective-noun answer choices (target + three foil types). Participants were instructed to select the phrase that best matched the meaning of the sentence. Results with healthy adults indicated good comprehension in both conditions, with a slight advantage for literal than metaphoric sentences. Single case statistics comparing individual patients to the control group indicated comparable literal comprehension in all five patients but significantly impaired metaphor comprehension in three of five patients. lvPPA patients with and without metaphor impairments were not distinguishable on the basis of general measures of cognitive function, nor several standard measures of literal language ability. Patients with metaphor comprehension impairment tended to select foils that were semantically related to the literal sense of the base term, suggesting an inability to derive the novel figurative sense.

## LONG-TERM MEMORY: Development & aging

### B72

### BOOSTING AND LINKING: COOPERATIVE CONTRIBUTIONS OF STRUCTURAL AND FUNCTIONAL CONNECTIVITY TO SUCCESSFUL MEMORY IN AGING

Simon Davis[1], Thomas Fink[2], Roberto Cabeza[1]; [1]Duke University, [2]Ludwig Maximilian University of Munich — Aging is associated with a dynamic reorganization of communication between cortical regions, both in the regions local to a given cognitive function in younger controls, as well as more distant regions. While a number of studies have described how brain regions work overtime in order to compensate for the deleterious effects of age, a growing number of studies find that increases in functional connectivity—independent of activity—predict sustained performance in older populations. We used a task-based, full-brain fCON analysis in order to assess the relative contribution of functional activity, functional connectivity, and structural connectivity to successful memory performance. Older and younger performed a source memory task based on word pairs. Functional and structural MR data during retrieval were used to evaluate a structural equation model (SEM) built to characterize the relative contributions of a) regional activation, b) pairwise dynamic functional connectivity, and c) white-matter connectivity, in supporting successful memory in older adults. We found that the pattern of connections stronger for successfully remembered trials varied dramatically between older and younger adults, with younger adults relying on a network of posterior parieto-occipital regions, while older adults relied on more long-range connectivity between frontal and occipital cortices. SEM results demonstrate that both functional and structural connectivity—but not functional activity—made independent contributions to memory success. These results suggest that successful aging increases the reliance on long-range connectivity and demonstrate a greater sensitivity to age-related changes in brain dynamics that is not measurable in typical activity-based designs.

### B73

### CARDIORESPIRATORY FITNESS IS ASSOCIATED WITH COGNITIVE PERFORMANCE IN OLDER BUT NOT YOUNGER ADULTS

Scott M. Hayes[1,2], Daniel E. Forman[3,4], Mieke Verfaellie[1,2]; [1]VA Boston Healthcare System, [2]Boston University School of Medicine, [3]VA Pittsburgh Healthcare System, [4]University of Pittsburgh Medical Center — Aging is associated with declines in executive function and episodic memory. Cardiorespiratory fitness (CRF) has been associated with enhanced executive function in older adults, but the relationship with episodic memory remains unclear. The purpose of the study was to examine the relationship between CRF and cognition in young and older adults and whether CRF mitigates age-related cognitive decline. Participants completed exercise testing to evaluate CRF (peak VO2) and neuropsychological testing to assess cognition. In older adults, peak VO2 was positively related to executive function, as well as to accuracy on an experimental face-name memory task and visual episodic

memory. In young adults, a relationship between peak VO2 and cognition was not evident. High fit older adults performed as well as young adults on executive function measures. On episodic memory measures, young adults performed better than high fit older adults, who in turn performed better than low fit older adults. CRF is positively associated with executive function and episodic memory in older adults and attenuates age-related cognitive decline. We provide preliminary support for the age-dependence hypothesis, which posits that cognition and CRF relationships may be most readily observed during lifetime periods of significant neurocognitive development.

## B74

### GAMMA OSCILLATORY DYSFUNCTION IN PREFRONTAL AND TEMPORAL CORTICES IN ALZHEIMER'S DISEASE

Jessica Gilbert[1], Sarah Adams[1], Alexandra Stiles[1], Rosalyn Moran[1]; [1]Virginia Tech Carilion Research Institute — Coordinated oscillations in membrane potentials provide a neurobiological basis for brain network efficiency. Non-uniform neural circuitry disruption is a hallmark of Alzheimer's diseases (AD) dysfunction, disproportionately impacting prefrontal and temporal circuits. Our aim was to determine specific neural network dysfunction in AD prefrontal and temporal circuitry during implicit and explicit memory performance. Eight patients (6 females) diagnosed with mild to moderate AD and 12 age-matched, sex-matched controls were scanned using EEG. Subjects performed an implicit picture-naming task and explicit recognition task following an encoding session. At test, novel (N=50) and repeated images (N=50) were presented. Naming facilitation (i.e., priming; Naming-Repeated) was not significantly different ($p=0.32$) between patients (mean=0.06 s, SD=0.2) and controls (mean=0.09 s, SD=0.04), suggesting relative sparing of implicit memory. Whole-brain source-localized gamma (31-56 Hz) responses contrasting Novel > Repeated trials found intact lateral ventral temporal cortex activation for both patients and controls. In contrast, in an explicit memory task of novel (N=50) and repeated pictures (N=50), prominent differences in behavioral performance between groups were observed (Control mean=74.8% correct, SD=5.6; AD mean=42.4% correct, SD=11.6; $p<0.01$). Whole-brain source-localized gamma responses contrasting Control > AD revealed regions in left anterior ventral temporal cortex and right orbitofrontal cortex showing enhanced gamma, while the contrast AD > Control revealed enhanced gamma responses for patients in right prefrontal cortex. Taken together, these findings suggest a longitudinal temporal gradient in gamma dysfunction that correlates with behavioral sparing and impairment in AD.

## B75

### DEVELOPMENT OF HIPPOCAMPAL RESTING-STATE NETWORKS DURING CHILDHOOD

Tracy Riggins[1], Sarah Blankenship[1], Elizabeth Redcay[1], Lea Dougherty; [1]University of Maryland, College Park — Although several studies have examined developmental changes in hippocampal structure during childhood, developmental changes in hippocampal function during this period remain relatively underexplored. Functional development is an important question given the dramatic improvements observed in behaviors thought to be subserved by this structure during this period (e.g., memory). In the present investigation, we explored age-related differences in hippocampal function by exploring age-related differences in the functional hippocampal network identified via rest. Participants included 111 4- to 10-year-old children (M=81.5 months, SD=18.6, range = 48-130 months) who successfully completed a 6 minute resting-state scan. Whole brain connectivity analyses with a bilateral hippocampal seed were used to identify age-independent and age-dependent regions of the hippocampal network. Age-independent analyses revealed a hippocampal network consistent with the mature hippocampal network identified in adults (Vincent et al., 2006), including cingulate gyrus extending into retrosplenial cortex, inferior parietal cortex including bilateral angular gyri and precuneus, medial prefrontal cortex, lateral temporal cortex, thalamus, and cerebellum, $ps<.0001$, corrected. The age-dependent analyses revealed increased connectivity with age in cingulate cortex extending into parietal cortices and bilateral cerebellum, $ps<.05$, corrected. These results suggest that the major components of the adult hippocampal network are relatively intact by age 4; however, some regions do undergo protracted development throughout childhood. Identification of the specific trajectory of the hippocampal functional network is an important question in its own right, however, these findings may also aid investigators examining both the typical and atypical development of hippocampally-mediated behaviors (e.g., episodic memory, stress responses).

## B76

### INDIVIDUAL DIFFERENCES IN THE NEURAL BASIS OF METACOGNITIVE MONITORING PREDICT CHANGE IN MEMORY ACCURACY OVER TIME

Yana Fandakova[1,2], Carter Wendelken[2], Joshua Lee[1], Silvia Bunge[2], Simona Ghetti[1]; [1]University of California, Davis, [2]University of California, Berkeley — Flexible monitoring and control of one's own memory enables effective learning and goal-directed behavior. The ability to introspect on uncertainty and strategically withhold responses continues to develop during middle childhood. The present study examined individual differences in the neural underpinnings of metacognitive monitoring and control during episodic retrieval and their contribution to memory development. Younger children (N=44, 8-10 years), older children (N=45, 10-12 years) and adults (N=30) encoded object-scene pairs followed by a source memory task while undergoing fMRI scanning. During retrieval, participants could select an 'I don't know' (DK) answer if they were uncertain about which scene had been originally studied with the target object. Compared to correct source decisions, DK responses were associated with increased activation in anterior insula, dorsal ACC, anterior PFC, and inferior parietal lobe. There were no age differences in the insula that demonstrated increased engagement for both incorrect source and DK decisions, in line with a role in uncertainty monitoring. Stronger insular engagement for these trials was associated with higher source accuracy across participants ($r=.25$, $p=.006$) and predicted memory improvement in children 9 to 24 months later ($r=.31$, $p=.02$). Anterior PFC and parietal regions were engaged specifically when participants chose to withhold a source response by using the DK option, indicating a role in metacognitive control of memory retrieval. The specificity of the APFC activation profile was reduced in younger children who showed lower source accuracy and higher DK response rates. These results underscore the role of metacognitive monitoring and control for memory development.

## B77

### THE RELATIONSHIP BETWEEN THE NEURAL CORRELATES OF TASK-UNRELATED THOUGHTS AND UNSUCCESSFUL EPISODIC MEMORY ENCODING IN YOUNG AND OLDER ADULTS

David Maillet[1], Natasha Rajah[2]; [1]Department of Psychology, Harvard University, [2]Department of Psychiatry, McGill University — In the current study, we investigated neural mechanisms during episodic encoding that can lead to two types of memory errors during a later episodic retrieval task: forgetting, and source misattributions (false memories). Twenty-one young and 20 older adults underwent functional magnetic resonance imaging (fMRI) while encoding words by making a pleasant/unpleasant or a man-made/natural judgement. Frequency and neural correlates of task-unrelated thoughts (TUT) were measured with thought probes during encoding. A source retrieval task followed (not scanned), in which subjects indicated in which of the two encoding tasks they had studied each word. There were no age-related differences in frequency of TUT at encoding or in frequency of forgotten words at retrieval. Across groups, frequency of TUT at encoding positively predicted the amount of forgetting at retrieval. Furthermore, subsequently forgotten words and encoded words preceding TUT reports were associated with similar activations, including posterior cingulate and dorsolateral prefrontal cortex. In contrast with forgotten items, there was an age-related increase in source misattributions. In older adults, words studied in the man-made/natural task were mistakenly claimed to have been studied in the pleasantness task. This source misattribution in older adults was associated with increased activation in regions typically involved in encoding using a pleasantness judgement, i.e. medial prefrontal cortex. We conclude that forgetting and source misattributions are associated with distinct phenomena at encoding; the former with exhibiting TUT, and the latter with reduced differentiation between the neural representation of different sources. Moreover, older adults may be especially prone to source attribution errors.

## B78

### AGE EFFECTS ON HIPPOCAMPAL FUNCTIONAL CONNECTIVITY DURING MULTIFEATURAL ENCODING

Chris Foster[1], Milton Picklesimer[1], Neil Mulligan[1], Kelly Giovanello[1]; [1]The University of North Carolina at Chapel Hill — During successful episodic memory encoding in young adults (YAs), functional connectivity of the hippocampus decouples from other regions of the Default Mode Network (DMN) to allow for efficient memory formation (Huijbers et al., 2011). The current study tested the hypothesis that older adults (OAs) would show a comparable decoupling of the hippocampus from the DMN during multifeatural source encoding. Functional magnetic resonance imaging was conducted while YAs and OAs intentionally encoded words along with their color and location. Through our experimental design, memory accuracy was deliberately equated between YAs and OAs. Univariate analyses revealed that successful multifeatural encoding, as compared to single item encoding, activated several regions in both age groups, including the left hippocampus. Additionally, while YAs deactivated parietal cortex during multifeatural encoding, OAs deactivated frontal regions. Functional connectivity analyses using left hippocampus as a seed region revealed a set of primarily frontal regions (e.g., superior and middle frontal gyrus and anterior cingulate) that were functionally correlated with the left hippocampus in YAs. In contrast, hippocampal activity among OAs correlated with bilateral superior, inferior, and middle temporal gyrus, as well as left angular and left supramarginal gyrus. Reductions in DMN activity and hippocampal connectivity are consistent with prior studies and have been suggested to support efficient encoding in YAs. Older adults, however, are less able to decouple the DMN even during successful episodic encoding. Given that functional connectivity differences manifested under equivalent behavioral performance, alterations to functional networks appear to precede age-related behavioral changes in source memory encoding.

## B79

### SLEEP BEFORE LEARNING IMPROVES EMOTIONAL MEMORY IN YOUNG CHILDREN

Rebecca Spencer[1], Laura Kurdziel[1], Maria Pietri; [1]Department of Psychological & Brain Sciences, University of Massachusetts, Amherst — Colloquially, parents and teachers find nap-deprived children to be emotionally disregulated. We posit that emotional memory encoding after a nap differs from encoding following wake as recent memories are consolidated over the nap (Kurdziel, Duclos & Spencer, 2013) providing a 'clean slate' for encoding new memories. To test this, 22 children (M=51.89, SD=7.64 months) encoded neutral expression faces paired with either mean or nice descriptions (based on Kinzler & Shutts, 2007). Immediate recall was probed by presenting a subset of images, paired with a distractor, and participants responded as to which was familiar. Encoding and immediate recall took place 30 minutes after a mid-day nap in a preschool classroom. One week prior or after (conditions separated by 1 week), the procedures were repeated but encoding took place following an equivalent interval awake. In both conditions, delayed recall was probed the following morning. There was no immediate benefit of the nap on emotional memory: immediate recall accuracy did not differ in the post-nap and post-wake conditions ($t(21)=1.368$, $p=0.186$). Likewise, there was no difference in performance across conditions when memory was probed the following morning ($t(21)=1.252$, $p=0.225$). However, when performance on mean and nice items was segregated, a delayed benefit of the nap for nice items ($t(21)=2.632$, $p=0.016$), but not mean items ($t(21) = -0.554$, $p=0.585$), was evident. In sum, we find that naps protect recent memories and facilitate new learning. Such evidence is important for establishing guidelines around nap opportunities in preschool classrooms.

## B80

### FORNIX MICROSTRUCTURE CORRELATES WITH EPISODIC MEMORY IN OLDER ADULTS

Jonathan T Siegel[1,2], Marianne de Chastelaine[1,2], Julia T Mattson[3], Tracy H Wang[1,2], Brian E Donnelly[1,2], Kristen M Kennedy[1,2], Michael D Rugg[1,2]; [1]The University of Texas at Dallas, [2]The Center for Vital Longevity and School of Behavioral and Brain Sciences, University of Texas at Dallas, [3]UT Southwestern Medical Center — The role of the fornix and its relationship to memory function is not completely understood. Although the fornix is recognized as an important white matter tract that couples the medial temporal lobe (MTL) with subcortical and cortical regions, its involvement regarding specific types of memory and learning is more complex. This tract may facilitate communication between these brain regions, and previous research has reported an association with fornix integrity and recollection-related recognition memory; however, no relationship concerning changes in fornix microstructure and familiarity-driven recognition have been described. Furthermore, only a few studies have attempted to investigate how microstructural integrity of the fornix may be related to age-related differences in episodic memory. The current study used diffusion tensor imaging (DTI) to examine whether differences in white matter integrity of the fornix, assessed via fractional anisotropy (FA), were correlated with differences in episodic memory performance. Associative recognition and familiarity, along with performance on standardized memory tests, were evaluated in 142 healthy participants aged 18 to 76 years of age. In older adults only, greater microstructural integrity in the fornix correlated with performance on both the California Verbal Learning Test and the Logical Memory subtests of the Wechsler Memory Scale. No significant relationship between integrity of the fornix and either associative or familiarity memory was found for any age group. Our results raise questions regarding the specificity of the relationship between integrity of the fornix and memory performance, and how this varies across the lifespan.

## B81

### SUBJECTIVE MEMORY COMPLAINTS IN OLDER ADULTS ARE ASSOCIATED WITH RELATIONAL MEMORY ERRORS IN SPATIAL RECONSTRUCTION

Heather D. Lucas[1], Patrick D. Watson[1], Jim M. Monti[1], Edward McAuley[1], Arthur F. Kramer[1], Neal J. Cohen[1]; [1]University of Illnois at Urbana-Champaign — Subjective memory complaints (SMCs) often motivate older adults to seek medical evaluation for age-related memory disorders. Moreover, SMCs among healthy elderly individuals are associated with increased rates of subsequent conversion to Alzheimer's disease, indicating that memory complaints can have both prognostic and diagnostic value. However, SMCs are extremely common in old age and likely stem from multiple causes, suggesting a need for sensitive and efficient methods to vet or corroborate reports of memory difficulties. Here we examined whether certain types of memory errors are more likely than others to relate to SMCs. Older adult participants completed a spatial reconstruction task in which they viewed and then attempted to recreate a series of complex, multi-item displays. This task allows for the quantification of multiple aspects of performance, including errors that are highly relational in nature (e.g. the pairwise "swapping" of relative item locations), as well as more traditional error metrics such as item misplacement. We found higher rates of "swap" errors, but not misplacement errors, in higher- relative to lower- SMC participants. This relationship remained after controlling for age and anxiety levels, which were also associated with SMCs. This pattern suggests a selective impairment in relational memory among older adults with memory complaints. Such selectivity is consistent with the presence of early pathology within the hippocampus—a brain region linked to relational processing—and underscores the potential utility of relational memory tests to detect preclinical stages of Alzheimer's disease.

## B82

### DEVELOPMENTAL CHANGE IN RELATIONAL BINDING AND HIPPOCAMPAL STRUCTURE

Joshua K Lee[1], Carter Wendelken[2], Lauren Hunter[1], Peter Desautels[1], Silvia A Bunge[2], Simona Ghetti[1]; [1]University of California, Davis, [2]University of California, Berkeley — Episodic memory, the capacity to remember the past in detail, is supported by operations that bind arbitrary spatial, temporal, and associative features to form an integrated event-representation; operations the hippocampus is posited to support. Little is known about the development of binding and whether the hippocampus contributes to that development. In a longitudinal sample of children aged 7-12 (time-1: n=151; time-2: n=61, 120-projected; $\Delta$time=1-2 years), and young adults (time-1: n=28;time-2: n=6,22 projected; $\Delta$time=1-2 years), we examined the development of item-space, item-time, and item-item binding using a single experimental paradigm, and examined how development of binding related to volumes of hippocampal head, body, and tail and cytoarchitectural subfields, as assessed from segmentation of 0.35x0.35x0.70mm MPRAGE and 0.22x0.22x0.95mm T2-weighted scans, respectively. In each binding task, three items appeared to three positions in order. Depending on task, participants learned the positions, orders, or

associations between items. After three encoding trials, memory for the relations was tested. Cross-sectional analysis revealed a significant task X age interaction such that item-space binding reached adult performance by middle-childhood, item-time binding by late-childhood, and item-item binding after childhood. In longitudinal analysis, the volumes of hippocampal body inversely predicted developmental change in overall capacity to bind relations; analysis of subfields suggested that this relation was predicated upon CA3/DG, but not CA1. Together, these results support the hypothesis that binding operations develop in childhood and that longitudinal improvements are associated with hippocampal structure. Further analyses will examine whether longitudinal changes in hippocampal structure differentially relate to developmental improvements in binding.

## B83

### COMBINED PHYSICAL EXERCISE AND COGNITIVE TRAINING ENHANCES HIPPOCAMPAL-DEPENDENT MEMORY

Ilana B Clark[1], Jennifer J Heisz[1]; [1]McMaster University — There is an established link between exercise, neurogenesis, and cognition. Most of this research has focused on non-human animal models, with little known about the effects of exercise on cognition in younger adults. Both physical exercise and cognitive training independently induce hippocampal neurogenesis in animals, suggesting that these different forms of training may work through synergistic neurological pathways to benefit memory in younger adults. The present study examined the effects of physical exercise and cognitive training on hippocampal-mediated memory processes in younger adults, to determine whether combined training yields synergistic benefits. Fifty-nine sedentary young adults (29 females; age range 18-30 years) were randomly assigned to one of four groups: 1) exercise training group, 2) cognitive training group, 3) combined exercise and cognitive training group, or 4) control group. Memory performance was assessed before and after the intervention on the Pattern Separation task, which targets the dentate gyrus and is associated with hippocampal neurogenesis. Preliminary results reveal that exercise training was associated with improved memory performance ($p<0.06$). Critically, combining exercise and cognitive training led to the greatest change in memory performance ($p<0.01$), suggesting exercise and cognitive training may work through synergistic pathways to support hippocampal function. The results demonstrate that different lifestyle activities can interact to improve memory.

## B84

### SEMANTIC OBJECT MEMORY RETRIEVAL IN AMNESTIC MILD COGNITIVE IMPAIRMENT: AN EVENT-RELATED POTENTIAL STUDY

Athula Pudhiyidath[1], Hsueh-Sheng Chiang[1], Raksha A. Mudar[2], Jeffrey S. Spence[1], Kyle B. Womack[1], C. Munro Cullum[3], Jeremy Tanner[4], Michael A. Kraut[4], John Hart, Jr.[1]; [1]Center for BrainHealth at the University of Texas at Dallas, [2]University of Illinois at Urbana–Champaign, [3]University of Texas Southwestern Medical Center, [4]The Johns Hopkins University School of Medicine — Amnestic mild cognitive impairment (aMCI) is a transitional clinical state between normal aging and Alzheimer's disease. Individuals with aMCI have been shown to have semantic memory deficits, but the evidence for the neural underpinnings of this semantic deterioration thus far has been scant. In the present study, 17 normal control subjects (12 female; mean age = 64.9) and 16 patients with aMCI (6 female; mean age = 69.7) underwent an EEG task in which they performed the Semantic Object Retrieval Test (SORT), a test which specifically targets object feature integration and object memory retrieval. Event-related potentials (ERPs) were measured and analyzed using a multi-variate analytical approach (STAT-PCA). Our results showed that aMCI patients (82.8%) performed significantly less accurately ($p = .001$) on the task than the controls (90.3%). Both groups showed a left fronto-temporal ERP component with successful retrievals (750-1000 ms post-stimulus). However, compared to controls, the aMCI patients showed an increased but delayed ERP difference (950-1050 ms post-stimulus) in fronto-parietal scalp potential between retrieval and non-retrieval conditions. These differences may reflect more effortful or compensatory neural mechanisms used by those with aMCI compared to controls; this in turn may be suggestive of some early signs of synaptic changes associated with aMCI within the cortical functions which underlie semantic object memory retrieval.

## B85

### PHYSICAL ACTIVITY, MOTIVATION, AND MEMORY IN HEALTHY, AGING ADULTS

Kristin Duffy[1], Arthur Kramer[1]; [1]University of Illinois, Urbana-Champaign — Physical activity is known to positively influence both the memory and motivation systems. Despite anatomical and functional connectivity of these systems, little research has investigated the intersection of these two constructs, particularly in the context of physical activity. This study used the monetary-incentive encoding (MIE) task to investigate whether physical activity (PA) level modulates motivationally driven episodic memory in healthy, aging adults (65 - 80 years old). During the MIE task, high PA (N=9) and low PA (N=5) participants viewed a monetary cue that indicated how much money they would win if they remembered the subsequent scene image during a memory test twenty-four hours later. Unlike previous work in young adults, older adults demonstrated reduced monetary reward sensitivity, remembering both high-valued and low-valued scene images equally well. Although there were no memory differences between the two groups, an independent t-test revealed that high PA participants had higher self-reported motivation to remember both high-valued ($p=0.16$) and low-valued ($p=0.03$) scene images than low PA participants. We calculated d-prime, a measure of memory that accounts for both hit rate and false alarm rate. We found that regardless of physical activity, body-mass index was negatively correlated with d-prime ($p=0.11$). Although preliminary, these results suggest that older adults may have reduced reward sensitivity to monetary rewards and physical activity may modulate motivation level in this task. Furthermore, body-mass index may be a better predictor of memory performance in a motivation-memory task in older adults.

## B86

### UNITIZATION SUPPORTS RELATIONAL LEARNING IN HEALTHY AGING AND AMNESIC CASES

Maria C. D'Angelo[1], Arber Kacollja[1], Victoria M. Smith[2], Jennifer S. Rabin[3], Felicia Zhang[2], Malcolm A. Binns[1,2], R. Shayna Rosenbaum[1,3], Morgan D. Barense[1,2], Jennifer D. Ryan[1,2]; [1]Rotman Research Institute, Baycrest, [2]University of Toronto, [3]York University — The relational memory theory of hippocampal function emphasizes the role of the hippocampus in forming lasting representations regarding arbitrary relations among distinct items. The transverse patterning (TP) task has often been used to evaluate the integrity of relational binding and hippocampal function. In TP, individuals learn the relations among three items, where each item wins in the context of one item and loses in the context of the other item. Consistent with relational memory theory, amnesic patients show impaired learning of novel relations in TP. Similarly, older adults show deficits in TP and these deficits correlate with age-related reductions in hippocampal volumes. Here we examined whether a unitization strategy could circumvent relational memory deficits in TP. We tested TP under standard and unitized conditions in a developmental amnesic case (N.C.) and in older adults. As in prior work, N.C. and the older adults showed impairments on standard versions of TP. In the unitization conditions, participants were encouraged to form fused representations of the pairs of items interacting with one another, highlighting the winner in each pair. Despite the impairments on the standard version, cognitively intact older adults showed normal TP performance in the unitized conditions. Older adults who failed the Montreal cognitive assessment (MoCA) (and thus may be at-risk for mild cognitive impairment) showed larger impairments in standard conditions and no evidence of benefiting from the unitization strategy. Like cognitively intact older adults, N.C. also benefited from unitization and, importantly, showed evidence of transfer to novel stimuli in later sessions.

## B87

### DISTINCT ROLE OF ESTROGEN RECEPTOR MODULATORS ON POSTMENOPAUSAL DIABETES-INDUCED MEMORY IMPAIRMENT IN RATS

Kanwaljit Chopra[1], Seema Bansal[1]; [1]University Institute of Pharmaceutical Sciences — Objective: Diabetes and menopause are frequent comorbidities. Expression pattern of estrogen receptors varies in diabetes resulting in differential effects of estrogen on neuronal and vascular functions. The objective of the present study was to delineate the effects of non-selective and selective ER agonists (α and β) on cognitive function in ovariectomized diabetic rats. Methods: Bilateral ovariectomy was performed in female Sprague dawley rats (200-250g) and streptozotocin was used to

induce experimental diabetes. Rats were administered with 10 µg/kg/s.c. of a nonselective estrogen receptor agonist, 17-β estradiol (E2), selective ER-α agonist (4, 4′, 4′′-(4-propyl-[1H] pyrazole-1, 3, 5-triyl) tris phenol (PPT) and selective ER-β agonist, 2, 3-bis (4-hydroxyphenyl)-propionitrile (DPN) for four weeks after STZ injection. Results: Marked impairment in memory coupled with a marked decrease in brain derived neurotrophic factors (BDNF) and increase in acetylcholinesterase activity were observed in ovariectomized diabetic rats as compared to sham rats. However, partial change in all these parameters was observed in ovariectomized or diabetic rats as compared to sham rats. Treatment with DPN and 17-β estradiol markedly while PPT treatment partially mitigated functional and neurotrophic factor changes induced in ovariectomized diabetic rats. Serum estradiol levels and uterine weights were used to assess feminizing action of allthe agents. 17-β estradiol reversed Ovx-induced decrease in serum estradiol levels and uterine weights but PPT and DPN treatment did not show any effect. Conclusion: Specific, ER-β agonists ameliorate memory dysfunction associated with postmenopausal diabetes and are devoid of feminizing side effects of non selective ER agonists.

# LONG-TERM MEMORY: Episodic

## B88

### CONFIDENT FALSE MEMORIES FOR SPATIAL LOCATION ACTIVATE CONTRALATERAL VISUAL REGIONS

Jessica M. Karanian[1], Scott D. Slotnick[1]; [1]Boston College — Previous work has shown that true memory for feature-specific information (e.g., spatial location, motion, shape) activates the corresponding early sensory cortical regions. For instance, true memory for spatial location can activate contralateral visual regions (i.e., memory for items previously presented in the left visual field activates right visual regions and vice versa). By comparison, false memory for feature-specific information activates later cortical regions, including those involved in language processing. In the present study, we investigated whether false memories for spatial location associated with higher confidence would, like true memories, activate contralateral visual regions. During encoding, sixteen participants viewed abstract shapes to the left or right of fixation. During retrieval, old shapes were presented at fixation and participants indicated whether each shape was previously in the "left" or "right" visual field followed by an unsure-sure-very sure confidence rating. Data was acquired at 3T with a 32-channel head coil and a random-effect general linear model analysis was conducted. Preliminary analysis revealed that confident false memory for the left spatial location (i.e., "left"/right) produced activity in right visual regions, while confident false memory for the right spatial location (i.e., "right"/left) produced activity in left visual regions. Moreover, this contralateral pattern of retrieval activity occurred within the same contralateral regions associated with perception/encoding (joint p-value < 0.001, corrected for multiple comparisons to $p < 0.05$). The present results suggest that reconstruction of higher confidence feature-specific false memories can produce activity in contralateral sensory cortical regions, which correspond to subjective experience rather than objective location.

## B89

### HIPPOCAMPAL AND ENTORHINAL INTEGRITY PREDICT ACCURACY OF SPATIO-TEMPORAL RECONSTRUCTION.

Patrick Watson[1], Gillian Cooke[1], Kelsey Campbell[1], Nirav Patel[1], Faizan Khawaja[1], Neal Cohen[1]; [1]University of Illinois at Urbana-Champaign — Mental reconstruction critically depends upon hippocampal integrity (Watson et al. 2013, Monti 2014). Yet it is unclear if this reconstruction error arises from disrupted spatial processing, failure to encode object-locations, or interference between related items. To investigate this, we constructed a spatio-temporal reconstruction task that involved reconstructing sequences or arrays of computer generated creatures. Two sets of 20 College-aged younger adults performed the spatial or temporal versions of the task, while one set of 20 older adults (65-85), performed the spatial version. Younger adults found sequentially presented creatures significantly more difficult than the simultaneously presented spatial arrays. Older adults scored above chance at reconstructing spatial arrays, but below younger adults, and their reconstruction scores were related to hippocampal volume and entorhinal cortex thickness. To identify memory strategies, participants in all conditions were eye tracked during study, and in a stimulus preview period immediately before reconstruction. During the preview period of the temporal version of the task, participants spent disproportionate time viewing stimuli they later configured incorrectly. This was not the case during study. Taken together, these findings generally support the account that errors in reconstruction arise from failure to correctly resolve bindings at reconstruction time.

## B90

### CONSOLIDATION-DEPENDENT CHANGES IN ASSOCIATIVE MEMORY REPRESENTATIONS

Alexa Tompary[1], Lila Davachi[1]; [1]New York University — Theories of systems-level consolidation propose that the neural traces of episodic memories become distributed across cortical regions over time (Alvarez and Squire 1994; Nadel et al. 2000). This is thought to be achieved through ongoing communication between the hippocampus and cortex (McClelland 1995). While recent work has provided evidence for enhanced hippocampal-cortical connectivity with consolidation (Gais et al. 2007; Vilberg & Davachi 2013), it is less clear how consolidation changes the representations of individual memories and links between related memories over time. We developed an fMRI study to test whether associative links are strengthened within and across memories after a 1-week retention interval. In the first scan session, subjects encoded object-scene pairs, where each object was paired with 1 of 4 repeating scenes. Object recognition and scene recall were then tested both immediately and after 1 week. Preliminary imaging data show that during object recognition, (1) hippocampal connectivity with PPA increased from the immediate to delayed test, and (2) at the delayed test, both hippocampal-PPA connectivity and PPA activation reflected later scene memory. These initial results suggest that incidental reactivation of an object's associated scene was greater after a delay, providing evidence for a strengthening of associations with time. Future analyses will use pattern similarity to further characterize how consolidation changes associative memory representations.

## B91

### TRANSCRANIAL DIRECT CURRENT STIMULATION IMPROVES ASSOCIATIVE MEMORY IN INDIVIDUALS WITH DEPRESSION.

Cheryl Abellanoza[1], James Schaeffer[1], Heekyeong Park[1]; [1]University of Texas - Arlington — The dorsolateral prefrontal cortex (DLPFC) is important for both working memory and long-term memory, such that DLPFC activity promotes associative memory by forming relational processing between items during on-line processing. fMRI studies have shown that increased DLPFC activity during encoding relates to successful associative memory in normal controls. Neuropsychological patients, including depression patients, show disorders in DLPFC activity, along with impairments in associative memory. Transcranial direct current stimulation (tDCS) is a noninvasive, safe, and cost-effective form of brain stimulation that is a useful tool for examining the causal relationship between brain areas and cognitive functions. The present study investigated whether tDCS of the left DLPFC would enhance associative memory in individuals with depressive symptoms. Subjects (depression, control) engaged in a double-blind, two-session (anodal, sham) study where they studied items and completed item and associative memory tests. tDCS was administered prior to memory tasks. For item memory test, subjects studied a list of items and made "old/new" recognition judgments with confidence ratings. For associative memory test, subjects studied word pairs and indicated if test pairs were studied in the same pairing at study ("intact"), studied but with different pairings ("rearranged"), or not studied ("new"). Results showed that only the depression group showed enhanced associative memory after anodal tDCS administration. However, such memory enhancement effects due to tDCS were not found in item memory. Control subjects did not show any difference due to tDCS. These findings demonstrate the role of DLPFC in associative memory and the nature of memory deficits in depression.

## B92

### FUNCTIONAL CONNECTIVITY BETWEEN THE NEURAL CORRELATES OF RECOLLECTION AND REINSTATEMENT DURING EPISODIC MEMORY RETRIEVAL

Emily K. Leiker[1], Jeffrey D. Johnson[1]; [1]University of Missouri — Neuroimaging studies of episodic memory have consistently demonstrated that memory retrieval involves reinstating patterns of neural activity that were present at the time of encoding. The magnitude of reinstatement effects has further been shown to be related to phenomenological experiences associated with retrieval, such as whether qualitative

information is recollected and the amount of such information recollected. At the neural level, however, interactions between reinstatement and other neural correlates of recollection, which are typically active regardless of the nature of retrieved information, are not well-characterized. In the current study, we used fMRI to investigate the functional connectivity between neural reinstatement and activity in a network of recollection-sensitive regions. Subjects (n = 16) viewed a series of words in the context of three encoding tasks and then completed a two-step memory test in which they identified the task (source) previously completed for a word, followed by rating the confidence of that judgment. Multivariate pattern analyses were conducted on fMRI data acquired during encoding and retrieval to provide the reinstatement measure. Consistent with prior findings, reinstatement magnitude increased with source-memory confidence. Additionally, trial-by-trial changes in reinstatement were positively correlated with activity in multiple regions of the recollection network, including the hippocampus, posterior parietal cortex, and posterior cingulate. The findings of interactions among reinstatement- and recollection-related activity thus elucidate the regions that are potentially involved in either guiding the completion of the cortical patterns of reinstatement or monitoring retrieved information in service of the memory decision.

## B93

### COMPARING PREFRONTAL CONTRIBUTIONS TO ASSOCIATIVE ENCODING AND METAMEMORY

Alexandra Gaynor[1], Elizabeth Chua[1,2]; [1]The Graduate Center, The City University of New York, [2]Brooklyn College, The City University of New York — Previous neuroimaging research suggests the dorsolateral prefrontal cortex (DLPFC) may be implicated in both associative encoding and in metamemory judgments about one's own learning. Here we test whether the DLPFC plays a causal role in these processes using transcranial direct current stimulation (tDCS). Forty-five healthy adults were randomly assigned to prefrontal (N=16), parietal (N=14), or sham (N=15) tDCS conditions, wherein the active conditions involved 20 min of stimulation at 2mA. During the study/tDCS phase, participants memorized 192 word pairs, and made a judgment of learning (JOL), a subjective judgment regarding their ability to later recall information that is currently retrievable. The next day, participants were presented with pairs of words, half studied together (intact) and half rearranged from different pairs (rearranged) and asked to make an intact/rearranged decision. At the behavioral level, preliminary analyses revealed that JOL accuracy for intact pairs was significantly higher than rearranged pairs ($p<0.001$), suggesting that JOLs may have been made based on the expectation of recognizing intact pairs, rather than ability to distinguish between intact/rearranged pairs. There was no difference between tDCS groups in JOLs. In terms of memory performance, a one-way ANOVA revealed a near-significant between-groups difference for intact pairs ($p<0.06$); post hoc tests showed that memory for intact pairs in the prefrontal tDCS condition was significantly lower than the sham condition ($p<0.05$), and marginally lower than the parietal condition ($p=0.075$). These preliminary results suggest prefrontal tDCS may have hindered memory for intact pairs by actually disrupting associative encoding mechanisms, but not metamemory judgments.

## B94

### CLASSIFICATION OF EEG SIGNALS OF MEMORY BETWEEN MUSICIANS AND NON-MUSICIANS

Kin Ming KAM[1], James Schaeffer[1], Shouyi Wang[1], Heekyeong Park[1]; [1]The University of Texas at Arlington — There has been much interest in the beneficial effects of musical training on cognition. Previous studies have indicated that musical training was related to better working memory and that these behavioral differences were associated with differences in neural activity in the brain. However, it was not clear whether musical training impacts memory in general, beyond working memory. By recruiting professional musicians with extensive training, we investigated if musical training has a broad impact on memory with corresponding electroencephalography (EEG) signal changes, by using working memory and long-term memory tasks with verbal and pictorial items. Behaviorally, musicians outperformed on both working memory and long-term memory tasks. A comprehensive EEG pattern study has been performed, including various univariate and multivariate features, time-frequency (wavelet) analysis, power-spectra analysis, and deterministic chaotic theory. The advanced feature selection approaches have also been employed to select the most discriminative EEG and brain activation features between musicians and non-musicians. High classification accuracy (more than 95%) in memory judgments was achieved using Proximal Support Vector Machine (PSVM). For working memory, it showed significant differences between musicians versus non-musicians during the delay period. For long-term memory, significant differences on EEG patterns between groups were found both in the pre-stimulus period and the post-stimulus period on recognition. These results indicate that musicians' memorial advantage occurs in both working memory and long-term memory and that the developed computational framework using advanced data mining techniques can be successfully applied to classify complex human cognition with high time resolution.

## B95

### IGNORING ENVIRONMENTAL INFLUENCES DURING RECOGNITION MEMORY JUDGMENT

Jihyun Cha[1], Diana Selmeczy[1], Justin C. Cox[2], Ian G. Dobbins[1]; [1]Washington University in St. Louis, [2]Brown University — Predictive environmental cues about upcoming recognition probes trigger robust parietal and prefrontal activation when probes violate cued expectations. In particular, left anterior angular gyrus, lateral premotor, and anterior prefrontal regions previously associated with source monitoring, demonstrated increased activation when environmental cues suggested an upcoming item should be novel, yet it was perceived as familiar. We refer to this as the unexpected familiarity activation response. Here we examine whether cue induced behavioral biases must be present in order for the unexpected familiarity activation response to occur by instructing participants to either use or ignore predictive environmental cues during their recognition judgments in alternating scans. Behavioral data demonstrated that the influence of cues was greatly dampened during ignore scans, although their effects were not fully eliminated. Replicating prior work, fMRI data under use instructions demonstrated the involvement of similar prefrontal and parietal regions for unexpectedly familiar items. Critically, during ignore instructions these regions showed preserved unexpected familiarity responses with the exception of bilateral dorsomedial prefrontal cortex (DMPFC). This suggests that DMPFC may be involved in the intentional incorporation of cues, whereas the remaining prefrontal and parietal responses track violations of cue-induced expectations even when observers are not gaining a behavioral advantage from the environmental cues. This is the first study to examine the neural consequences of ignoring predictive environmental cues when subjects attempt to base their memory judgments solely on internally derived memory evidence.

## B96

### RELATIONSHIP BETWEEN ELECTROPHYSIOLOGICAL AND BEHAVIORAL MEASURES OF PROSPECTIVE MEMORY IN INDIVIDUALS WITH MILD AND SEVERE ACQUIRED BRAIN INJURY

Consuelo M.A Pedro[1], Sarah A. Raskin[1], Navneet Kaur[1], Erin Aisenberg[1], Tessa Bloomquist[1]; [1]Trinity College — Prospective memory (PM) involves the ability to form and realize intentions after a time delay (Einstein & McDaniel, 1990). This experiment aims to examine the relationship between clinical measures of PM and an event-related potential paradigm (West & Ross-Munroe, 2002). Electrophysiological data was collected while performing a computerized laboratory PM measure and was compared to a clinical measure, the Memory for Intentions Screening Test (MIST) (Raskin, Buckheit, & Sherrod, 2011) in healthy adults (HA), individuals with mild acquired brain injury (mABI), and individuals with severe acquired brain injury (sABI). Results revealed that individuals with sABI performed significantly worse than HA on all variables of the MIST except for the 24 hour task. Individuals with mABI and HA had no significant difference in performance on all variables of the MIST. Similar findings were obtained for the laboratory measure performance. MIST total score was found to correlate significantly with performance on the laboratory task and with the formation LPC waveform, previously shown to differentiate intention trials from ongoing trials. Both the N300 and formation LPC waveform were found to differ significantly in amplitude between HA and sABI, while between HA and mABI and between mABI and sABI, there was no significant difference. These findings indicate that individuals with sABI have deficits in PM compared to HA. This suggests that individuals with mABI do not have deficits in PM. Furthermore, given the relationship between the measures, these findings support the validity of the MIST as a measure of PM in these populations.

## B97

### AUTONOMIC CONTRIBUTIONS TO ADAPTIVE MEMORY

Jordan DeKraker[1], Chris Fiacconi[1], Stefan Köhler[1,2]; [1]Brain and Mind Institute, Department of Psychology, Western University, [2]Rotman Research Institute, Baycrest Centre, Toronto, ON — Studies demonstrating a mnemonic benefit for encoding words in a survival scenario have revived interest in how human memory is shaped by evolutionary pressures. Prior work on the survival-processing advantage has largely examined cognitive factors as potential proximate mechanisms. The current study, by contrast, focused on autonomic emotional arousal. Guided by the idea that a survival scenario implies threat, we combined measures of heart rate (HR) with affective ratings to probe the potential presence of fear bradycardia - a parasympathetically dominated HR deceleration triggered by threat. We replicated the mnemonic advantage in behaviour, and found that the survival scenario was rated higher in negative arousal than a commonly used control scenario. Critically, words encountered in the survival scenario were associated with more extensive HR deceleration, and this effect was directly related to subsequent recall performance. Our findings identify autonomic emotional arousal as a potent proximate mechanism for the survival processing advantage.

## B98

### SOURCE MEMORY FAILURES: COMPARING SOURCE MISATTRIBUTION TO CONTEXT OF FALSE MEMORIES

Meagan O'Neill[1], Heather Lustig[1], Rachel Diana[1]; [1]Virginia Tech — Episodic memory is subject to many types of errors. One such error is a false memory, or memory for an event that did not occur. Theoretically, false memories should not contain any contextual information. However, these memories often involve some form of contextual information. Another error is source misattributions, or a memory for an event with incorrect contextual information. Despite these contextual errors being studied independently, little is known about how they interact. We investigated these errors within one task, induced by the Deese-Roediger-McDermott paradigm. Participants studied semantically-related lists with the same contextual detail (background color). All words converged on a single semantically-related word, known as the critical lure. The critical lure was either not shown (in the false memory condition) or shown in a novel background color that did not match the color of the semantically-related list (in the source misattribution condition). If a false memory was induced, participants overwhelmingly contributed the contextual information to the semantically-related list's background color. However, source misattribution caused a conflict in contextual information recall. Participants chose the background color of the list or that of the critical lure equally. These results emphasize that recalling false memories and recalling incorrect contextual details are separate processes. Furthermore, these results allow us to test the neural correlates of the processes directly, as they can be induced through the same task. This is the first study to examine these simultaneously. The study informs us about the memory process and furthers our knowledge of errors in memory.

## B99

### AUTOBIOGRAPHICAL EXPERIENCE, SEMANTIC KNOWLEDGE, AND NOVELTY MODULATE THE HIPPOCAMPAL RESPONSE TO LABORATORY-BASED EPISODIC RECOLLECTION OF SPATIAL SCENES

S. W. Baker[1], K. K. Szpunar[2], R. S. Rosenbaum[1,3]; [1]York University, [2]Harvard University, [3]Rotman Research Institute — It has been suggested that the hippocampus (HC), known for its role in the encoding of new declarative memories, may be tuned to processing spatial scenes and/or other types of relational information retrieved from Autobiographical Episodic Memory (AEM). One possibility is that these memory processes and content may reflect a shared underlying process. If so, overlap in hippocampal response to the encoding and retrieval of spatial scenes would be expected, whether the scenes are known prior to the experiment due to personal experience or fame, or whether viewed for the first time. Another possibility is that separable regions of the hippocampus are responsible for different aspects of memory, segregated along the anterior-posterior axis. The present fMRI study set out to differentiate among these alternatives by directly comparing, through the use of common control tasks, hippocampal activity during laboratory-based episodic memory of spatial landmarks and scenes. Stimuli included autobiographically significant (personally visited), semantically known (famous), and pre-experimentally unknown scenes. Behavioral results indicated a performance advantage for personally visited and famous places vs. previously unknown places. Neuroimaging results revealed greater activation in the anterior hippocampus in response to episodic recollection of place stimuli with pre-experimental associations and to the identification of unstudied unknown stimuli. Additional posterior hippocampal activation was unique to previously unknown places at recall. The results confirm previous findings that the anterior hippocampus may be more sensitive to episodic stimuli with pre-experimental contextual associations. The posterior hippocampus may be sensitive to the encoding and retrieval of newly learned novel scenes.

## B100

### TEMPORAL EXPECTANCY ENHANCES RECOGNITION MEMORY

Sathesan Thavabalasingam[1], Edward B O'Neil[1], Zheng Zeng[1], Andy C H Lee[1,2]; [1]University of Toronto, [2]Rotman Research Institute — Exposure to temporal regularities in stimulus presentation can lead to the development of temporal expectancy, an anticipatory bias reflecting the successful extraction of these regularities. While temporal expectancy has been shown to enhance attentional focus and perceptual processing of relevant, incoming sensory information, there has, to our knowledge, been little research on the impact of temporal expectancy on long-term memory. Suggestive evidence that temporal expectancy can impact mnemonic processing comes from recent fMRI work demonstrating that the hippocampus is sensitive to the duration structure of events within sequences (Barnett et al., Neuropsychologia, 2014). To investigate this further, we presented mini-sequences of scene images to participants within a structured or unstructured temporal framework. Specifically, we hypothesized that presenting events within a regular interval duration structure may be associated with enhanced recognition memory for these events. Pairwise comparisons of performance (d-prime scores) revealed that memory was superior for scenes encoded within a structured as opposed to unstructured temporal framework. This finding was consistent across three separate behavioural experiments, regardless of whether encoding was intentional or incidental (all $p$'s $< .05$). Additionally, analysis of performance during early and late phases of retrieval revealed that a structured temporal framework at encoding attenuated the negative impact of retroactive interference (consequent of an accumulation of task trials) on recognition memory. These findings indicate that temporal expectancy can impact long-term memory processing by potentially improving the ability to encode information.

## B102

### BLOCKING GAP JUNCTIONS DURING SLEEP IMPAIRS DECLARATIVE MEMORY CONSOLIDATION IN HUMANS

Gordon B. Feld[1], Andreas Fritsche[1], Jan Born[1], Manfred Hallschmid[1]; [1]University of Tuebingen, Germany — Sleep essentially contributes to the consolidation of declarative memory. Declarative memory traces formed by highly plastic hippocampal neuronal networks are initially labile. They are reactivated and stabilized during nonREM (non rapid eye movement) sleep so that the hippocampus gradually disengages in favor of cortical networks ("systems consolidation"). In rats this reactivation process has been shown to coincide with sharp-wave/ripples, i.e., neuronal oscillations that are coordinated by slow oscillations and sleep spindles, both of which hallmark nonREM sleep. Gap junctions (direct electrical synapses between neurons) are assumed to play a crucial role in generating sharp-wave/ripples. In the present study, we investigated the contribution of gap junction signalling to sleep-dependent declarative memory consolidation assessed by means of a word pair task learned before sleep and retrieved thereafter. Sleep-associated gap junction activity was blocked by orally administering 250 mg mefloquine after learning before 8 hours of nocturnal sleep. Blocking gap junctions during sleep significantly reduced the retention of word pairs, whereas the amount of polysomnographically evaluated slow wave sleep was increased. Our results, for the first time, demonstrate a crucial involvement of the direct electrical coupling between neurons in sleep-dependent declarative memory consolidation.

# PERCEPTION & ACTION: Development & aging

## B103

### DYNAMICS OF NEUROMAGNETIC RESPONSE TO BIOLOGICAL MOTION IN ADOLESCENCE

Marina Pavlova[1], Christel Bidet-Ildei[2], Alexander Sokolov[3]; [1]Department of Biomedical Magnetic Resonance, Medical School, Eberhard Karls University of Tübingen, [2]Centre de Recherches sur la Cognition et l'Apprentissage (CeRCA), CNRS-UMR 7295 ; and Department of Sport Sciences, University of Poitiers, Poitiers, France, [3]Center for Women's Health, University Hospital, Eberhard Karls University of Tübingen, Tübingen, Germany — Brain imaging points to several brain regions engaged in the network subservingn visual processing of point-light body motion. However, temporal dynamics of this network remains largely unknown. Here we focus on the link between the visual sensitivity and neuromagnetic response to body motion. Typically developing adolescents detected a point-light walker embedded into a simultaneous scrambled walker mask. At early latencies of 180-244 ms, the visual sensitivity to biological motion negatively correlates with the root-mean-square (RMS) amplitude of the evoked neuromagnetic response over the right occipital, temporal and frontal cortices and over the left temporal cortex. At latencies of 276-340 ms, the visual sensitivity negatively links with the RMS amplitude over the right occipital and bilateral temporal cortices. At later latencies, there is still a tight inverse link between visual sensitivity and activation over the temporal cortices of both hemispheres. The outcome indicates that already in adolescence, the right temporal cortex is a hub of the social brain circuitry. For the first time, the topographic patterns of MEG activation unfolding over time and linked to visual sensitivity reveal temporal dynamics of the entire cortical network underpinning body motion processing.

## B104

### WHITE MATTER INTEGRITY PREDICTS AGE-RELATED DIFFERENCES IN NEURAL SPECIFICITY IN THE VENTRAL VISUAL PATHWAY

Jenny R. Rieck[1], Kristen M. Kennedy[1], Denise C. Park[1]; [1]University of Texas at Dallas — Young adults show robust differences in neural activity in the ventral visual pathway associated with viewing face stimuli compared to object stimuli (e.g., chairs, houses). In old age, differences in neural activity for processing face and object stimuli are less pronounced, a phenomenon termed "dedifferentiation" or "decreased neural specificity". In the current study we hypothesized that age-related degradation of underlying white matter structure—specifically in the inferior longitudinal fasciculus (ILF)—would account for age-related dedifferentiation of neural activity in the ventral visual pathway. Our sample included 306 cognitively-normal adults, ages 20-89, from the Dallas Lifespan Brain Study. Participants underwent diffusion tensor imaging, and ILF tracts were identified using probabilistic tractography. Participants also underwent functional magnetic resonance imaging while passively viewing photographs of faces and objects. Neural dedifferentiation was quantified using a metric of similarity (i.e., Euclidian distance) between neural response to face versus objects—a smaller distance was indicative of a more similar neural responses (e.g., dedifferentiated response). Using age and mean ILF fractional anisotropy to predict functional activity, we show that decreased white matter integrity predicted dedifferentiation of neural response beyond the effect of age. Further, we find an interactive effect of age and ILF integrity, such that ILF integrity explained more variance in neural response for younger adults compared to later stages of the lifespan. Our findings show a strong relationship between white matter integrity and functional activity that deteriorates with age, suggesting that additional factors in old age may be influencing the specificity of neural response in ventral visual pathway.

## B105

### ROLE OF CARDIORESPIRATORY FITNESS AND PHYSICAL ACTIVITY IN AGE-RELATED CORTICAL ATROPHY

Agnieszka Burzynska[1], Edward McAuley[1], Arthur F Kramer[1]; [1]University of Illinois — Advanced age is associated with decreases in volume and structural integrity of the brain, which coincides with cognitive decline. Previously, we demonstrated that objectively measured cardiorespiratory fitness (CRF) and increases in CRF as a result of an aerobic exercise intervention positively influences brain volume in older adults. However, the role of physical activity (PA) in this relationship is not known. In the current study, we collected objective measures of sedentary behavior, light, and moderate-to-vigorous PA over 7 days with an accelerometer from 225 healthy but low active older adults (age 60-80, 68 males, MMSE >26). We obtained cortical thickness measures by processing anatomical T1 MRI images (3T Siemens) in Freesurfer. First, age and cortical thickness were negatively related in multiple regions ($p<.001$, uncorrected). Second, we confirmed previous volumetric findings of a positive relationship between (sex-corrected) CRF and cortical thickness, which was independent of age effects in some frontal and temporal regions. There was a positive association between moderate-to-vigorous PA and thickness of the bilateral enthorinal cortex, and in other regions, a negative association between sedentary time and cortical thickness ($p<.01$). These preliminary results suggest that CRF and PA may differentially play a role in age-related cortical thinning and will be followed by assessment of cortical thickness change as a result of exercise, dance, and nutritional interventions, and the impact of these brain changes on cognitive performance.

## B106

### IN VIVO EVIDENCE FOR LONG-TERM POTENTIATION IN OLDER ADULTS

Fabio Porto[1], Anne Fox[1], Erich Tusch[1], Farzaneh Sorond[2], Abdul Mohammed[3], Kirk Daffner[1]; [1]Division of Cognitive and Behavioral Neurology, Brigham and Women's Hospital, Harvard Medical School, [2]Division of Stroke and Cerebrovascular disease, Brigham and Women's Hospital, Harvard Medical School, [3]Department of Psychology, Linnaeus University. — Long-term potentiation (LTP) is a process by which synaptic strength is augmented. It is believed to serve as a critical mechanism underlying learning, memory and neuroplasticity. In vitro work on LTP has been done on hippocampal slices using high frequency stimulation. However, it has been difficult to demonstrate LTP in vivo. Recently, LTP was reported in young adults by measuring visual evoked potentials (VEPs) before and after tetanic visual stimulation (TVS). The current study investigated whether LTP in the visual pathway persists in older subjects. Seventeen healthy adults, 65 years and older, were recruited from the community. Subjects had a mean age of 77.4, mean MMSE of 29.1, and demonstrated normal visual acuity and performance on neuropsychological tests. 1Hz checkerboard stimulation, presented randomly to the right or left visual hemi-field, was followed by two minutes of 9Hz stimulation (TVS) to one hemi-field. After two minutes of rest, 1Hz stimulation was repeated. The N1 component was measured at occipital electrode sites in the hemisphere contralateral to tetanic stimulation. We found that the amplitude of the N1 component was larger after TVS than before TVS [-6.6 (6.5) μV vs. -5.7 (6.0) μV], $p = 0.023$, indicating a reliable increase in N1 amplitude in response to TVS. Our results demonstrate that high frequency visual stimulation can enhance the N1 response in cognitively normal older adults, suggesting that LTP in visual pathways may continue into late life. Future studies should determine if this marker of neural plasticity is affected by age and neurodegenerative disease.

## B107

### FUNCTIONAL CONNECTIONS DURING LETTER PERCEPTION REFLECT EXPERIENCE WITH HAND-PRINTING INDIVIDUAL LETTERS

Sophia Vinci-booher[1], Laura Engelhardt[1,2], Thomas James[1], Karin James[1]; [1]Indiana University, [2]University of Texas at Austin — The neural substrates of letter processing typically include the left fusiform gyrus (LFG), left precentral gyrus (LPrG), left inferior frontal gyrus (LIFG), and parietal cortex. In children, these regions support letter perception only after they have learned to hand-print letters (James, 2010, 2012, 2013). When adults hand-print individual letters or passively view letters, the LFG engages alongside LPrG and LIFG (James & Gauthier, 2006), suggesting that mature letter perception is supported by a neural link among perceptual and motor processing areas that is related to experience hand-printing individual letters. Here, we investigated this potential neural connectivity using generalized psychophysiological interactions analysis (McLaren et al., 2012). We used the LFG as a seed region and determined regions that were functionally connected to it when 4-6 year-old children viewed letters and shapes during fMRI scanning after learning them through three different visuospatial motor training tasks: printing, tracing, or typing. Only after printing practice (compared to typing) with letters were functional connections established between LFG and LPrG. Only after printing practice with let-

ters (compared to shapes) were functional connections established between LFG and LIFG. Any type of visuospatial motor experience with letters promoted functional connections between LFG and the right intraparietal sulcus and inferior parietal lobe of the parietal cortex. Therefore, the results indicate that the different neural substrates of letter processing in the adult may reflect different aspects of experience with hand-printing individual letters.

# PERCEPTION & ACTION: Other

## B108

### TO BE PRECISE, THE DETAILS DON'T MATTER: ON PREDICTIVE PROCESSING, PRECISION, AND LEVEL OF DETAIL OF PREDICTIONS

Johan Kwisthout[1], Harold Bekkering[1], Iris van Rooij[1]; [1]Radboud University — Many theoretical and empirical contributions to the Predictive Processing framework emphasize the important role of precision modulation within the framework. The weighting of prediction errors according to the precision of the predictions that generated them is believed to capture phenomena as diverse as contextual influences, planning, off-line simulation, and attention; deficits in the mechanism are suggested to account for impairments such as autism and schizophrenia. Importantly, the precision of a prediction is not to be mistaken for the level of detail with which a prediction is made. The distinction between precision (or uncertainty) and level of detail (or selectivity) of predictions, however, only becomes manifest when the Predictive Processing framework is fleshed out in structural (graphical) models that allow for the modeling of higher cognition, such as Theory of Mind, social interaction, and action understanding. We show how precision and level of detail interact in Predictive Processing; in particular, we propose that lowering the level of detail can be a suitable mechanism to lower prediction errors by actually increasing the precision of the prediction; this comes at the price, however, of lowering the amount of information that can be gained by correct predictions. We identify the question how the brain optimizes the trade-off between predictions with high precision and predictions with high information gain as one of the crucial theoretical open issues for Predictive Processing.

## B109

### ASSOCIATIONS BETWEEN STRIATAL GRAY AND WHITE MATTER DENSITIES AND BODY MASS IN TYPICALLY DEVELOPING ADOLESCENTS

James T. Kennedy[1], Paul F. Collins[1], Monica Luciana[1]; [1]University of Minnesota — Previous research has linked obesity to differences in brain structure and function. Structural differences have been found in the putamen, cerebellum, and prefrontal cortex. While the structural differences in obesity have been investigated in adults, there is little research on children or adolescents. In this study, 137 typically-developing children, adolescents, and young adults (ages 9.3 to 19.7 years; n=68 female) participated in a longitudinal study of adolescent brain and behavioral development. Structural brain imaging was acquired on a Siemens 3T Tim Trio with a T-1 weighted scan. Body mass index (BMI) was indexed through measures of height and weight. Data were preprocessed using SPM12. Whole-brain analysis of gray and white matter volumes was implemented through SPM 12's voxel-based morphometry module. Regions were identified that showed associations with gray and white matter volumes and BMI percentiles (5.2 to 99.6th), controlling for age and gender. Using a clusterwise FWE < .05, reduced gray matter volume was found with increasing BMI in one extensive cluster (2222 voxels) extending to the left and right caudate, the left putamen, and left anterior cingulate. Reduced white matter volume was found bilaterally in two clusters (left hemisphere 1469 voxels, right 974), both lateral to the caudate. As the caudate is involved in reward evaluation, reduced gray and white matter volumes in this region may reflect links between atypical eating behaviors that underlie obesity and altered reward processing that varies with degree of adiposity. The observation of such associations before adulthood suggests potential targets for intervention during development.

## B110

### IS HYPERICUM PERFORATUM A FAVORABLE THERAPEUTIC MODALITY FOR THE TREATMENT OF DIABETES INDUCED COGNITIVE DISORDERS?

Yusuf Ozturk[1], Ozgur Devrim Can[1], Umide Demir-Ozkay[1]; [1]Anadolu University, Faculty of Pharmacy, Departments of Pharmacology, Eskisehir, Turkey — St.-John's Wort is a well-known antidepressant plant which has been used as both therapeutic drug and OTC product. It seems to be quite effective in the treatment of mild-to-moderate depression, as reported in various controlled clinical trials. In addition, St.-John's Wort has been reported to be used in folkloric medicine for the cure of diabetes mellitus. We have quite recently reported that extracts of this plant normalize blood glucose levels and metabolic parameters in streptozotocin-diabetic rats (1). Additionally, administration of this extract improves emotional and cognitive disorders (2) occurring in connection to diabetes. Incidences of cognitive disorders have been reported to be high in diabetes. Especially, vascular pathologies observed frequently in diabetic patients have been reported to be related with cognitive dysfunctions, dementia and even with Alzheimer disease. Further, clinical management of these cognitive disorders is a dilemma in diabetic patients. There are only a few number of cognitive enhancers and their effectiveness or side effect profile in diabetic patients have not been evaluated, yet. Hence, St.-John's Wort, as a drug, having both of the antihyperglycemic and cognitive enhancer effects seem as an appropriate cure for the diabetic patients having cognitive disorders. Further, implications are discussed on the basis of literature data. (1) Can ÖD, Öztürk Y, Öztürk N, Sagratini G, Ricciutelli M, Vittori S, Maggi F. Fitoterapia 82:576, 2011. (2) Can ÖD, Öztürk Y,Ozkay UD Planta Med 77:1970, 2011.

## B111

### POST-STROKE CORTICAL REORGANIZATION SUBSEQUENT TO SOMATOSENSORY LESION

Jared Medina[1], Olufunsho Faseyitan[2], H. Branch Coslett[2]; [1]University of Delaware, [2]University of Pennsylvania — For cortical reorganization to occur, there are two necessary components: sufficient neural substrate for reorganization and intact pathways from the periphery to undamaged tissue. In work with animal models, it has been proposed that large lesions result in post-stroke reorganization in the intact hemisphere, whereas smaller lesions results in perilesional reorganization. We examined an individual with a large left hemisphere lesion that encompassed most of left primary somatosensory cortex (S1), extending to posterior parietal cortex but sparing contralesional motor cortex and thalamus. Presented with a battery of tests to assess somatosensory processing, he demonstrated a clear impairment in tasks involving touch and proprioception on the contralesional limb, including tactile localization, finger identification, and localization of hand landmarks and arm position without vision. Although he had increased sensory thresholds on his contralesional hand compared to his ipsilesional hand, he could still detect contralesional tactile stimuli of moderate intensity. Given the extensive damage to left S1, cortical reorganization likely occurred to represent contralesional touch. To examine the location of this remapped representation, we presented the individual with tactile stimulation (2 Hz brush stimulus on the dorsal surface of each hand) using a blocked fMRI design. For ipsilesional stimulation, we found activation in the intact, right somatosensory cortex. For contralesional stimulation, we found a cluster of activation in right motor cortex, demonstrating that this neighboring region was sufficient for reorganization. We discuss these and related findings with regards to potential mechanisms and pathways for plasticity after stroke.

## B112

### HAMMERING DOWN THE PERFECT AMOUNT OF INHIBITION FOR TIME PERCEPTION ACCURACY

Kristina Hernandez[1], Christopher Thomas[2], Keisha Woodall[2], Alyssa Spurling[2], Julie Matsen[2], Stephanie Simon-Dack[2]; [1]Oregon Health & Science University, [2]Ball State University — Attentional mechanisms are important for temporal accuracy, specifically the role of neural inhibition on attention. Time perception accuracy at the millisecond range is crucial for everyday activities (e.g. communication, typing, sensory perception). However, it is unclear how low levels vs. high levels of neural inhibition impact time perception task performance. Time perception deficiency is characteristic of many clinical disorders, including ADHD, language disorders, and dementia (Grondin, 2010). The present study investigated temporal processing accuracy at the millisecond range

in a non-clinical population. Participant ages ranged from 18-23 (M=20.53, SD=1.38). Participants completed a duration discrimination task and the Barkley Adult ADHD Rating Scale. A Pearson product-moment correlation coefficient was computed to assess the relationship between temporal processing accuracy and scores on the ADHD scale. Performance on the duration discrimination task and scores on the ADHD Scale were positively correlated, r=0.332, N=33, p=0.059. Although the literature suggests that individuals diagnosed with ADHD have temporal processing deficits, our current research suggests a less clear-cut relationship between lowered cortical inhibition and temporal processing; there may be a certain level of neural disinhibition that is beneficial to temporal processing, with too little or too much leading to decreased accuracy in a non-clinical sample. Future studies should focus on creating a large profile for the relationship between neural inhibition and time perception, as well as a examining the underlying neural activity associated with temporal processing tasks. The present study adds to our understanding of temporal processing mechanisms and how differing amounts of inhibition impact time perception.

## B113

### RECRUITMENT OF THE ACTION OBSERVATION NETWORK IN CHRONIC STROKE PARTICIPANTS WITH MILD TO MODERATE LOWER EXTREMITY IMPAIRMENTS

Panthea Heydari[1], Kathleen Garrison[2,3], Carolee Winstein[1,3], Hanna Damasio[1], Nerses Sanossian[1,5], Sook-Lei Liew[6,7], Lisa Aziz-Zadeh[1,4]; [1]University of Southern California, [2]Yale University School of Medicine, [3]USC Division of Biokinesiology and Physical Therapy, [4]USC Division of Occupational Science and Occupational Therapy, [5]Keck School of Medicine of USC, [6]National Institute of Neurological Disorders and Stroke, [7]National Institute of Health — The Action Observation Network (AON), comprising the inferior frontal gyrus, ventral premotor, and posterior parietal cortices, is active both when performing an action and observing others performing the same action. Previously, our group found that individuals with stroke-related upper extremity paresis demonstrate AON activation in perilesional tissue, anterior to the canonical AON. Here, we explore if there exists similar patterns for the lower extremity(LE). We recruited 8 individuals with chronic stroke and right LE impairments (Fugl-Meyer LE mean=23.4/34, range 13-34) and 13 nondisabled matched controls to observe, execute, and imitate LE movements during an fMRI scan. A conjunction analysis for action observation and execution for each effector as compared to the control condition (a moving dot) was performed. Preliminary analyses indicate that stroke participants demonstrate activity bilaterally in the AON, including the inferior frontal gyrus and posterior parietal cortex, during action observation of both limbs. Mentalizing regions, such as medial prefrontal cortex, are also recruited to process observation of right foot actions (corresponding to the affected side). The nondisabled group showed less activity in all regions compared to the stroke group, inline with previous suggestions that the AON is more attuned to hand/mouth actions than foot/leg actions in nondisabled individuals. Our data indicates the AON may be engaged for the LE in individuals after stroke, as use of this effector becomes more salient. This data may have implications for rehabilitation of the LE post-stroke. Engaging this system may enhance recovery post-stroke through priming of motor networks for execution via observation.

## B114

### INFLUENCE OF ILLUSORY KINESTHESIA BY VIBRATORY TENDON STIMULATION ON ACUTE PAIN AFTER SURGERY.

Ryota Imai[1,2], Michihiro Osumi[1], Shu Morioka[1]; [1]Department of Neurorehabilitation, Graduate School of Health Science, Kio University, [2]Department of Rehabilitation, Kawachi General Hospital — Postoperative acute pain, pain-related anxiety and catastrophizing lead to chronicity of pain and exacerbation of disability. Our objective was to study the effects of inducing illusion of motion by tendon vibration on sensory and emotional aspects of pain and range of motion (ROM) of the affected joint. As part of a quasi-randomized controlled trial, 20 patients were assigned to the group with illusory movements (10 patients) in which their tendon was vibrated, or the control group (10 patients) in which their tendon was not vibrated. In both groups, pain (Visual Analog Scale; VAS), pain catastrophizing scale (PCS) and hospital anxiety and depression scale (HADS), and ROM were assessed before and after the intervention. The intervention was performed on seven consecutive days from postoperative day 1. Evaluation was performed at 7 days, 1 month and 2 months after the surgery. On two-way ANOVA, a significant interaction among VAS scores for resting and movement pain, ROM, PCS score for rumination, and HADS score for anxiety was recognized in both the illusory kinesthesia and control groups ($p < 0.05$). We confirmed that pain, ROM and the emotional aspect of pain improve after inducing illusion of motion by tendon vibration from the postoperative day. This clinical study was performed to develop a method to prevent the occurrence of chronic pain.

## B115

### AUTOMATIC MOTOR ACTIVATION ON THE BASIS OF SPATIAL WORDS: A TMS STUDY

Carsten Bundt[1], Lara Bardi[1], Elger Abrahamse[1], Marcel Brass[1], Wim Notebaert[1]; [1]University of Ghent, Ghent, Belgium — Various cognitive paradigms suggest an intimate link between perception and action. The theory of embodied cognition conceptualizes this link theoretically. However, behavioral, electrophysiological and hemodynamic methods that have been used to investigate this relation might not be ideally suited to directly demonstrate motor activation on the basis of perceptual information. Here, transcranial magnetic stimulation (TMS) has been applied to directly probe the automatic activation of effectors in response to semantic, task-irrelevant stimuli (i.e., the words 'LEFT' and 'RIGHT'). Specifically, two sorts of trials were employed: on half of the trials, participants were asked to respond to the color of target stimuli with the left or right first dorsal interossei (FDI). Crucially, on the remaining half of the trials, irrelevant spatial words were presented and participants were explicitly instructed not to respond to these stimuli. TMS was applied to the primary motor cortex to probe corticospinal excitability, which was measured at the left and right FDI via electromyography (EMG). Results revealed that motor evoked potentials (MEPs) were larger when the task-irrelevant stimulus (e.g. 'RIGHT') spatially corresponded with the effector (i.e. right FDI; caused by stimulating left motor cortex), compared to when it did not (e.g. 'LEFT' and right FDI). This finding suggests an automatic lateral motor activation on the basis of spatial words. Results are discussed in the context of the embodied cognition theory and spatial compatibility effects. In a follow-up experiment, we test whether participants can exert control over this 'automatic' motor activation.

## B116

### DOPAMINE IS NECESSARY FOR REWARD-RELATED INCIDENTAL LEARNING IMPROVEMENTS: EVIDENCE FROM PATIENTS WITH PARKINSON'S DISEASE.

Michael Freedberg[1], Jonathan Schacherer[1], Kuan-Hua Chen[1,2], Kumar Narayanan[1,2], Ergun Uc[1,2], Eliot Hazeltine[1]; [1]The University of Iowa, [2]University of Iowa Hospitals and Clinics — Midbrain dopamine neurons respond to both the presence of an unexpected reward and the absence of an expected reward (Schultz, 1998). This dopamine reward-prediction signal has been inferred to be involved in various forms of learning including incentive learning and instrumental learning (Wachter et al., 2009; Frank et al., 2004). However, recently it has been demonstrated that rewards can be used to bolster incidental learning, even when participants demonstrate little to no awareness of which associations were rewarded (Freedberg et al., in prep). The primary pathology in Parkinson's disease (PD) is the degeneration of dopaminergic neurons in the midbrain that project to brain regions important for motor function, cognition, and behavior. Here, we examine the role of dopamine in these reward-related improvements by comparing performance and learning of patients with PD, who are not demented and live independently, to age-matched comparisons. Participants performed a single-session experiment in which they were asked to respond to pairs of faces in which half the pairs were linked to a monetary reward. Immediately following training of the rewarded and unrewarded combinations participants performed a transfer block where they were asked to perform the same pairs without rewards. The data indicate that patients with PD showed significantly less reward-related incidental learning improvements compared to age-matched comparisons ($F(1, 10) = 9.794$, $p < 0.05$). These results show learning deficits of patients with PD in acquiring rewarded information and support the role of dopaminergic transmission in rewarded incidental learning.

# PERCEPTION & ACTION: Vision

## B117

### CONTEXTUAL PROCESSING MODULATES HEMISPHERIC DIFFERENCES IN VISUAL PERCEPTUAL SELECTION

Elise Piazza[1], Karen Wong[1], Michael Silver[1]; [1]University of California, Berkeley — The right hemisphere processes low spatial frequencies (SFs) more efficiently than the left hemisphere, which preferentially processes high SFs. We employed binocular rivalry to determine how these hemispheric differences in spatial frequency processing influence visual perceptual selection. Participants viewed a pair of rivalrous orthogonal gratings with different SFs, presented either to the left or right of central fixation, and they continuously reported which grating they perceived. At the onset of the rivalry pair, the low SF grating was perceived more often when presented in the left hemifield (right hemisphere) than in the right hemifield (left hemisphere), whereas the high SF grating showed the opposite pattern of results. In a subsequent experiment, we found that this hemispheric asymmetry is based on relative, rather than absolute, frequency processing. For example, a medium SF grating, when rivaling with a high SF grating, was more likely to be perceptually selected when the rivalry pair was presented in the left, compared to the right, visual hemifield. However, this same medium SF grating, when it was paired in rivalry with a low SF grating, was more likely to be perceptually selected in the right, compared to the left, visual hemifield. Thus, the visual system's classification of a given SF as "low" or "high" (and therefore, which hemisphere preferentially processes that SF) depends on the other SFs that are present in the environment at any given time, demonstrating an influence of top-down, contextual processing on hemispheric differences in visual perceptual selection and conscious representations of space.

## B118

### STATISTICALLY-INDUCED PREDICTABILITY OF THE CATEGORY AND/OR LOCATION OF VISUAL STIMULI RESULTS IN WIDESPREAD ACTIVITY REDUCTION IN PARTIALLY OVERLAPPING BRAIN REGIONS.

Ben Davis[1], Magda Altman[1], David Melcher[1,2], Uri Hasson[1,2]; [1]Center for Mind/Brain Sciences (CIMeC), University of Trento, Italy., [2]Department of Psychology and Cognitive Sciences, University of Trento, Italy. — Regularities in the environment license predictions that enable adaptive behavior. However, it is unclear whether predictions about object category, location, or both are mediated by overlapping systems. Using fMRI, we found that viewing image series in which the upcoming image category, location or both were predictable was associated with widespread reduction in BOLD activity relative to a random condition where neither feature was predictable. For all three predictable conditions, savings were found in 4 clusters: 1) Left dACC/dmPFC, 2) bilateral putamen caudate and thalamus, 3) right PCG, and 4) left primary visual cortex. In addition, category regularities reduced metabolic demand in the ventral visual stream and semantic areas of lateral temporal cortex while location regularities decreased activation in a dorsal fronto-parietal cluster long implicated in the endogenous control of spatial attention. These findings confirm and expand a role for dACC/dmPFC and striatum in monitoring uncertainty in the environment, and are consistent with Bayesian models of perceptual inference in which increased predictability results in decreased computational demand when expected and observed stimulus features converge. Our findings are also consistent with an account based on anticipatory suppression, where cortical areas not predicted to process an upcoming stimulus are down regulated. Finally, the effects we observe are more widespread and further upstream in the cortical hierarchy than previously reported.

## B120

### SCENE CATEGORIZATION: THE GOOD, THE BAD AND THE EARLY

Manoj Kumar[1], Yanqi Zhang[1], Diane M. Beck[1], Kara D. Federmeier[1]; [1]Univeristy of Illinois, Urbana-Champaign — Humans are extraordinarily quick at processing natural scenes. Furthermore, good exemplars of natural scene categories are not only categorized more easily but are also more readily detected than bad exemplars. However, it remains unclear when and how this good exemplar advantage arises. To address this question, we measured event-related potentials (ERPs) while participants viewed (and made a delayed judgment about) good and bad exemplars of six scene categories: beaches, city streets, forests, highways, mountains and offices. Good and bad exemplars first evoked differential ERPs 250 to 350ms after onset, with bad exemplars producing greater frontal negativity than good exemplars. This effect is consistent with the N3 complex, previously associated with global structure in an image. The results thus indicate that structural processing is easier for good than for bad exemplars. Good exemplars then elicited a larger late positive complex (LPC) response, likely reflecting more confident judgments for these items. Overall, the results indicate that the good exemplar advantage may not only extend to eased cognitive processing, but also to perceptual processing, having its roots in higher order visual processing and possible feedback to lower level processing areas.

## B121

### ATTENTIONAL SCOPE MODULATES BINDING WITHOUT CONSCIOUS AWARENESS

Sol Z. Sun[1,2], Julia Rybkina[1], Brittany Danishevsky[1], Jonathan S. Cant[2], Susanne Ferber[1,3]; [1]University of Toronto, [2]University of Toronto Scarborough, [3]Rotman Research Center at Baycrest — Most current theories of consciousness propose that binding of multiple sensory inputs is not possible without awareness. Visual attention is another process implicated in binding multiple visual features. However, few studies have examined the separate contributions of attention and awareness to visual binding, due to methodological difficulties in teasing apart these interrelated processes. We examined the influence of attention on integration of faces without awareness using continuous flash suppression (CFS). Observers were presented with high-contrast arrays of flashing circles to one eye and a face to the other eye. The face is initially suppressed from consciousness, but eventually breaks from suppression. Prior to this task, we manipulated observers to adopt either a global or local scope of attention using Navon letters (large letters composed of small letters). Past studies demonstrated a global scope of attention facilitates holistic face perception, thus we predicted that faces would break from suppression more quickly under a global scope, relative to a local scope. Results from two experiments support this hypothesis, which suggests that attention can operate without awareness to influence unconscious holistic face perception. Additionally, we did not find these scope differences in a non-rivalrous face detection task, nor when the faces were replaced with houses in an otherwise identical CFS task. This suggests that our findings cannot be accounted for by differences in detection thresholds, and that they are likely specific to face stimuli. Overall, our results suggest that attention can operate without conscious awareness to modulate the binding of multiple visual features.

## B122

### NEURAL MECHANISMS OF PUPILLARY DYNAMICS AND COGNITIVE EFFORT

Joshua Elkins[1], Gahangir Hossain[1], Yoshida Ken[1]; [1]Indiana University-Purdue University Indianapolis — The pupillary response has been used to measure mental workload because of its sensitivity to stimuli and high resolution. The goal of this study is to understand the interconnections between the visual pathway, auditory pathway, and the pupillary response relative to cognitive effort for a mental task presented visually or through audio. A multinomial processing tree was used to disentangle and measure separate cognitive processes, with the final response category being a change in pupil diameter. This model was fitted to previous test data related to the pupillary response when presented a mental multiplication task. The parameters linking the response categories are compared between three different multiplication task difficulties (easy, medium, and hard). A further experiment was performed to compare the connections between the visual and semantic neural pathways. The relationship between the neural pathway and subjects learning predisposition was determined. This predisposition or bias was quantified by the results of an index of learning styles (ILS) questionnaire. The parameters of the multinomial processing tree were related to the ILS score. For the preliminary analysis, the magnitudes of the parameter values involved in the neural pathway were positively correlated with cognitive task difficulty. Without loss of generality, the magnitudes of the parameter values are greater in the visual pathway for subjects with an ILS score that indicates a sensing learning style. As a result, a parsimonious model of the specific neural pathway that involves the pupillary response to cognitive effort could be constructed.

### B123

**PROCESSING FACES AND FACIAL EXPRESSIONS OF EMOTICON: AN ERP STUDY** Taejin Park[1]; [1]Chonnam National University — Emoticon faces have been widely used for expressing a person's feeling or mood. This study examined neural mechanisms of facial processing and facial expression processing of emoticon compared to those of human faces. Pictures of emoticon faces and human faces expressing anger or neutral emotion were presented in mixed mode (mixed context) or each in separate block (single context) along with pictures of houses. All stimuli had oval-shaped contours with two gaps, and 33 participants had to decide which of the gaps was located higher. ERPs were recorded from 40 scalp electrodes and early ERP components (P1, N170) were measured at inferior occipito-temporal sites. Amplitudes of N170 showed neither facial expression effect nor difference between emoticon faces and human faces both in single context and mixed context. N170 amplitudes of faces (both of emoticon and human) were larger than those of houses. Amplitudes of P1 also showed no facial expression effect but showed differences between emoticon and human face both in single context and mixed context. The positivity of P1 was larger to human faces than to emoticon faces and houses, and made no difference between emoticon faces and houses. These findings suggest that facial processing of emoticon and human faces might be distinguished at early visual processing stage (reflected by P1), but also might be undistinguishable at very next processing stage (reflected by N170).

### B124

**FAMILIAR FACE DETECTION IN 180MS** Matteo Visconti di Oleggio Castello[1], M. Ida Gobbini[1,2]; [1]Dartmouth College, [2]University of Bologna — The visual system is tuned for rapid detection of faces, with the fastest choice saccade to a face at 100ms (Crouzet, Kirchner & Thorpe 2010). During everyday interactions, however, we mostly look at faces of individuals we know. Familiar faces have a more robust representation than do unfamiliar faces, and are detected faster in the absence of awareness and with reduced attentional resources (Gobbini et al., 2013). We asked whether personally familiar faces are also detected faster in a saccadic-choice task than are unknown faces. Subjects made correct and reliable saccades to familiar faces when unfamiliar faces were distractors at 180ms, 30 to 70ms earlier than the earliest evoked potential modulated by familiarity (Schweinberger, Huddy & Burton, 2004; Caharel, Ramon, Rossion, 2014). By contrast, subjects were slower and less accurate when asked to make a saccade to unfamiliar faces with familiar faces as distractors. We propose that detectors of diagnostic facial features for familiar faces develop in visual cortices through learning and allow rapid detection that precedes explicit recognition of identity.

### B125

**LOST IN 3-D-SPACE: IMPAIRED BINOCULAR FUSION IN A CASE WITH VISUAL DEPTH PERCEPTION LOSS AFTER RIGHT OCCIPITAL PARIETAL LESION** Anna Katharina Schaadt[1], Brandt Stephan[2], Kraft Antje[2], Kerkhoff Georg[1]; [1]Saarland University, Saarbruecken, Germany, [2]Charité Berlin, Germany — The complete loss of binocular depth perception ("Flat Vision"), first described by Holmes and Horrax (1919), occurs mostly after bilateral posterior-parietal lesions. Patients are unable to perceive visual depth any longer; 3-D visual scenes appear like flat 2-D pictures. All visuomotor activities (reaching, grasping, taking stairs) are impaired. Surprisingly, the precise functional/neuroanatomical bases of "Flat Vision" are still obscure. We studied a unique patient (EH) with a large right-sided occipito-parietal hemorrhage showing a complete loss of visual depth perception for several months post-stroke. EH could well describe simultaneously multiple visual objects in a topographical scenery - hence did not show simultanagnosia - but at the same time was completely unable to estimate their distance from him. In every 3-D visual scene, objects appeared equidistant to him. EH showed bilateral lower, homonymous field loss and a severely impaired binocular convergent fusion, but preserved stereopsis and unimpaired eye functions (visual acuity, accommodation, contrast sensitivity). Repetitive dichoptic training resulted in a stepwise and finally complete recovery of binocular fusion ($p < .05$, $d = 1,4$). Most interestingly, subjective depth perception improved in a "far-to-near-space", gradient-like manner. In parallel, objective visual depth judgments also improved up to a normal level, whereas stereopsis remained unchanged. This case shows that impaired fusion is involved in the genesis of "Flat Vision" and shows a hither to unreported plasticity of the lesioned visual brain to regain 3-D-space perception. Furthermore, our results provide new insights into the complex interplay of basic binocular (dys-)functions and higher-order visual space perception.

### B126

**REDUCED ACCURACY OF TIME ESTIMATION IN AUTISM SPECTRUM DISORDERS** Savanna Sablich[1], Yukari Takarae[1]; [1]UT Southwestern Medical Center — Differences in time estimation in individuals with autism spectrum disorder (ASD) have yielded findings of both increased and decreased accuracy, and the extent to which this time estimation ability is impacted in ASD remains equivocal. We examined time estimation in short and long stimulus durations to potentially differentiate function of frontocerebellar and frontostriatal circuitries, both of which have been implicated in ASD. Time estimation accuracy was assessed in seven individuals with ASD and eight typically developing controls (TD) matched on age (12-32 years), gender, and full scale IQ. Participant's time estimation was examined by requiring participants to reproduce the duration of a previously perceived visual stimulus through depression of a mouse key. Durations of the presented stimuli were either in subseconds or over seconds and were randomly assigned to trials. Proportional error in reproducing the stimulus timing was calculated, then its average and standard deviation were used to examine accuracy and variability in time estimation respectively across groups and conditions. Participants with ASD produced overall less accurate estimations than typically developing controls. The group difference, however, was due to individuals with ASD showing drastic overestimation and greater variability in short duration reproduction compared to controls, while their performance for longer duration stimuli remained very similar to the control group. Specific impairments in reproducing subseconds time durations are consistent with involvement of frontocerebellar circuitries. An additional implication in the detection of these abnormalities may be linked to an inflexibility in processing changes of stimulus duration when they are randomly presented.

## THINKING: Development & aging

### B127

**FRONTAL NAA CONCENTRATIONS PREDICT GLOBAL COGNITIVE FUNCTION IN OLDER ADULTS** Adam Woods[1], Eric Porges[1], Andrew O'Shea[1], Vaughn Bryant[1], Ashley Harris[2], Richard Edden[2], Ronald Cohen[1]; [1]University of Florida, [2]Johns Hopkins University — The neurometabolite N-Acetyl aspartic acid (NAA) plays an important role in modulating oxidative stress in the brain. NAA concentration decreases in disorders causing neuronal loss or axonal degradation. For example, NAA concentrations decrease following structural brain changes associated with normal aging. In general, frontal cortices are thought to undergo the most prominent structural and functional changes with age. Furthermore, these changes are associated with a broad pattern of cognitive decline in older adults. NAA concentrations, as measured by proton magnetic resonance spectroscopy (1H-MRS), may serve as a neuroimaging biomarker of cognitive aging. We hypothesized that age-related changes in frontal, but not posterior NAA concentrations would predict global cognitive function in a population of older adults. Fifty-one older adults (mean age±SD = 72.6±8.8, range = 52-92 years, mean education±SD = 15.9±2.7, range = 12-20 years) underwent the Montreal Cognitive Assessment (MoCA) and MEGA-PRESS 1H-MRS in medial frontal versus posterior cingulate cortices (PCC; voxel size =3cm3). Frontal NAA concentrations decreased with age in medial frontal ($t=-4.2$, $p<.001$, partial $r=-.52$), but not PCC regions ($t=-.44$, $p=.66$, partial $r=-.06$). Frontal NAA concentrations were associated with MoCA scores ($t=2.6$, $p=.01$, partial $r=.36$), while PCC concentrations were not ($t=-.05$, $p=.96$, partial $r=-.008$). Frontal NAA decreased with age and was associated with decreased global cognitive function. These data provide initial evidence supporting 1H-MRS measures of NAA in frontal cortices as a neuroimaging biomarker of cognitive aging. Future research will be needed to investigate the selectivity, specificity, and malleability of this marker.

### B128

### THE DEVELOPMENTAL RELATIONSHIP BETWEEN CEREBELLAR GREY MATTER AND COGNITION IN A PEDIATRIC POPULATION

Dorothea M. Moore[1], Anila M. D'Mello[1], Lauren M. McGrath[1], Catherine J. Stoodley[1]; [1]American University — There is growing evidence that the cerebellum is involved in cognition. Cerebellar volume is related to general intelligence in adult and pediatric populations. Cerebellar structural and functional differences are reported in developmental disorders, and early cerebellar damage negatively impacts later cognitive outcomes, emphasizing the potential importance of the cerebellum during development. Previous studies have investigated the relationship between cognitive subdomains and cerebellar grey matter (GM) in adults, but no study has looked at this relationship in typically-developing children. Structural T1 MRI scans and cognitive measures of 110 individuals aged 8-17 were obtained from the Pediatric Imaging, Neurocognition, and Genetics (PING) Study. The correlations between cerebellar GM and measures of language, processing speed, working memory, and executive function were examined using whole-brain voxel-based morphometric multiple regression analysis. Covariates included total intracranial volume, gender, age, age2, and site. Higher scores on cognitive measures were associated with increased GM in the posterior cerebellum: language scores correlated with GM in left lobule VI, bilateral Crus II/VII/VIIIA, and midline VIIIA/VIIIB/IX/X; working memory performance with right Crus II/VIIB; and executive function scores with lobules VIIB/VIIIA bilaterally. These cerebellar regions are active during cognitive tasks and form circuits with dorsal attention and frontoparietal networks. The age x score interactions for working memory and processing speed indicate that these relationships differ across development. These results suggest that, as in adults, cerebellar GM is associated with cognitive task performance in a pediatric population. These findings provide further evidence for the involvement of the cerebellum in cognition and cognitive development.

### B129

### DISTINCT NEURAL CIRCUITRY UNDERLYING NUMERICAL DEVELOPMENT IN 4- TO 6-YEAR-OLD CHILDREN.

Alyssa Kersey[1], Jessica Cantlon[1]; [1]University of Rochester — Numerical representations are hypothesized to be integrated with representations from other visuospatial domains, such as length or surface area. However, it is unclear whether or not different quantitative representations rely on overlapping neural mechanisms, if these mechanisms develop at similar rates, and how the development of these neural systems relates to cognition. Here we test how the development of numerical cognition relates to the neural processing of different ordered, continuous, quantifiable properties (number, brightness, and area). Using functional magnetic resonance imaging (fMRI) and an adaptation paradigm, we measured changes in brain activity in children (4- to 6- years) in response to visual arrays that varied from standard arrays in the number, cumulative area, and brightness of elements. We found that an area in the right intraparietal sulcus (IPS), which showed a decreasing neural response during adaptation, also showed an effect of numerical distance when the stimuli suddenly changed in value – the IPS responded more strongly to large compared to small changes in the number of items. The number-sensitive region of the IPS did not show any significant relation to changes in area or brightness, suggesting that numerical processing is separable from other quantifiable dimensions in the developing brain. We measured children's numerical discrimination abilities using behavioral tasks outside of the scanner. Children's numerical sensitivity predicted their neural responses to changes in numerical values independently of age. This suggests that neural activity in the IPS underlies the development of numerical processing systems in early childhood.

### B130

### MATHEMATICAL SKILLS OF COLLEGE STUDENTS ARE ASSOCIATED WITH RAPID ACCESS TO A MENTAL NUMBER LINE AND PREFRONTAL ACTIVATION

Keri Weed[1], Laura Swain[1]; [1]University of South Carolina Aiken — Proficiency in mathematical reasoning has been related to the establishment of a mental number line (MNL), or a cognitive representation of numerosity (Rusconi et al., 2009). Although evidence points to the intraparietal sulcus (IPS) as the site of the MNL the prefrontal cortex may also be involved (Ansari, 2008; Libertus et al., 2013). Some evidence suggests that college students who have difficulty with math may have formed a distorted mental number line as children (Izard & Dehaene, 2008; Schneider & Siegler, 2010). The purpose of the current research was to examine relationships between mathematical reasoning, MNL representation, and prefrontal brain activation. Fifteen college students completed: a standardized assessment of math skills, a ruler estimation task designed to measure the MNL, and a series of magnitude judgments that required determining whether the quantity of two simultaneously presented dot arrays was the same or different. Prefrontal brain activation was measured using fNIR technology during the magnitude judgment task. Regression analyses revealed that 63% of the variance in math scores was associated with reaction time during ruler estimations ($b = .57$, $p = .01$) and with peak deoxygenated blood volume during magnitude estimations ($b = .68$, $p < .01$). Results confirm that mathematical skills of college students may be related to the ability to quickly access a MNL as well as greater activation of the prefrontal cortex. Implications suggest that repair of distorted mental number lines may contribute to improved mathematical reasoning of some college students.

## THINKING: Problem solving

### B131

### FRONTAL THETA SYNCHRONIZATION INCREASES AS A FUNCTION OF THE AMOUNT OF INTERMEDIARY MOVES DURING PLANNING.

Steven R. Green[1], Taylor M. Hurst[1], Sharlene D. Newman[1]; [1]Indiana University — In problem solving, it can be difficult to measure the cognitive processes involved in formulating a plan. Take for example elaboration, the set of processes that occur during planning which identifies, evaluates, and maintains moves which are eventually incorporated into the solution. One approach to measuring these processes is through frequency analysis, which has been used to identify synchronization increases in the theta band during working memory tasks. The current study sought to measure elaboration during planning by manipulating the amount of intermediary moves in problems and observes changes in the frontal theta synchronization. Results confirmed that parametric changes in the amount of intermediary moves resulted in linear increase in frontal theta synchronization. A secondary analysis also revealed that the amount of theta burst – defined as transitory periods of high theta synchronization during planning – predicted performance for that problem. However, the relationship between the amount of theta burst and performance was mediated by motivation and intermediary moves, such that when solving problems with several intermediary moves, the low motivated group benefited by more theta bursts while the high motivated group was impaired by them. Given the unique nature of intermediary moves, these results suggest that changes in frontal theta during planning may be reflecting the maintenance of moves in working memory. Furthermore, frontal theta may serve as an effective method for measuring elaboration during problem solving, but the meaning of frontal theta can vary by motivated state, so care must be taken when using this measure.

### B132

### BUILDING AN INTEGRATED REPRESENTATION OF QUANTITY: INCREASED SIMILARITY OF BRAIN RESPONSES FOLLOWING NUMBER SENSE TRAINING

Emma Adair[1], Miriam Rosenberg-Lee[1], Vinod Menon[1]; [1]Stanford University — Can a training targeted at strengthening the mapping between symbols and their quantities create a more integrated representation of numerical information? Here we investigate the neural correlates of number sense training on thirty 2nd and 3rd grade typically developing children. Children finished a 4-week one-on-one number sense training program focused on building magnitude representations for symbolic quantities. Training was bracketed by functional magnetic resonance imaging, where children completed two tasks involving magnitude comparisons of Dots and Numbers that were either Near (8 vs. 9) or Far (3 vs. 8) apart. Prior to training, the Dot task produced a neural distance effect (NDE) – more activation for Near relative to Far problems – in multiple frontal, visual, and parietal regions including the intra-parietal sulcus (IPS), while no regions showed an NDE during the Numbers task. For the Dots task, training reduced the regions showing NDE to core brain areas implicated in numerical cognition, including the bilateral IPS. In contrast, for

Numbers, training induced an NDE in the left superior parietal lobule and lingual gyrus. A direct comparison confirmed that brain responses for the two tasks became more alike after training. Further, a whole-brain representational similarity analysis revealed increases in similarity in the left IPS and right lingual gyrus. These results suggest training number sense can contribute to the maturation of a common format for quantity representations.

# Poster Session C

## ATTENTION: Multisensory

### C1

**ANGRY FACES REDUCE SENSITIVITY FOR AUDITORY-VISUAL TEMPORAL ASYNCHRONY** L. Jacob Zweig[1], David Brang[1,2], Satoru Suzuki[1], Marcia Grabowecky[1]; [1]Northwestern University, [2]University of Chicago — Perception of a multisensory event, such as a person speaking, relies on binding information from different sensory modalities into a unitary percept. A temporal window of integration for multisensory events allows flexibility to account for latency differences arising from both variable physical transmission rates through the environment and neural transmission rates within the brain (Shelton, 2010). Previous research has shown that the width of the temporal window is subject to influences of factors including attention, spatial disparity, and stimulus complexity (e.g., Spence & Parise, 2010). The extent to which the temporal window of integration for speech is influenced by emotion, however, remains unknown. Here, we demonstrate that an angry expression reduces temporal sensitivity for detecting auditory-visual asynchrony in speech perception. Using the method of constant stimuli, a video of a person uttering syllables was presented to participants with varying delays between the auditory and visual streams. For each auditory stream, the accompanying visual stream assumed a happy, neutral, or angry facial expression. Participants made unspeeded temporal order judgments indicating whether the auditory or visual stream occurred first. Facial expression did not influence the point of subjective simultaneity, suggesting that expression either does not influence the perception of speech onset or does so equally for the visual and auditory modalities. An angry expression significantly increased the just noticeable difference, suggesting that an angry expression reduces sensitivity for detecting temporal asynchronies between auditory and visual speech streams. This result provides evidence that emotion processing influences the perception of audio-visual synchrony.

### C2

**DIFFERENTIAL INFLUENCE OF ALPHA MODULATION IN TASK RELEVANT AND TASK IRREVERENT REGIONS** Rosanne van Diepen[1], Ali Mazaheri[1]; [1]Department of Psychiatry, Academic Medical Center, University of Amsterdam — The most predominant frequency of ongoing oscillatory activity present in the EEG/MEG is 10 Hz and is commonly referred to as the alpha rhythm. There has been a number of findings that functional inhibition of a sensory system not important for a given task is achieved by an increase in alpha activity. The majority of studies have examined shifts of attention (often spatial) within one modality. Switching attention between modalities is hypothesized to be mediated by the same mechanism. In the current study participants performed a cross-modal attention-task in which visual and auditory targets were preceded by either modality informative cues (i.e. informing the modality of the target) or a non-informative cue. We employed a block-design where visual and auditory targets were presented by themselves or simultaneously with a distractor in the other modality. Comparing the post-cue alpha activity (10 Hz) between the informative and non-informative cue trials revealed that preparation for a visual target induced a decrease in alpha activity over posterior regions. This decrease in alpha activity was correlated with faster visual discrimination times. In contrast, preparation for an auditory target induced an increase in alpha activity in posterior regions but only when the auditory targets were paired with visual distractors. However, this increase in alpha activity did not correlate with faster auditory discrimination times but did with distractor cost. These results taken together suggest a multi-faceted role of alpha activity in cross-modal attention.

### C3

**DELTA PHASE COHERENCE IN INTEGRATING AUDIO-VISUAL INFORMATION** Takefumi Ohki[1,2], Atsuko Gunji[2,3], Yuichi Takei[4], Hidetoshi Takahashi[2], Yuu Kaneko[2], Yosuke Kita[2], Naruhito Hironaga[5], Shozo Tobimatsu[5], Masumi Inagaki[2], Kazuo Hiraki[1]; [1]The University of Tokyo, [2]National Centre of Neurology and Psychiatry, [3]Yokohama National University, [4]Gunma University, [5]Kyushu University — Multisensory process is an ability to combine cues from various modalities, and a basic feature of brain function (Ghazanfar and Schroeder, 2006). As one hypothesis to explain such a neural state, cross-frequency coupling (CFC) has been proposed (Senkowski et al., 2008). Especially, it is reported that phase-phase CFC plays an important role in audio-visual speech processing (Luo et al., 2010). To investigate this issue, interpreting "the cocktail-party effect" in a broad sense, we designed an audio-visual speech-matching task. Since it is widely known the motion of mouth enhances speech processing even in a noisy environment (Golumbic et al., 2013), in our task, two films were presented simultaneously, which consisted of two different sentences spoken by the identical female person. Furthermore, two conditions "Temporal Synchrony (TS)" vs. "Temporal Asynchrony (TA)" were created. In TA, the motion of mouth doesn't temporally coordinate with auditory stimuli (420 ms mismatch). We assume that if phase-phase CFC would serve as an essential component in binding audio-visual processing, a mismatch between auditory and visual stimuli would interfere with not only binding process but also phase coherence. Then, using imaginary coherence analysis (Nolte et al., 2004), we obtained behavioral and magnetoencephalographic data (N=19; mean age 25.6 yrs), which support our hypothesis; behavioral performance and delta (1-3Hz) phase coherence in TS are significantly higher than TA. In conclusion, delta phase coherence among occipital lobe and anterior temporal lobe, PFC and motor area, we propose, contributes to a fundamental binding process for temporally matching audio-visual speech.

### C4

**WHEN MULTIPLE MODALITIES REQUIRE ATTENTION, THETA STEPS UP TO THE PLATE** Arielle S. Keller[1], Lisa Payne[1], Robert Sekuler[1]; [1]Brandeis University — Although alpha oscillations are known to play a role in suppressing distracting information from a single modality, the neural mechanisms implicated when multiple modalities must be simultaneously attended are not known. To address this, we investigated the effects of divided attention on the processing of auditory and visual temporal sequences. Subjects performed an oddball task with auditory, visual, or simultaneous audiovisual sequences in separate blocks, while the electroencephalogram was recorded using high-density scalp electrodes. During a divided-attention audiovisual condition, an oddball (a rare and unusual stimulus) could occur in either the auditory or the visual domain, requiring that attention be divided between modalities. Fronto-central theta band (4-7 Hz) activity source-localized to the anterior cingulate was strongest in this audiovisual condition. That activity appears to be a marker of either divided attention or multisensory processing. Additionally, posterior alpha activity, which has been found to be a marker of selective ignoring of visual stimuli, was stronger during the auditory condition than the visual condition, suggesting that subjects suppressed visual processing in order to attend to the auditory stimuli. These findings show that neural processes marked by oscillations in alpha and theta frequency bands are important in attending to and processing temporal sequences in the visual and auditory domains. Given that the anterior cingulate plays a role in divided attention (Corbetta et al., 1991) and theta-band activity is involved in multisensory integration (Sakowitz et al., 2000), future studies should focus on differentiating possible roles of theta activity during multisensory divided attention.

### C5

**ACTIVATION OF VISUAL CORTEX BY SALIENT SOUNDS: AUTOMATIC?** Pawel J. Matusz[1,2], Micah M. Murray[1,3,4]; [1]Vaudois University Hospital Center and University of Lausanne, Switzerland, [2]University of Oxford, [3]Center for Biomedical Imaging (CIBM) of Lausanne and Geneva, Switzerland, [4]Vanderbilt University — Laterally-presented sounds activate contralateral extrastriate visual cortices ~250ms post-sound onset, and they do so even when completely task-irrelevant and spatially uninformative when preceding subsequent targets. An auditory-evoked contralateral occipital positivity (ACOP) has been argued to be an event-related potential correlate of this "automatic" sound-driven activation of visual cortices that results from the

orienting of spatial attention to the sound location. All previous experiments involved tasks where the spatial location of stimuli was relevant. We tested whether variation in and thus implicit predictability of the location of lateralized sounds modulates the cross-modal activation of visual cortices under conditions where there was no task. We addressed this with a completely passive auditory paradigm following a 2x2 factorial design while recording 128-channel EEG. The spatial position or pitch of sounds was varied (80% vs. 20%) while the other factor was held equi-probable across different blocks. Brain responses to identical acoustic information were compared. Mean activity at 260-360ms across posterior electrodes confirmed the presence of sound-induced contralateral occipital activity. However, this activity was exclusively observed in contexts wherein sound position was implicitly predictable (i.e. when sounds were more often presented to one location vs. contexts when sound position was equi-probable). Distributed source modelling localized this effect to a network of calcarine, fusiform, and superior temporal cortices. Thus, cross-modal activation of visual cortices by sounds is critically dependent on the overarching spatial context and cannot be regarded as completely automatic.

### C6

### A TRADE-OFF BETWEEN SPATIAL AND TEMPORAL BINDING IN MULTISENSORY PERCEPTION.

Raquel E. London[1], Durk Talsma[1]; [1]Ghent University — To be integrated into a unified percept, multisensory stimuli must be perceived as occurring simultaneously (Colonius & Diederich, 2004, JOCN). We have some tolerance for asynchrony which results in a window within which two stimuli are perceived as simultaneous. The width of this temporal binding window (TBW) varies considerably between individuals (Stone et al., 2001, RSPSB) and influences their susceptibility to audiovisual illusions (Stevenson et al., 2012, JEP:HPP). An individual's peak alpha frequency seems to be an important determinant of the width of their TBW (Romei et al., 2014, IMRF meeting, Amsterdam), with higher frequencies resulting in narrower TBW's. In the spatial domain there is also evidence that the width of a binding window influences integration of audiovisual stimuli. For example, the extent to which visual search is facilitated by auditory stimuli (an effect known as "Pip & Pop" (Van der Burg et al., 2008, JEP:HPP) is modulated by the width of the spatial binding window (SBW) (Van der Burg et al., 2012, PLOS ONE). We present data exploring the relationship between individual differences in the width of the TBW, and the width of the SBW. Our data show that a narrow TBW is accompanied by a broad SBW, and vice versa, suggesting a trade-off between spatial and temporal sensitivity. These differences are related to individual's peak alpha frequency. Our results imply that there is an intimate correspondence between spatial and temporal characteristics of perception on both functional and structural levels.

## ATTENTION: Spatial

### C7

### OBJECTS UNAMBIGUOUSLY SEGREGATED FROM THE BACKGROUND INVOLVES EARLIER SPATIAL SELECTION

Ryuji Takeya[1], Tetsuko Kasai[1]; [1]Hokkaido University — When attention is directed to a part of an object, the whole spatial regions that belong to the object is obligatorily activated (object-based attention-spreading). Several studies have shown that this process is reflected in the posterior N1 component (150-200 ms post-stimulus) of event-related potentials (ERPs). However, previous studies generally used simple rectangles as objects, which may not necessarily be clear "figures" against the background because they can also be interpreted to be holes in two-dimensional display. The present study used modified Kanizsa stimuli and examined object-based attention-spreading for objects that were perceived in front (Experiment 1) and in back (Experiment 2) of the surrounding. In the both experiments, the task was to covertly attend to one hemifield and to detect infrequent shallower dents (targets) among frequent dents (standards) at the attended hemifield, which appeared upon connected or separated objects. In response to standards, the typical P1 (100-140 ms) and N1 (150-220 ms) attention effects at occipital-temporal electrode sites (i.e., greater amplitudes for stimuli at attended locations than for those at unattended locations) were observed. Importantly, an attention-spreading effect was found as decreased P1 attention effect for connected objects compared to separated objects only in Experiment 1. This suggests that object-based attentional selection occurs at earlier stages of processing than previously indicated when objects are unambiguous figures in front of the background.

### C8

### CAN THE EXPLORATION OF LEFT SPACE BE INDUCED IMPLICITLY IN UNILATERAL NEGLECT?

Murielle Wansard[1], Paolo Bartolomeo[2], Valérie Vanderaspoilden[3], Marie Geurten[1], Thierry Meulemans[1]; [1]Department of Psychology, Behavior and Cognition, Neuropsychology Unit, University of Liège, Belgium, [2]INSERM-UPMC UMRS 1127, Centre de Recherche de l'Institut du Cerveau et de la Moelle épinière. Brain and Spine Institute, Paris, France, [3]Service de Revalidation Neurologique, CHU Brugmann, Bruxelles, Belgium — The purpose of the present study was to explore the ability of neglect patients to detect and exploit the predictive value of a cue to respond more quickly and accurately to targets on their contralesional side in a Posner spatial cueing task. The majority of the cues (i.e. 80%) were invalid, indicating that the target would appear on the opposite side, although patients were not informed of this bias. Our results demonstrate that some neglect patients were able to extract the cue's predictability and use it to orient faster toward the left. This cueing effect was present even in patients who were subsequently unable to describe the predictive character of the cues, and thus was not modulated by reportable awareness of the cue-target relation.

### C9

### LINKING VIRTUAL STREET CROSSING PERFORMANCE TO SPATIAL WORKING MEMORY AND CORTICAL THICKNESS IN A HEALTHY AGING POPULATION

Sarah Banducci[1], Agnieszka Burzynska[1], James Crowell[1], Hank Kaczmarski[1], Edward McAuley[1], Arthur Kramer[1]; [1]University of Illinois at Urbana Champaign — Most daily tasks require the ability to manage multiple simultaneous cognitive demands. However, age-related decline in cognitive abilities translates into less independence in completing everyday tasks for older adults. For activities such as crossing the street or driving a car, the consequences of this deterioration are serious, e.g. greater risk of injury or traffic accident. As little is known regarding the cognitive and neural correlates of real world pedestrian behaviors, we investigated the link between success in a complex 3D virtual street crossing task, computer-based spatial working memory accuracy, and age-related cortical atrophy. Subjects were 203 adults age 60–80 years (M = 65.22, 130 female). Spatial working memory accuracy positively predicted virtual street crossing success. Furthermore, preliminary analyses positively linked cortical thickness to spatial working memory and street crossing performance in brain regions that support decision making and cognitive control including the insula, posterior cingulate and the prefrontal cortex. These results introduce the possibility of identifying older adults at high risk of traffic accidents via neuropsychological and imaging measures while in a safe laboratory setting.

### C10

### NATURAL SCENE RECOGNITION IN THE CHILDREN'S BRAIN

Nicolas Poirel[1,2], Grégory Simon[1], Sonia Dollfus[3,4], Olivier Houdé[1,2], Carole Peyrin[5]; [1]LaPsyDÉ, UMR 8240, CNRS, Université Paris Descartes, Université de Caen, France, [2]Institut Universitaire de France (IUF), Paris, [3]ISTS, UMR 6301, CNRS, CEA, Caen, France, [4]CHU de Caen, Service de Psychiatrie, Centre Esquirol, Caen, France, [5]LPNC, UMR 5105, CNRS, Université Pierre Mendès France, France — Recent models of visual perception suggested that scene recognition is processed in terms of spatial frequencies: low spatial frequencies (LSF) rapidly reach high-order cortical areas to allow initial scene recognition and high spatial frequencies (HSF) subsequently carry fine details analysis. In the present MRI study we studied for the first time in children the relationship between the cortical thickness and behavioral performances to LSF and HSF processes. Sixteen children (10 years old) were presented with natural scenes and they had to indicate as rapidly and as accurately as possible for each trial whether the scene was outdoor or indoor. Each scene was filtered either in LSF or in HSF. Children were scanned with a 3-Tesla MRI scanner, and mean cortical thickness values were extracted with Freesurfer software according to the Destrieux Atlas. Regression analyses, which included age as covariable, were computed to determine the degree of relationship between the cortical thickness and behavioral performances to LSF and

HSF filtered scenes. The results indicated that children exhibited (1) faster reaction times to LSFs associated to a decreased cortical thickness in higher order cortical areas constituted of middle frontal, lateral orbital and insula regions and (2) faster reaction times to HSFs associated to an increased cortical thickness in parietal and calcarine regions. These findings constitute the first structural study that supports the hypothesis that both synaptic pruning (i.e. decreased cortical thickness) and expansion mechanisms (i.e. increased cortical thickness) co-occur to allow healthy children to develop an efficient perception of the visual world.

## C11

### DIRECT CURRENT BRAIN STIMULATION INDUCES CHANGES IN CORTICAL ACTIVATION MEDIATING VISUAL SEARCH: A CONCURRENT TDCS AND FMRI STUDY

Brian Falcone[1], Atsushi Wada[2], Raja Parasuraman[1], Daniel Callan[2]; [1]George Mason University, [2]Center for Information and Neural Networks (CiNet) — Transcranial direct current stimulation (tDCS) is a non-invasive technique that has been shown to enhance many different cognitive components by affecting cortical excitability changes in the brain. Studies have shown improvements on a plethora of different cognitive components; however, generally only behavioral effects are recorded. The purpose of this study was to investigate what effects tDCS has on brain function during training on a complex unmanned aerial vehicle (UAV) visual search simulation task. Functional magnetic resonance imaging was used concurrently with tDCS stimulation in order to observe these effects. Following a baseline task performance assessment, anodal stimulation (1mA) was applied over right posterior parietal cortex for 30 minutes during training, followed by a post-training assessment. Participants were randomly assigned into either an active or sham stimulation condition. The active stimulation group received stimulation for the full 30 minute training duration and the sham stimulation group only received stimulation for 30 seconds. Our results showed that behavioral performance was not significantly different between stimulation groups after training. However, imaging results revealed that brain activity that correlated with improved performance for the active stimulation group was significantly different from sham. These effects involved bilateral activation of pre-motor, motor and somatosensory cortices. While the behavioral effects of tDCS seen in other, more basic, visual attention tasks were not observed, our neuroimaging results shed some light on the neuro-modulatory effects tDCS has on brain function that is mediating enhancement in learning and performance.

## C12

### IT'S TIME TO LOOK LEFT - LEFT HEMISPHERE INVOLVEMENT IN CONTROLLED VISUAL SEARCH

Krista Schendel[1], Lynn C. Robertson[1,2], And U. Turken[1]; [1]VA Northern California Health Care System, Martinez, CA, USA, [2]Department of Psychology, University of California, Berkeley, USA — Visual search for targets containing a conjunction of features requires controlled attentional search across a visual display. Studies in patients with right hemisphere damage (RHD) have demonstrated significant deficits in conjunction search performance despite relatively good detection of singleton features. Neuroanatomical regions implicated in the control of such spatially directed attention have likewise included extensive right fronto-parietal regions as well as the right temporo-parietal junction. Here, we investigated visual conjunction search performance in a group of chronic, left hemisphere damaged (LHD) stroke patients (n=34). Using an adaptive, computerized conjunction search task, we detected a significant lateralized impairment in the left hemisphere patients, compared to a healthy, age-matched control group (n=14). High resolution, T1-weighted anatomical MRI scans were then analyzed for 30 of the stroke patients. Of interest, lesions within/near the left temporo-parietal junction (including the left superior temporal gyrus and Heschl's gyrus) were associated with the magnitude of the lateralized deficit, suggesting that this region of the left hemisphere is also related to spatially directed attention. These results corroborate other findings that impairments in visuospatial attention are not unique to right hemisphere damage. Here we show that cortical lesions within the left temporo-parietal junction also impact directional bias and/or spatial precision when the deployment of serial attention search is required.

## C13

### TRANSCRANIAL RANDOM NOISE STIMULATION ACCENTUATES REWARD-DRIVEN PLASTICITY IN VISUAL CORTEX

Martijn van Koningsbruggen[1], Stefania Ficarella[1], Clayton Hickey[2], Lorella Battelli[1,3]; [1]Center for Neuroscience and Cognitive Systems@UniTn, Istituto Italiano di Tecnologia, Rovereto, Italy, [2]Center for Mind/Brain Sciences, University of Trento, Trento, Italy, [3]Berenson-Allen Center for Noninvasive Brain Stimulation and Department of Neurology, Beth Israel Deaconess Medical Center, Harvard Medical School — Previous studies have shown that reward feedback in visual search causes target features to become salient and attention-drawing, but the mechanisms underlying this function remain unclear. Here we use transcranial random noise stimulation (tRNS) to demonstrate that this reflects plasticity in visual cortex. Participants completed a feature-search reward-learning task that involved the selection of a red or green coloured target presented among distractors of various color. Each correct trial garnered feedback where the magnitude of reward was determined by the color of the target. During this task tRNS was applied either over a parietal-occipital area (n=20, P07/8 electrode sites), a frontal area (n=20, F3/4 electrode sites), or sham stimulation (n=20). In a subsequent test phase, during which no tRNS was applied and no reward was available, subjects performed a different visual search task requiring selection of a unique shape presented among colored distractors. Importantly, in some trials a single distractor had a color associated with either high-magnitude or low-magnitude reward during the training task. Consistent with prior results, RTs in the sham group increased when a reward-associated distractor was present at test, demonstrating a non-strategic residual influence of reward. Relative to the sham group, the occipital stimulation group showed a significant increase in this interference. The frontal stimulation group did not differ significantly from the sham group, demonstrating the spatial specificity of stimulation. Plasticity in early parietal and occipital cortex thus contributes to reward's impact on visual selection and this can be accentuated by tRNS.

## C14

### PRISM ADAPTATION SPEEDS MOVEMENT INITIATION IN THE DIRECTION OF THE AFTER EFFECT: IMPLICATIONS FOR PREMOTOR NEGLECT

Christopher Striemer[1,2,3], Carley Borza[1,2]; [1]MacEwan University, Edmonton, Alberta, [2]University of Alberta, [3]Glenrose Rehabilitation Hospital — Damage to the temporal-parietal cortex in the right hemisphere often leads to spatial neglect – a disorder in which patients are unable to attend to items on their contralesional (left) side. Neglect has been associated with both attentional and premotor deficits. That is, in addition to having difficulty with attending to the left side, patients are often slower to initiate leftward vs. rightward movements. Previous research has indicated that a brief period of adaptation to rightward shifting prisms can reduce symptoms of neglect by adjusting the patient's movements leftward, towards the neglected field. Although prism adaptation (PA) has been shown to reduce spatial attention deficits in patients with neglect, very little work has examined the effects of PA on premotor symptoms. To examine this in healthy individuals we used leftward shifting prisms to induce "neglect-like" behaviour by adjusting participant's movements rightward, similar to neglect patients prior to PA. Specifically, we examined the speed with which participants initiated leftward and rightward reaches (without visual feedback) prior to and following adaptation to either 17° leftward (n=15) or 17° rightward (n=15) shifting prisms. Our results indicated that, following PA, participants were faster to initiate reaches towards targets in the direction opposite the prism shift (i.e., faster reaches toward right targets following leftward PA and vice-versa). These results are consistent with the idea that PA has larger effects on tasks that require a directional motor response. In addition, these data indicate that PA may be useful for treating premotor symptoms of neglect.

# EMOTION & SOCIAL: Emotion-cognition interactions

## C15

### EFFECTS OF EMOTIONAL STATE ON PROCESSING CONCEPTUAL MISMATCHES IN A PICTURE-SENTENCE MATCHING TASK

Martine Verhees[1], Randi Goertz[1], Constance Vissers[2], Dorothee Chwilla[1]; [1]Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, The Netherlands, [2]Kentalis Academy, St. Michielsgestel, The Netherlands — It has been shown that emotional state affects language processing at the sentence and discourse level as reflected by modulations of N400 and P600. The aim of this study was to investigate whether emotional state also affects the processing of conceptual mismatches. Different emotional states (happy vs. sad) were induced via film clips. ERPs of 38 participants were recorded in a picture-sentence matching task. The pictures showed spatial arrays and were followed by a sentence that gave a description of the picture. Picture-sentence pairs provided a match ('☆O-The star stands in front of the circle.'), an intra-dimensional mismatch ('☆O-The star stands behind the circle.') or an extra-dimensional mismatch ('☆O-The star stands above the circle.'). The main results were as follows: The mood manipulation was effective. The ERPs were not modulated by emotional state, suggesting that the effect of mood does not generalize to the conceptual level. Nevertheless, in a previous study an early negativity and a P600 effect were found for both conceptual mismatches relative to the match condition (Vissers et al., 2008). In the present study a P600 effect was only present for the extra-dimensional mismatch condition. Given that the mood manipulation was the only difference between studies, we take the present results to indicate that being in an emotional state does influence conceptual language processing. In particular, we propose that people in an emotional state (be this positive or negative) only detect conceptual mismatches when they are salient.

## C16

### EVENT-RELATED POTENTIAL (ERP) CHANGES IN THE PROCESSING OF EMOTIONAL OBJECTS AND BACKGROUNDS

Katherine Mickley Steinmetz[1], Grace Longanecker[1], Jennifer Sellers[1]; [1]Wofford College — Emotional scenes are often more likely to be remembered than neutral scenes. However, this effect may be modulated by neural differences in the processing of positive as compared to negative objects, as well as foreground as opposed to background scene elements. In order to investigate these effects of valence and scene element, event-related potentials (ERPs) were measured during the processing of scenes that included either a positive, negative, or neutral object, placed on a neutral background. Later, participants were probed for memory of objects and backgrounds separately, allowing analyses both of the processing of scenes, as well as the memory for various scene components. Analyses revealed an effect of valence at frontal electrodes, and an effect of arousal at central electrodes. At 400-500ms for frontal recording sites, ERPs were more negative-going during the processing of positive as compared to negative and neutral scenes, while at central recording sites, ERPs were more negative-going during the processing of both positive and negative as compared to neutral scenes. In addition, at central electrodes during an early epoch (200-300ms), waveforms elicited by processing scenes in which the emotional scene component was later remembered, but the background was forgotten, were more negative-going as compared to instances where the entire scene was remembered. These results indicate that early prioritization of emotional information may influence the processing of different valences and the memory for different types of scene elements.

## C17

### DISTINCT NEURAL ACTIVATION PATTERNS DURING COGNITIVE CONTROL OF EMOTION IN EARLY PSYCHOSIS

Stefania Ashby[1], Laura Tully[1], Tyler Lesh[1], Cameron Carter[1], Tara Niendam[1]; [1]University of California, Davis — Dysfunctional activation in the cognitive control network for "cold" cognitive control deficits has been associated with more severe disorganization symptoms and functional impairment in psychosis; however the study of cognitive control of emotion in this population remains relatively unexplored. We examined differences in neural patterns of activation during an emotion reappraisal task in individuals with recent onset of psychosis. We hypothesized that individuals with early psychosis (EP) would show different patterns of activation within the fronto-limbic cognitive control of emotion network during reappraisal of negative emotional stimuli compared to healthy controls (HC). Ten HC and ten EP participants from the UC Davis Early Psychosis program completed emotion reappraisal of negative stimuli and self-ratings of negative emotional arousal during fMRI; a neural network of cognitive emotion regulation, comprising eight a priori regions of interest identified by Kohn et. al (2014), was selected for Multi-Voxel Pattern Analysis. Preliminary results show, across subjects, classification was successful for active reappraisal vs. active viewing of negative images (ACC=72.5%; p=.005) and active viewing of negative vs. active viewing of neutral images (ACC=80%; p=.001), demonstrating that active viewing and active reappraisal of negative stimuli differentially engage the cognitive control of emotion network. Classification was trending toward significance for HCs vs. EPs on active viewing (ACC=70%; p=.0510) but not on active reappraisal of negative images (ACC=35%; p=.8510), indicating that negative emotional stimuli activate this neural network differently for EPs, but that EPs may be able to successfully engage cognitive control of emotion following explicit reappraisal instruction.

## C18

### A HORSE OF MANY COLORS: EMOTION STROOP EFFECTS ARE ENHANCED BY THE PRESENCE OF COGNITIVE CONFLICT

Eric Lorentz[1], Marla Mickleborough[1], Layla Gould[1], Chelsea Ekstrand[1], Ron Borowsky[1]; [1]University of Saskatchewan — The literature on affective and cognitive tasks using fMRI points to a reciprocal relationship of activation in emotion and cognitive processing that may be mediated by connections between the ventral and dorsal anterior cingulate cortex (ACC; see Bush, Luu & Posner, 2000). We tested the link between emotion and cognition by employing both pure and mixed lists of emotion-related words (e.g., anxious, unhappy) or traditional Stroop words (e.g., blue, pink) in a colour-naming Stroop task, with pure lists of neutral words (e.g., dial, spin). Consistent with previous theories, emotion-related words and traditional Stroop words generated longer RTs than their neutral counterparts in pure-list form. In addition, mixed lists generated longer RTs and more interference for both emotion and traditional Stroop stimuli compared to pure lists. These results indicate that list-level conflict resolution takes place when both affective and traditional Stroop stimuli are present. Given recent reports of color-emotion Stroop effects (e.g., Sutton & Altarriba, 2008), we also investigated color-emotion associations in the emotion Stroop task. Contrary to earlier reports, however, we found evidence for congruent words taking longer for color naming than incongruent words. Our findings indicate that the emotion Stroop effect involves both affective and cognitive conflict. These behavioral findings also provide a control comparison for a patient with intractable depression undergoing fMRI assessment.

## C19

### IMPAIRED EARLY PROCESSING OF FEARFUL FACES IN HAZARDOUS DRINKERS: EVIDENCE FROM AN ERP STUDY

Yi Jin[1], John Shing-Yu Chan[1], Yuejia Luo[2]; [1]State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, [2]Institute of Affective and Social Neuroscience, Shenzhen University — It was reported that people with alcohol dependence have impaired neurocognitive processing which is often indexed by reduced amplitudes of P3 and early ERP components such as P1/N170. However, there were few studies investigating whether people with less severe drinking problems have the similar deficits. Thirty-five male hazardous drinkers (score□8 on the Alcohol Use Disorders Identification Test, AUDIT, mean age = 26.03±4.63) and 35 gender/age-matched controls (mean age = 24.12±3.77) were recruited in the present study. They were asked to memorize emotional (fearful/disgust/neutral) faces with two levels of memory load (1 face vs. 3 faces) in a working memory task during which event-related potentials were recorded. Results showed that while controls had larger P2 (150-200ms) amplitude to fearful faces, hazardous drinkers failed to show any P2 amplitude differences to 3 emotional faces in this early processing stage. In contrast to previous studies reporting P3 reduction in alcohol dependent participants, the current study did not show reduced P3 in hazardous drinkers. Our results indicate that people at risk developing alcohol dependence may have preserved capacity to

mobilize mental resources toward task relevant stimuli, but their automatic processing of threatening social signals may have been dampened, contributing to their early dysfunction in social life.

### C20

### FAMILIAR AND EMOTIONALLY INTENSE MUSIC ON AUTOBIOGRAPHICAL MEMORY, EEG, AND PAIN MODULATION

Christine R. Jimenez[1], Trevor C. J. Jackson[1], Mark W. Geisler[1]; [1]San Francisco State University

— Highly individual associations and memories from familiar music may be aiding duration to cold stimulus (Mitchell & MacDonald, 2012). In this experiment, participants selected ecologically familiar music, one song that was emotionally intense in happiness and another in sadness. Forty-five seconds directly prior to and during a cold-pressor task, participants listened to each song. EEG was collected at bands of interest that included alpha (8-13 Hz), theta (4-8 Hz), and beta (13-30 Hz), and was recorded from Fz, F3, F4, Cz, C3, C4, Pz, P3, and P4. Preliminary results suggest that experiencing music-evoked autobiographical memories while listening to sad music decreased time in the cold-pressor task. EEG measures showed that for negative music, frontal-midline theta power increased during the painful stimulus. This could indicate more attention to the music instead of memory. Also, experiencing music-evoked autobiographical memories while listening to happy music increased time in the cold-pressor task. EEG measures showed for positive music, frontal-midline theta power decreased during the painful stimulus. This could indicate more attention to the memory instead of music. Emotional music often affects autobiographical memory and may be operating through underlying psychological mechanisms that may be memory-related.

### C21

### AMYGDALA VOLUME MODULATES THE EFFECT OF CORTISOL ON MEMORY FOR POSITIVE STIMULI IN DEPRESSED WOMEN

Carlton P. Frost[1], Stacey M. Schaefer[1], Allison L. Jahn[2], Erin C. Walsh[1], Tory A. Eisenlohr-Moul[3], Richard J. Davidson[1], Heather C. Abercrombie[1]; [1]University of Wisconsin-Madison, [2]Clement J. Zablocki VA Medical Center, [3]Duke University

— It is well-established that the stress hormone cortisol alters memory formation in response to emotional stimuli and events. There is also evidence that cortisol function is dysregulated in depression. The current study sought to elucidate factors that modulate cortisol's effect on emotional memory formation using structural magnetic resonance imaging (MRI). In a repeated-measures design, 18 unmedicated depressed and 40 healthy individuals were administered fifteen mg oral hydrocortisone (i.e., cortisol) or placebo (order counterbalanced and double-blind) 1 hour prior to encoding of emotional and neutral words during MRI scans. Free recall for presented words was measured 4-6 days later, and volumes for subcortical structures were extracted from T1 images using Freesurfer. Among depressed women only, cortisol administration significantly decreased memory for words with positive valence relative to placebo ($p < .05$); however, greater bilateral amygdala volume strongly predicted increased cortisol-driven memory for positive words, ameliorating this effect ($p < .01$). In fact, among depressed women with larger amygdalae, cortisol has no effect on positive memory ($p = 0.85$). This finding suggests that, although cortisol and amygdala volume are both implicated in the pathogenesis of depression, a larger amygdala may actually protect positive memory formation from the effects of elevated cortisol.

## EMOTION & SOCIAL: Person perception

### C22

### TWO-PERSON HYPERCLASSIFICATION REVEALS SHARED NEURAL SIGNATURES FOR PHYSICAL AND VICARIOUS PAIN PERCEPTION.

Fanny Lachat[1], Dmitry Smirnov[1], Tomi Peltola[1], Juha Lahnakoski[1], Olli-Pekka Koistinen[1], Enrico Glerean[1], Aki Vehtari[1], Riitta Hari[2,3], Mikko Sams[1,4], Lauri Nummenmaa[1,2,3,4]; [1]Department of Biomedical Engineering and Computational Science (BECS), School of Science, Aalto University, Finland, [2]Brain Research Unit, O.V. Lounasmaa Laboratory, [3]Advanced Magnetic Imaging Centre, Aalto NeuroImaging, Aalto University, FI-0076 Espoo, Finland, [4]Turku PET Centre, FI-20520 Turku, Finland

— Seeing someone in pain may trigger both sensory and affective components of pain in the observer. But to which extent does the shared neural signature of physical and vicarious pain allow prediction of another person's somatovisceral state? We tested this in a pseudo-hyperscanning setup. First, one 'transmitter' subject received painful (needle pricks) and non-painful (makeup brush) stimuli to his right hand and foot during 3T fMRI (five 20-s blocks of 24 stimuli in each). The stimulations were videotaped, with closeups to the hand and foot, and shown subsequently to 12 'receiver' subjects during fMRI. Bayesian canonical correlation analysis was applied to model shared information between transmitter and receivers subjects, and the model was then used for functional realigning of the brains. Pattern classifier (Bayesian logistic regression) was trained on the transmitter's data and tested with the receivers' data in regions-of-interest derived from separate pain localizer scans in each individual. The transmitter's brain activity successfully predicted the receiver's brain activity (accuracy 54% vs. 25% chance level) in primary and secondary somatosensory cortices, anterior cingulate cortex and insula. Our hyperclassification results demonstrate that the brain activity associated with a person's physical pain allows predicting another person's (receiver's) vicarious pain, implying robustness of the shared brain circuitries.

### C23

### DECODING SOCIAL NETWORK POSITION FROM AUTOMATICALLY ELICITED PATTERNS OF BRAIN ACTIVITY

Carolyn Parkinson[1], Adam M. Kleinbaum[2], Thalia Wheatley[1]; [1]Dartmouth College, [2]Tuck School of Business at Dartmouth College

— How we perceive and interact with others is influenced by direct social ties, relationships between third parties (e.g., "friends-of-a-friend"), and topological characteristics of our social networks (e.g., cliques). Yet, little is known about how this information is processed in the brain, or how it impacts cognition and behavior. We sought to test what information about social network position is spontaneously encoded when encountering familiar individuals, and the brain systems involved, by combining social network analysis with multivariate pattern analysis of functional magnetic resonance imaging data. After reconstructing the social network of all students in a graduate program, a subset of these individuals participated in a neuroimaging study where they viewed several of their classmates' faces. Several characteristics of others' social network positions (e.g., social distance from the perceiver; eigenvector centrality–the extent to which an individual is well-connected to well-connected others; the extent to which an individual bridges structural holes in the network) were automatically encoded when seeing those individuals' faces, and this information was carried in largely distinct brain regions. For example, social distance could be decoded from activity patterns in a region of right inferior parietal cortex previously implicated in egocentric spatial and social distance encoding, and eigenvector centrality was represented in brain areas involved in perceptual/attentional and saliency processing, possibly indicating differential attentional capture for high vs. low centrality individuals. These results demonstrate that multiple aspects of social network position are automatically represented, and inform hypotheses about how this information impacts subsequent mental processing and behavior.

### C24

### MEETING ONE'S MATCH? STEREOTYPE CONGRUENCY INFLUENCES CORTICAL PROCESSING OF MARGINALIZED GROUPS

Sierra P. Niblett[1], Jordan M. Seliger[1], Adam Fogarty[1], Eric D. Splan[2], Avi Ben-Zeev[1], Mark W. Geisler[1]; [1]San Francisco State University, [2]University of Delaware

— Electrophysiological research has demonstrated that stereotypes exert an influence on face processing reflected in greater attentional allocation (larger N1 amplitudes) toward Black male faces paired with positive stereotypes (Dickter & Gyurovski, 2012). Gender stereotypes have elicited larger P3 amplitudes to occupation expectancy violations (Osterhout, Bersick, & McLaughlin, 1997). Notably, stereotypical associations for marginalized groups are often strong, such as the hostile Black man or the passive woman (Hilton & von Hippel, 1996). Herein, the aim of the current study was to examine cortical processing of marginalized group members in the presence of congruent/incongruent stereotypic information. During a categorization task, participants were randomly assigned to view Black and White male faces (race condition; n = 8 White participants) or White male and female faces (gender condition; n = 14, 11 females) while electroencephalography was recorded at midline electrode sites. Faces were preceded

by traits priming congruent stereotypes (e.g., "athletic" for Black males) or incongruent stereotypes (e.g., "assertive" for females). Preliminary findings revealed significantly larger N1 amplitudes (μV) for stereotype congruent Black male faces (M = -5.55, SE = .99) compared to stereotype incongruent Black male faces (M = -3.903, SE = 1.29). Additionally, a trend in larger P3 amplitudes (μV) was observed at Pz for incongruent female faces (M = 16.22, SE = 1.56) compared to congruent female faces (M = 13.98, SE = 1.72). Neither of these findings was present for White male faces. Our results suggest that stereotypes are more diagnostic for marginalized group members during face processing.

## C25

### MALE FACIAL STIMULI EVOKE GREATER N170 AMPLITUDES IN DIFFERENT CORTICAL REGIONS FOR EITHER FEMALE OR MALE PARTICIPANTS

William Krenzer[1,2], Kristina Pfeifer[2], Callan Lujan[2], Avi Ben-Zeev[2], Mark Geisler[2]; [1]DePaul University, [2]San Francisco State University — Ito and Urland (2005) state that social category cues, such as race and gender can be easily ascertained from faces. One of the most utilized ERP components for facial processing is the N170 (Eimer, 2000). Our previous investigation showed that regardless of participant gender, male facial stimuli evoke greater amplitudes in several ERP components, such as the N100, P200 and N200 (Krenzer et al., 2014). Differences in N170 amplitudes have been shown for in-group and out-group processing. One explanation for these differences is that individuals have more exposure to their in-group (Wiese, 2013). In the current study, we found increased N170 amplitudes to male facial stimuli. Male participants (n = 10) had increased N170 amplitudes at the T5 electrode site when viewing male facial stimuli ($t(9) = -2.071$, $p < 0.05$), suggesting that this region may be more responsive to in-group processing. In addition females (n = 17) had increased N170 amplitudes at the T6 electrode site when detecting male facial stimuli ($t(16) = -2.153$, $p < 0.05$), suggesting a shift in cortical activation for out-group processing. The T5 and T6 regions showed increased activity to male facial stimuli as it applied to the gender of the participant. This suggests that males and females may process male stimuli differently between hemispheres, further research is needed to elucidate this relationship.

## C26

### LINKING SOMATIC STATES AND SUBJECTIVE EXPERIENCE DURING THE PERCEPTION OF FACIAL AND VOCAL EXPRESSIONS OF EMOTION

Philip A. Kragel[1], Kevin S. LaBar[1]; [1]Duke University — Studies of emotion perception have linked a distributed set of brain regions to the recognition of emotion in facial, vocal, and body expressions. In particular, lesions to somatosensory cortex in the right hemisphere have been shown to impair recognition of facial and vocal emotional expressions. These findings suggest that somatosensory cortex may represent components of emotional states that occur when displaying such expressions, such as a furrowed brow or gaping jaw, yet evidence directly linking somatosensory activation and subjective experience during emotion perception is lacking. To address this issue, we conducted an fMRI study in which participants viewed facial and vocal expressions of emotion (fearful, angry, sad, surprised, happy, and neutral) and made on-line ratings of their own emotional state. Self-report data indicated that the expressions produced moderately distinct subjective experiences, which often mirrored the emotion conveyed in the stimuli. Multivariate classification of neural activation within a number of regions implicated in emotion recognition (i.e. posterior superior temporal sulcus, fusiform gyrus, postcentral gyrus in the right hemisphere, amygdala, inferior frontal operculum, insula, and medial orbitofrontal cortex) revealed that somatosensory cortex and insula predicted the emotional content of stimuli with highest levels of accuracy. Further, classification accuracy in somatosensory cortex was found to increase as subjects made more distinct experiential ratings. Together, these findings provide novel evidence linking somatic states and subjective experience during emotion perception, both supporting embodied accounts of emotion recognition and providing a potential mechanism for the spread of emotional states between individuals during social interactions.

## C27

### SEXUAL ORIENTATION IS ASSOCIATED WITH TEMPORAL DIFFERENCES IN NEURAL PROCESSING: AN ERP STUDY OF IN-GROUP BIAS

Maia T. Nguyen[1], Stephanie Bastidas[1], Robert Ross[1], Lucy J. Troup[1]; [1]Colorado State University — Social biases have been demonstrated in many domains, including race, age, and sexual orientation. Behavioral research addressing sexual orientation identification has shown that individuals perform better than chance at recognizing the sexual orientation of others. Time processing for sexual orientation congruent and incongruent stimuli, based on participant self-report, was examined. A Neuroscan EEG system fitted with a 64-electrode cap was used to examine event-related potential P1, N170, P300, and LPP components in a sexual orientation identification/discrimination task. Undergraduates and young adults completed questionnaires regarding their own sexual orientation and then reported their best judgment on the sexual orientation for images of self-identified homosexual and heterosexual individuals. Analyses compared homosexual and heterosexual participants' event-related potentials to heterosexual and homosexual faces. A greater vertex positive potential (VPP) was found for heterosexual individuals viewing heterosexual (in-group) stimuli compared to homosexual (out-group) stimuli. The N170 was reduced at P8 (right parietal site) for homosexual individuals viewing heterosexual faces. The late positive potential (LPP) was much smaller for heterosexual females viewing homosexual faces. These findings suggest greater amplitudes for congruent compared to incongruent stimuli based on sexual orientation for the VPP, N170, and LPP. However, incongruent faces elicited greater P300 amplitudes at P3 and P4. Results suggest that face processing differs as a function of own and other sexual orientation, providing a possible mechanism for group differences in sexual orientation identification previously found. These findings are consistent with in-group studies and support an expertise theory of face recognition.

## C28

### EMOTION PROCESSING DIFFERENCES IN CURRENT AND PAST USERS OF CANNABIS

Stephanie Bastidas[1], Maia T Nguyen[1], Jacob T Braunwalder[1], Jeremy Andrzejewski[1], Jason S Nomi[1], Lucy J Troup[1]; [1]Colorado State University — Cannabis abuse and addiction is associated with detrimental effects on cognition and behavior. Recent neuroimaging research suggests that casual users present morphological differences in brain areas associated with emotion processing; it is unclear whether these differences are reflected in cognitive, behavioral, and functional measures. We examined event-related brain potentials (ERPs) in current and past cannabis users and non-users during emotion processing. Electroencephalogram was recorded while participants viewed images of male and female faces depicting happy, angry, fearful, and neutral emotional expressions. Participants completed three tasks in which they identified the sex or the emotion for all faces, or empathized with the emotion depicted by each image (implicit, explicit, and empathic conditions, respecitvely). Current and past users presented differences in ERP components during emotion processing. Specifically, users presented with decreased ERPs overall, but especially in P1 amplitude over parietoccipital electrodes and to P3 amplitude over parietal and frontal medial sites. This P3 attenuation in current users was most noticeable during empathic processing, in which participants were instructed to empathize with the emotion depicted as they would for a close friend or relative. This data supports a relationship between cannabis use and changes of affective systems in the brain. Further study will assess a larger population of users that will allow us to examine in more detail the relationship between levels of use and altered emotion processing as measured by electrophysiological and behavioral measures.

## C29

### BRAIN AND PSYCHOLOGICAL MEDIATORS OF IMITATION: SOCIOCULTURAL VERSUS PHYSICAL TRAITS

Elizabeth Reynolds Losin[1,2], Choong-Wan Woo[1], Anjali Krishnan[1], Tor D. Wager[1], Marco Iacoboni[2], Mirella Dapretto[2]; [1]University of Colorado Boulder, [2]University of California, Los Angeles — The acquisition of cultural beliefs and practices is fundamental to human existence, but the psychological and neural mechanisms underlying cultural acquisition are not well understood. Here we sought to determine whether the physical or sociocultural characteristics of others

are more influential during imitative learning, a critical component of cultural acquisition. While undergoing fMRI, 17 European American young adults imitated models from three different racial groups performing novel hand gestures. Participants learned that half the models shared their political ideology and half did not, balanced across race. We found that the models' political ideology – a sociocultural characteristic devoid of any physical correlates – was sufficient to influence imitative accuracy, and that this effect was mediated by changes in feelings of similarity to the models. Furthermore, brain regions included in both the mentalizing network (e.g., dorsomedial prefrontal cortex) and those previously associated with imitation (e.g., inferior frontal gyrus, pars opercularis) mediated the relationship between the imitative models' political ideologies and imitation accuracy. Finally, comparing these results with a previous study without the political ideology manipulation, knowledge of the models' political ideology actually decreased the influence of race on feelings of similarity to the models, imitation accuracy, and neural activity during imitation. These findings strongly support the hypothesis that the sociocultural characteristics of the models, rather than their physical (e.g., racial) characteristics, most influence the psychological and neural mechanisms underlying imitative biases during cultural learning.

### C30

### VENTRAL MEDIAL PREFRONTAL CORTEX SUPPORTS A MULTIDIMENSIONAL CODE FOR SIMILARITY TO SELF

Mark Thornton[1], Jason Mitchell[1]; [1]Harvard University — One person can differ from another in an almost infinite variety of ways. However, people make holistic judgments of interpersonal similarity easily and naturally, and use similarity as a basis for how to interact with others. How do perceivers integrate the vast array of potential differences between self and other into a single representation of similarity? One way their brains might accomplish this is through a multidimensional code: within a single brain region, neural subpopulations would modulate activity in response to different dimensions of similarity. The pattern of activity across the region would thus represent overall similarity, despite the heterogeneous responses of its subpopulations. To test this hypothesis, in the present study participants underwent functional magnetic resonance imaging while they imagined personally familiar others in a number of scenarios. Using representational similarity analysis, we decoded the perceived similarity to self of these targets from patterns of neural activity within ventral medial prefrontal cortex (vMPFC). This result is highly consistent with earlier research implicating vMPFC in the representation of similarity, making social inferences, and integrating information. Moreover, we observed similarity-encoding patterns within a portion of vMPFC previously demonstrated to be involved in self-reference. The effect remains robust even when controlling for a wide range of other social variables. The presence of a multidimensional code was further supported by the absence of parallel univariate effects and the results of cross-validated factor analysis. These findings support the hypothesis that similarity is represented in a deeply multidimensional, rather than monolithic, way.

### C31

### IDIOSYNCRATIC BRAIN ACTIVATION PATTERNS WHILE VIEWING COMPLEX SOCIAL SITUATIONS ARE ASSOCIATED WITH POOR SOCIAL COMPREHENSION IN AUTISM

Lisa Byrge[1,3], Julien Dubois[2,3], J. Michael Tyszka[2], Ralph Adolphs[2], Daniel P. Kennedy[1]; [1]Indiana University, Bloomington, IN, [2]California Institute of Technology, Pasadena, CA, [3]these authors contributed equally — Prominent social deficits are at the core of the heterogeneous condition known as Autism Spectrum Disorder (ASD). Attempts to understand the neural bases of these deficits using conventional neuroimaging techniques have been largely restricted to presenting reduced-complexity, often static, stimuli and examining differences from neurotypicals at the group level. Here we used a technique that allowed us to present rich, semi-naturalistic stimuli and examine heterogeneity within the ASD group: measuring inter-subject synchronization of BOLD-fMRI responses (Hasson et al., 2004). Participants with ASD (N=17) and matched controls (N=20) watched an episode from the television sitcom "The Office" (NBC) in the MR scanner. Inter-subject correlations in the pattern of evoked activation were reduced within the ASD group (consistent with previous work; Hasson et al., 2009; Salmi et al., 2013), but this effect was driven by five ASD subjects with responses that were highly idiosyncratic relative to others and highly unreliable upon repeated viewings. Brain responses of the remaining ASD individuals were indistinguishable from those of controls using several machine learning approaches. Atypical brain responses in the five idiosyncratic ASD subjects were not explained by their neuropsychological profile or by acquisition artifacts (including motion); however, these subjects showed specific impairments in understanding the social motivations of characters in the video. Our findings highlight heterogeneity within the ASD "group" (Brock, 2011), demonstrate the importance of ecologically potent stimuli in identifying brain signatures of ASD, and establish the first link between abnormal brain responses evoked by such stimuli and a specific impairment in social comprehension.

## EXECUTIVE PROCESSES: Development & aging

### C32

### AGING OF EXECUTIVE FUNCTIONS IS ASSOCIATED WITH THICKNESS OF REGIONAL PREFRONTAL AND PARIETAL CORTEX

Elizabeth D. Reese[1], Kristen M. Kennedy[1], Asha K. Unni[1], Karen M. Rodrigue[1]; [1]University of Texas at Dallas — Executive functioning exhibits significant decline with increasing age across the lifespan. Previous investigations into the neuroanatomical correlates of executive functioning have been largely limited to measures of prefrontal cortex volume and revealed relatively modest age-related associations. In this study, we investigate the effects of age-related thinning in selected regional prefrontal and parietal cortices on executive function in a healthy lifespan sample (N=137, aged 20-93). Regional thickness was measured in prefrontal and parietal association cortex parcels and was averaged across hemisphere. Executive function measures from DKEFS Trails, Stroop, and verbal fluency and WCST assessments were submitted to principal components analysis and revealed two factors: verbal fluency and inhibition/task-switching. General linear models were conducted using executive function construct as dependent variable and age and regional cortical thickness as predictors. We found significant main effects of both age and regional thickness on verbal fluency selectively in the inferior frontal parsopercularis (Broca's area) and superior and inferior parietal lobules. For inhibition/task-switching, main effects of both age and cortical thickness were evident in a broad range of areas, including superior and middle frontal gyri, inferior frontal parsopercularis and parstriangularis, lateral and medial orbitofrontal, superior and inferior parietal, and precuneus. Thus, in a healthy lifespan sample, for both aspects of executive function (verbal fluency, inhibition/task-switching) greater thickness is predictive of better executive function performance beyond the aging effects. Whereas verbal fluency may be associated with select language-related frontal and parietal regions, inhibition/task switching appears to be dependent upon a wide network of frontal-parietal association cortices.

### C33

### MODULATION OF FUNCTIONAL ACTIVATION TO WORKING MEMORY LOAD ACROSS THE ADULT LIFESPAN: FINDING THE CRUNCH POINT

Kristen M. Kennedy[1], Asha K. Unni[1], David A. Hoagey[1], Karen M. Rodrigue[1]; [1]University of Texas at Dallas — Working memory (WM) performance decreases with age and as WM load increases, these deficits are magnified. fMRI studies in young adults suggest that brain activation increases with increasing WM load. It is unclear how the aging brain responds to this increased mental challenge. fMRI studies comparing older to younger adults suggest modulation to increased WM load decreases with age, however a lifespan approach would allow investigation of when in the lifespan and where in the brain these modulation differences occur. To examine this we scanned 140 adults across the lifespan (20-93) during a digit n-back task. We contrasted activation modulation from digits presented 2-back with those presented 4-back in a factorial ANOVA in SPM with age as a four-level categorical factor. Both age-related increases and decreases in modulation were examined in paired comparisons: Young vs Middle-age, Middle-age vs Old, Old vs Very Old. We found that in the transition from Young-Middle age, there was no decreased modulation, but increased modulation in bilateral occipital, parietal and fusiform cortices. Middle-Old transition revealed selective decreases in the left caudate and increased modulation in bilateral superior temporal, right superior and left middle frontal cortices. Old-Very Old transition showed decreased modulation in frontal and

parietal (precuneus, inferior parietal, middle and inferior frontal) cortices, with increased modulation selective to left caudate. The overall pattern of findings revealed modulation of activation to WM load increased progressively from Young-to-Middle-to-Old age, but then decreased sharply in the Very Old, consistent with a Compensation-Related Utilization of Neural Circuits Hypothesis (CRUNCH).

## C34

### HIGHER-ORDER COGNITIVE FUNCTIONS IN THE "VISUAL" CORTEX OF CONGENITALLY BLIND ADULTS

Marina Bedny[1], Connor Lane[1], Shipra Kanjilia[1]; [1]Johns Hopkins University — In adults distinct cortical networks support vision, language and working memory. How do intrinsic constraints and experience drive this specialization? According to one view, cortical areas are innately constrained to a single cognitive function. Some cases of cross-modal plasticity are consistent with this hypothesis. E.g. In blindness visual motion regions process auditory motion. Here we report plasticity that breaks from this pattern. Nineteen congenitally blind adults and seventeen sighted controls performed two tasks while undergoing fMRI. In Experiment 1 participants made same/different judgments for pairs of math equations and pairs of sentences. Math equations were more (double digit) or less (single digit) complex. In Experiment 2 participants heard sentences and answered true/false questions about them. Sentences were either more (contained syntactic movement) or less (no syntactic movement) complex. In a control condition, participants judged sequences of non-words. We found that in blind but not sighted individuals a subset of occipital areas responds 1) more to language than math, 2) more to language than sequences of non-words and 3) more to syntactically complex than syntactically simple sentences but 4) is insensitive to math complexity. By contrast, a distinct set of occipital areas responds 1) more to math equations than sentences and 2) to complexity of both equations and sentences. We conclude that in blind adults distinct occipital areas support linguistic and non-linguistic working-memory functions. These results suggest that "visual" cortical areas can support a wide range of cognitive functions, including language and working memory.

## C35

### INTRINSIC FUNCTIONAL CONNECTIVITY OF STRIATAL AND CORTICAL STRUCTURES IN MARIJUANA DEPENDENCE: A PROSPECTIVE STUDY OF ADOLESCENT ONSET COLLEGE-AGED USERS

Monica Luciana[1], Paul F. Collins[1], Jazmin Camchong[1], Mary P. Becker[1], Kelvin O. Lim[1]; [1]University of Minnesota — Background: Marijuana use (MJU) has accelerated among youth in the United States and is associated with cognitive deficits such as lower-than-expected IQs, memory problems, and executive dysfunction. Neuroimaging studies suggest deviations in cortical white matter microstructure. MJU before age 17 is associated with greater impairment. Most studies are cross-sectional case-control comparisons. Until recently, examinations of functional connectivity have been lacking. Methods: Self-reported daily marijuana users were prospectively assessed relative to demographically-matched controls (n=74) using a combined behavioral and neuroimaging protocol. Participants completed baseline assessments and were retested after two years. MJUs initiated use before age 17 and maintained heavy use over time. Resting state, diffusion tensor imaging (DTI), and volumetric scans were collected on a 3T Siemens Tim Trio scanner using standard procedures. Intrinsic functional connectivity was measured by placing seeds in cognitive control regions (e.g., cingulate cortex; dorsolateral PFC) as well as dorsal and ventral striatum. The neurobehavioral assessment included multiple executive function measures. Results: Despite above average IQs, MJUs show deficits in verbal learning, memory, working memory, and reward-related decision-making. DTI findings reveal several frontal regions where white matter microstructure is distinct in its development. These distinctions are most pronounced after 3-4 years of chronic MJU. Intrinsic functional connectivity analyses reveal group differences in connectivity between the ventral striatum and dorsolateral prefrontal cortex as well as between anterior cingulate and prefrontal regions. These findings are not attributable to alcohol use. Discussion: Findings will be discussed in terms of marijuana's effects on the developing brain and impacts of legalization.

## C36

### A NEURAL CORRELATE OF EXPLORATORY BEHAVIOR IN EARLY ADOLESCENCE

Andrew Kayser[1], Zdena Op de Macks[2], Ronald Dahl[2], Michael Frank[3]; [1]UC San Francisco, [2]UC Berkeley, [3]Brown University — The onset of adolescence is associated with in increase in the behavioral tendency to explore and seek novel experiences. However, this increase in exploratory behavior has rarely been quantified, and its neural correlates during the onset of adolescence remain unclear. Recently, work in adults has begun to characterize individual variability in exploration, and to associate greater exploratory tendencies with specific regions within the rostrolateral prefrontal cortex (rlPFC). Here we take advantage of a recently developed task to assess exploration, defined as the degree to which the relative uncertainty of rewards directs responding toward less well-evaluated choices, in a group of 62 girls examined near the onset of puberty (ages 11-13). Behaviorally, this task divided our subjects into groups of explorers (N = 41) and non-explorers (N = 21). Notably, the degree of exploration was uncorrelated with a measure of risk aversion. When seed regions of interest within the rlPFC were used to interrogate resting state data, we identified a lateralized connection between the rlPFC and posterior putamen/insula whose strength differentiated explorers from non-explorers. Based on Granger causality analyses, the preponderant direction of influence may proceed from posterior to anterior, rather than vice versa. Together these data provide initial evidence concerning the neural basis of exploratory tendencies emerging in early adolescence.

## C37

### EFFECT OF REMOTE TBI ON CORTICAL THICKNESS, NEUROCOGNITIVE AND PSYCHOSOCIAL FUNCTIONING: EVIDENCE FROM RETIRED SEMI-PROFESSIONAL AND PROFESSIONAL HOCKEY PLAYERS

Carrie Esopenko[1], Melissa Pangelinan[1], Aggie Bacopulos[1], Nicola de Souza[1], Nivethika Jeyakumar[1], Anthony R. McIntosh[1,2], Stephen Strother[1,2], Brian Levine[1,2]; [1]Rotman Research Institute, Baycrest Health Sciences, [2]University of Toronto — Traumatic brain injury (TBI) is associated with neurocognitive changes that can result in cognitive impairment, and can elevate the risk of developing dementia (Alzheimer's disease (AD) and chronic traumatic encephalopathy (CTE)), with even seemingly mild TBIs, or concussions, in sport being linked to accelerated cognitive impairments during aging. However, little is known about the relationship between remote mild TBI and age-related brain changes. Given that many professional athletes experience repetitive brain trauma during their athletic careers, these individuals provide an excellent model to assess the long-term effects these injuries have on brain aging. Twenty-seven retired semi-professional and professional male hockey players (e.g., National Hockey League Alumni) and nineteen age-matched comparison subjects were assessed using a comprehensive battery of neuropsychological, psychosocial, and computerized neurocognitive assessments, as well as high-resolution structural magnetic resonance imaging (sMRI). Within alumni athletes, higher TBI dose, a measure of TBI frequency and severity, was associated with greater self-reported impairments in psychosocial function. Moreover, alumni athletes demonstrated greater age-related decreases in performance on tasks assessing speeded processing, visuospatial abilities, and inhibitory control than did comparison subjects. Finally, we found greater diffuse age-related decreases in cortical thickness in the alumni than in comparison subjects, and that the relationship between cortical thickness and neurocognitive function was enhanced with age among the alumni relative to the comparison subjects. Together, these results suggest that sports-related TBI may accelerate the aging processes in the brain, which result in changes in behavioural function.

## C38

### FRONTAL GABA CONCENTRATIONS ARE RELATED TO GLOBAL COGNITIVE FUNCTION IN AN AGING POPULATION.

Eric C. Porges[1], Adam J. Woods[1], Richard A.E. Edden[2], Ashley D. Harris[2], Ronald Cohen[1]; [1]University of Florida, [2]Johns Hopkins University — Cerebral concentrations of γ-Aminobutyric acid (GABA), the principal inhibitory neurotransmitter in CNS, have been positively associated with performance in tasks requiring visual attention regulation and sensory discrimination. Cerebral concentrations of GABA, measured by magnetic resonance spectroscopy (MRS), and global

cognitive function have independently been demonstrated to decrease with aging. To date, the relationship between GABA concentrations measured with MRS and global cognitive function have not been reported. To explore this relationship, fifty-one older adult's [mean age (±SD) = 72.6±8.8, range = 52-92 years, mean education (±SD) = 15.9±2.7, range = 12-20 years] GABA concentrations in frontal and posterior midline cerebral regions were assessed with GABA–edited (MEGA-PRESS) 1H-MRS and quantified using GANNET software. These subjects were also assessed with the Montreal Cognitive Assessment (MOCA). Using a GLM approach, there was significant relationship between GABA and MOCA scores for both frontal and posterior voxels. When age was controlled for in the model, frontal GABA concentrations were positively related to MOCA scores ($p < .05$). The relationship between frontal GABA concentrations and global cognitive function, controlling for age, may inform biological mechanisms underlying cognitive dysfunction as well as provide potential portals for pharmacological remediation.

### C39

### AGE-RELATED DE-DIFFERENTIATION OF FUNCTIONAL BRAIN NETWORKS AT REST IS ASSOCIATED WITH THE INSTABILITY OF EXECUTIVE FUNCTION.

Timothy B. Weng[1], Chelsea N. Wong[2], Agnieszka Z. Burzynska[2], Laura Chaddock-Heyman[2], Gillian E. Cooke[2], Jim M. Monti[2], Edward McCauley[2], Arthur F. Kramer[2], Michelle W. Voss[1]; [1]The University of Iowa, [2]The University of Illinois at Urbana-Champaign

— The brain is organized into functionally differentiated networks that support either internally-oriented or externally-oriented cognitive processes. The differentiation between the two classes of networks may facilitate the performance of executive functions (EF). Previous findings indicate that even in a resting state, greater differentiation predicted better performance stability (i.e., intra-individual variability) during a later attention-demanding task in young adults. However, it is unknown whether this property of network organization applies to older individuals. We hypothesized that 1) aging would be associated with reduced differentiation between internally-oriented and externally-oriented networks at rest, and 2) age-related network de-differentiation would predict EF performance. We collected resting-state fMRI data from a sample of older (N=236, age=64.9 years) and younger individuals (N=48, age=21.9 years). We then extracted resting-state activity from the default-mode network (DMN), a primary internally-oriented network, along with several externally-oriented networks (executive control and dorsal attention networks). Next, we quantified the inter-network connectivity between pairs of networks as a measure of network differentiation and evaluated whether these indices predicted performance during an attention-demanding task. We found an age-related reduction of functional differentiation between the DMN and externally-oriented networks that predicted greater intra-individual variability in task performance. These results demonstrate that the stability of EF performance is positively related to the differentiation between internally and externally-oriented networks. Consistent with inhibition theories of cognitive aging, our results suggest that older adults may be less able to filter internally-oriented processes during tasks that demand externally-oriented attention, which may stem from age-related reductions in network differentiation at rest.

## EXECUTIVE PROCESSES: Monitoring & inhibitory control

### C40

### UNCERTAINTY MONITORING AS A MECHANISM FOR FLEXIBLE COGNITIVE CONTROL: NEW INSIGHTS FROM INDIVIDUAL DIFFERENCES

George A. Buzzell[1,2], Daniel M. Roberts[1,2], Logan R. Cummings[3], John R. Fedota[4], James C. Thompson[1,2], Raja Parasuraman[1,2], Craig G. McDonald[1,2]; [1]George Mason University, [2]Center of Excellence in Neuroergonomics, Technology, and Cognition, [3]University of Tampa, [4]National Institute on Drug Abuse

— Goal-directed behavior requires that individuals monitor their performance over time and flexibly adapt response strategies when necessary. For example, slowing down after errors is generally thought to reflect an increased allocation of top-down control over behavior to prevent future mistakes. We recently reported that uncertainty also serves as a signal for the performance monitoring system to instantiate cognitive control, as indexed by slowing on post-uncertain trials. Additionally, post-uncertainty slowing was accompanied by increased activation within the medial frontal cortex (MFC). Here, we replicate this finding and explore how individual differences in post-uncertainty slowing are correlated with activation of the performance monitoring and dorsal attention networks. fMRI was acquired while participants performed a difficult visual discrimination task and reported their certainty of stimulus identity on each trial. Analysis of correct trials confirmed our previous finding that participants respond slower following correct-unsure (relative to correct-sure) trials and that uncertainty is associated with increased activity within MFC, dorsolateral prefrontal cortex and insula. Whole-brain analysis further revealed that these same regions were correlated with individual differences in the magnitude of post-uncertainty slowing. Complimentary regions within the dorsal attention network were also correlated with the magnitude of post-uncertainty slowing. Together, these data provide additional support that uncertainty can serve as a signal to engage control, leading to increased attentional allocation.

### C41

### SOCIAL SIMON EFFECT: NO EVIDENCE OF ACTION CO-REPRESENTATION AT THE BRAIN LEVEL

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— While the Simon effect is typically obtained when single participants perform a choice reaction time task, an analogous effect—called the social simon effect or SSE—can emerge when performing a Go/Nogo task in co-action. Sebanz and collaborators proposed that action co-representation, one of the prevalent notion to account the SSE, brings about assimilating the coactor to one's own body. When co-acting, participants would behave as if they were choosing between alternative responses albeit such a choice is objectively unnecessary. Here, we question this account of the SSE through an electroencephalographic (EEG) study, assuming that the activation/inhibition pattern record over M1s and the N-40 can be taken as indices of motor processes and response decision, respectively. If action co-representation is a viable interpretation of the SSE, we reasoned, then the N-40 and the activation/inhibition pattern over M1s should be present when the Go/No-Go task is performed in co-action and should disappear when it is performed in isolation. Twenty eight participants performed: a joint Go/Nogo task and an individual Go/Nogo task. Participants were asked to respond according to the color of the stimulus whatever the location of the stimulus. The EEG signal, recorded for both participants, revealed no sign of response decision (N-40) or change in motor processes (activation/inhibition pattern), and so did not support the action representation account of the SSE. Our reaction time data suggested that the SSE can be assimilated to a basic social facilitation effect.

### C42

### BILINGUAL PROFICIENCY AND AGE OF ACQUISITION ARE INDEPENDENTLY RELATED TO NON-VERBAL COGNITIVE CONTROL: EVIDENCE FROM AN FMRI STUDY

Maya R. Greene[1], Aurora I. Ramos-Nuñez[1], Kelly A. Vaughn[1], Arturo E. Hernandez[1]; [1]University of Houston

— Many previous studies compare bilingual and monolingual cognitive control, however few of these take into account individual differences within the bilingual population. The current study sought to examine how individual differences in bilingual language proficiency and age of second language acquisition (AOA) are related to brain activity during a non-verbal cognitive control task. Spanish-English bilinguals (n=46) performed the Simon task while in an fMRI scanner. Participants had to respond to the color of circles, in neutral, congruent, and incongruent conditions. Multiple regression analyses of regions of interest were carried out on a priori selected brain areas. AOA and proficiency were found to be differentially related to brain activity in the incongruent condition only. AOA was positively correlated with activity in the left inferior parietal lobe (IPL). Language proficiency was negatively related to activity in the right anterior cingulate (ACC) and dorsolateral prefrontal (DLPFC) cortices. The results imply that these language variables are related to activity in cognitive control areas even in a non-verbal task. AOA seems to indicate training; greater experience with management of two languages (lower AOA) is related to less activation during the incongruent condition--a graded bilingual advantage. Language proficiency appears to indicate that greater language skill

is related to increased non-verbal cognitive control ability, suggesting a relationship between verbal and non-verbal processing. The results of this study highlight the need to address these individual differences that exist in the bilingual population even in examinations of non-verbal processing.

## C43

### THE NEURAL BASES OF INHIBITION-INDUCED FORGETTING

Yu-Chin Chiu[1], Tobias Egner[1]; [1]Duke University — Response inhibition is considered a core executive function, but its relation to other cognitive processes is not well-understood. We have recently shown that response inhibition impairs memory encoding, with no-go cues being remembered more poorly than go cues following a go/no-go task (Chiu & Egner, 2014, Psychol Sci). We hypothesized that this inhibition-induced forgetting effect arises from competition for a common attentional resource, whereby response inhibition saps attention away from stimulus encoding. Here, we used fMRI to examine two neural predictions of this hypothesis - (a) brain regions associated with response inhibition should exhibit greater activation (reflecting greater resource demands) during encoding of subsequently forgotten no-go cues than remembered ones, and (b) brain regions associated with memory encoding should display less activation (indicative of sapped resources) during encoding of subsequently forgotten no-go cues than remembered ones . Participants categorized face stimuli by gender in a go/no-go task and, following a short delay, performed a surprise recognition memory test for those faces. Replicating previous behavioral findings, recognition memory (d') was lower for no-go than for go stimuli. Crucially, the fMRI data showed that activity in "no-go areas" (compared to "go areas") was larger for forgotten than for remembered no-go stimuli. Moreover, activity in ventrolateral PFC predicted encoding success, but this region was less active in forgotten than in remembered no-go trials. This seesaw pattern of activity between response inhibition and memory encoding regions supports the hypothesis that response inhibition temporarily saps attentional resources away from memory encoding processes.

## C44

### CATCHING INHIBITORY PROCESSES DURING SPEECH PLANNING ON THE FLY

Rhonda McClain[1], Eleonora Rossi[1], Judith F. Kroll[1]; [1]Penn State University — When bilinguals prepare to speak, words from both languages compete for selection. Inhibition of the dominant language (L1) has been hypothesized to resolve cross-language competition. At the same time, the two languages interact seamlessly during code-switching, suggesting bilinguals recover from inhibition. Inhibitory processes during speech planning have been hypothesized to be the source of bilingual cognitive advantages. However, there is virtually no evidence that directly links inhibition in bilingual speech to cognitive advantages. Additionally, little is known about the developmental trajectory of these inhibitory processes. Second (L2) language speakers who are not yet proficient, may have a particular need to inhibit the more dominant L1. We examined these issues by using ERPs to catch inhibition on the fly. Monolinguals and L2 learners completed a Go/No-go task in which pictures were initially named and then later repeated as Go trials or No-go trials. L2 learners named pictures in L1 after L2. Monolinguals named in L1 only. We predicted that if learners inhibit L1 as a consequence of speaking L2, there should be costs for Go trials when they are required to name a picture in L1 that was previously named in L2. Monolinguals demonstrated increased negativity in the N200 window (200-300 ms) for No-go trials. L2 learners generated a different pattern, with increasing negativity starting in the N200 window and persisting throughout the epoch, for Go trials. The results suggest that when learners plan speech in the L2, there are immediate and long lasting effects for cognitive control in the L1.

## C45

### RELATIONSHIPS BETWEEN TRAIT AND SPONTANEOUS EMOTIONAL REGULATION STRATEGIES DURING STRESS AND ERROR-RELATED NEGATIVITY

Cierra M. Keith[1], David A.S. Kaufman[1], Tony W. Buchanan[1]; [1]Saint Louis University — The error-related negativity (ERN) is an event-related potential (ERP) thought to reflect error detection and conflict monitoring. Previous research has found that individuals with greater negative affect tend to exhibit greater ERN amplitude. The ERN can also be influenced by instructed emotion regulation strategies in response to stress. However, the relationship between spontaneous emotion regulation strategies and error processing is poorly understood. In this study, 32 healthy undergraduate males were randomly assigned to either perform the Trier Social Stress Task (TSST) or a placebo TSST, followed by spontaneous and trait level emotion regulation questionnaires, and a computerized Go-no go task during which ERPs were measured. Heart rate and cortisol were examined throughout the experiment, revealing significant physiological effects of the TSST. In the stress group, spontaneous emotional suppression was associated with enhanced ERN amplitude, while spontaneous emotional reappraisal was associated with reduced ERN. Greater endorsement of trait level emotional suppression was also associated with reduced cortisol response during the TSST. These results support prior findings that error processing is related to emotional regulation. Importantly, different stress-related spontaneous emotional regulation strategies had divergent associations with ERN amplitude. Spontaneous use of emotional suppression in the face of a stressor was associated with enhanced error detection. Spontaneous emotional reappraisal had an opposite relationship with ERN, but no associations with physiological stress. The general tendency to rely on emotional suppression was associated with reduced cortisol response to stress. These findings provide intriguing new evidence about the differences between spontaneous and trait level emotional regulation.

## C46

### NO EFFECT OF SELF-CONTROL EXERTION ON AMYGDALA REACTIVITY AND EMOTIONAL MEMORY

Matthias Luethi[1], Malte Friese[2], Clemens Schroeder[1], Noemi Ribaut[1], Peter Boesiger[3], Roger Luechinger[3], Björn Rasch[1,4]; [1]University of Zurich, Switzerland, [2]Saarland University, Germany, [3]Swiss Federal Institute of Technology Zurich, Switzerland, [4]University of Fribourg,Switzerland — Emotional events are better remembered than neutral ones, mainly through the involvement of limbic brain areas such as the amygdala. Emotional reactivity depends on self-regulatory processes, which can become impaired by repeated use of self-control. In one study, emotional reactivity in the amygdala was increased after a strenuous self-control task, indicating that increased emotional responses may be one consequence of exerting self-control (Wagner and Heatherton, 2012). Here, we sought to replicate this finding and tested whether this increase in emotional reactivity after exerting self-control leads to improved emotional memory. Participants did or did not exert self-control before viewing neutral and emotional pictures while brain activity was recorded with fMRI. In addition, participants rated their arousal and engaged in a memory task of the pictures viewed 24 hours later. We expected better recall after the exertion of self-control because increased emotional reactivity in the amygdala has been associated with better subsequent memory performance. Results revealed increased amygdala activity, higher arousal ratings and better recall performance in response to emotional as compared to neutral pictures, as expected. However, exerting self-control had no influence on any of these variables or on prefrontal functioning while viewing the pictures. This null finding occurred despite a strong self-control manipulation using established tasks and despite employing a set of emotional pictures that was successfully used repeatedly in previous memory research. We conclude that increased amygdala reactivity in response to emotional cues may not be a reliable consequence of self-control exertion.

## C47

### DOES SCRIPT SIMILARITY AFFECT EXECUTIVE FUNCTION?

Jack Darrow[1], Chirag Dalibar[1], Hunter Johnson[1], Kenneth Paap[1]; [1]San Francisco State University — Does Script Similarity Affect Executive Function? Different languages use different writing systems. Coderre and van Heuven (2014) hypothesized that similar scripts generate more cross-lexical competition requiring more inhibitory control and, consequently, an enhancement of general executive functioning (EF). Three of their nine comparisons showed significant advantages in global RT for the bilingual group having the greatest script similarity. In contrast, Bialystok, Craik, Grady, Chau, Ishii, Gunji, and Pantev (2005) and Linck, Hoshino, and Kroll (2008) each reported one comparison showing an advantage for different scripts over same scripts. We also investigated the effect of script similarity on EF using the composite database described in Paap, Johnson, and Sawi (2014). The English/other bilinguals were partitioned into three groups: 1) same-alphabet, n=107, 2) different alphabet/syllabary, n=25, and 3) logographic, n=28. There was also a control group of English speaking monolinguals, n=114. The participants completed a Simon task, a flanker task and a col-

or-shape switching task. Separate one-way ANOVAs were conducted on global RT and interference scores for both the Simon and flanker tasks and on mixing costs and switching costs. There were no significant differences among the bilingual groups on any of the measures. There were no significant differences between monolinguals and the three bilingual groups in either the flanker or switching task, but there was a significant monolingual advantage on the Simon interference effect. In summary, no evidence was found to support the hypothesis that script similarity affects general EF and no evidence for a bilingual advantage over monolinguals.

### C48

### NETWORK DYNAMICS OF COGNITIVE CONTROL

Derek M. Smith[1], Christine A. Godwin[1], Joshua K. Grooms[1,2], Shella D. Keilholz[1,2], Eric H. Schumacher[1]; [1]Georgia Institute of Technology, [2]Emory University — Both the connectivity between functional brain networks and prestimulus activity have been associated with enhanced performance on cognitive control tasks (Kelly et al., 2008; Weissman et al., 2006). Research has shown that the dynamics of the interaction between the default mode network (DMN) and the task positive network (TPN) is related to performance on an attention task (Thompson et al., 2013). Analysis of the connectivity dynamics demonstrated that faster reaction times were associated with greater anticorrelation between these networks before detected targets. To better understand the role of dynamic connectivity in control processing subjects completed the flanker and the global/local tasks during two functional magnetic resonance imaging sessions. Both tasks had long intertrial intervals (averaging 18.8 s & 18.2 s). Images were captured using a multiband sequence with a 700 millisecond repetition time. Thompson and colleagues' method was applied to the current data set. Changes in functional connectivity were charted by calculating network correlations for 12 second sliding time windows centered at each instance of the stimulus. It was predicted that faster performance especially for incongruent trials would be associated with more anticorrelation between the DMN and the TPN. Results support this prediction. These findings show that dynamic connectivity analysis has the potential to open a new dimension of control research.

### C49

### SOCIOECONOMIC STATUS ASSOCIATED WITH RECRUITMENT OF RESPONSE INHIBITION NETWORK DURING A GO/NO-GO TASK

Christopher N. Cascio[1], Gwendolyn M. Lawson[1], Martha J. Farah[1], Emily B. Falk[1]; [1]University of Pennsylvania — Socioeconomic status has long been linked to health and educational disparities, and recent research suggests that some of these disparities may arise as the result of SES effects on brain development. The current study aims to extend our knowledge of SES and brain function in young people by examining individual differences in the response inhibition network (basal ganglia and right inferior frontal gyrus). Seventy-one adolescent males between the ages of 16-17 were recruited from the State Driver Registry of recently licensed Michigan teens as part of a larger multi-study project examining adolescent driving behavior. Participants completed an fMRI go/no-go task as well as self-report measures of SES (parental education and ladder measures of subjective social status [SSS]). Although neither measure of SES predicted no-go inhibitory performance, SES effects were observed in brain activation on inhibitory trials. Parents' education significantly correlated with activity in the response inhibition network controlling for task performance, $t(64)=2.55$, $\beta=.30$, $p=.013$. The association between parents' education and response inhibition network activity was primarily driven by father's education, $t(61)=3.60$, $\beta=.42$, $p<.001$. SSS measures were not available for all subjects but for the 35 who filled out US and community ladders, community status was also predictive, $t(31)=2.51$, $\beta=.41$, $p=.018$. The current results demonstrate that holding performance constant, teens of lower SES, and defined by parental (particularly father's), education show less responsivity in the response inhibition network during a go/no-go task. Overall, these results reveal SES differences in neural inhibitory control even when behavioral performance is equivalent.

# LANGUAGE: Lexicon

### C50

### THE ROLE OF MORPHOLOGICAL PRODUCTIVITY IN THE NEUROCOGNITIVE PROCESSING OF DERIVED WORDS

Francesca Carota[1,2], Mirjana Bozic[1,2], William Marslen-Wilson[1,2]; [1]Neurolex, Department of Psychology, University of Cambridge, [2]MRC-CBU — A recurring question in the neurocognition of language is whether words (e.g. happiness) formed by existing stems (e.g. happy) and suffixes (e.g. -ness) rely on morpheme- or word-based representations. Cross-modal priming studies suggest that semantically transparent words, in which the meaning of the stem is preserved, are decompositionally analysed. Morphological decomposability has been proposed to correlate with productivity, i.e. the readiness of suffixes to form new words. However, cross-linguistic neuroimaging evidence showed that derived words activate bilateral fronto-temporal network underlying perceptual/semantic interpretation of whole-form words, rather than left perisylvian regions specialised for decomposable grammatical sequences. Yet, absence of competition effects between transparent forms and their stems suggests some preservation of their internal morphological structure. Here, we investigated how morphological productivity affects the neurocognitive representation of derived words in a synthetic language, Italian. In an fMRI experiment combining univariate and multivariate analyses, we covaried transparency/opacity of the stems with productivity of the suffixes. Univariate results showed that transparent and opaque words, whether productive or not, engaged the language system bilaterally. Using parametric modulator analyses we found that decreased suffix productivity elicited bilateral fronto-temporal activations. These effects were driven by non-decompositional opaque words. Multivariate results from Representational Similarity Analysis revealed that suffix productivity predicted single-word information patterns in LIFG and bilateral temporal regions. These effects were predominant in transparent words. These neurocognitive properties of derived forms reflect whole-word representations, but also a degree of decompositional processing of transparent words, with preserved marking of morphological structure for the derivational suffix.

### C51

### A LINEAR REGRESSION ERP INVESTIGATION OF WORD READING IN ARABIC: MORPHOLOGY FIRST, FORM AND SEMANTICS LATER

Sami Boudelaa[1], Hosny M. Al-Dali[1], Yury Shtyrov[2]; [1]United Arab Emirates University, Linguistics Department, [2]Center of Functionally Integrative Neuroscience, Institute for Clinical Medicine, Aarhus University, Denmark — The brain mechanisms underlying the simultaneous processing of different types of psycholinguistic information remain obscure; particularly lacking are investigations of such processes in non-Indo-European languages. Here, we used multichannel EEG to investigate the neurophysiological time course of lexical processes for a range of psycholinguistic variables in Arabic. Ten psycholinguistic variables of 200 Arabic nouns were submitted to a principal component analysis, which yielded three orthogonal components likely to have different spatio-temporal signatures. The first component loaded significantly on morphological variables, particularly the family size of the root and its token frequency. The second component loaded on form-related variables (e.g., word pattern frequency, orthographic neighbourhood), and the third one on semantic variables (e.g., transparent root family size i.e., the number of words featuring the same root and sharing a transparent semantic relationship). These components were combined with the variables Laterality (left, central, right) and Caudality (anterior, middle, posterior) and regressed against the neurophysiological responses recorded in a visual lexical decision task at two time windows where most prominent responses were observed: 200-300 ms, and 350-500 ms. The results indicate that while morphological variables had a significant effect at both time windows and lateralized to the left hemisphere, form-related variables and semantic variables showed significant effects only in the later time window and were bilaterally distributed. These results underline the primacy of morphology as a domain that governs lexical processing in Semitic languages and suggest that information about different domains of knowledge have different time courses and distinct underlying neural generator topographies.

## C52

### VISUAL AND LINGUISTIC INFLUENCES IN A NEW AMERICAN SIGN LANGUAGE (ASL) NAMING TEST

Svenna Pedersen[1], Cindy Farnady[1], Shane Blau[2], Ursula Bellugi[1], David Corina[2], Greg Hickok[3]; [1]The Salk Institute for Biological Studies, [2]University of California, Davis, [3]University of California, Irvine — The Boston naming test (BNT) (Kaplan, Goodglass & Weintraub, 1983) is a widely used neuropsychological assessment tool to measure confrontational word retrieval in individuals with aphasia. While the BNT has been used in patients who speak languages other than English, many of the items are not appropriate for use with deaf users of a signed language such as ASL. Here we report on an ASL naming test developed for probing naming functions in deaf signers with left and right hemisphere damage. The Salk Institute Naming Test (SNT) contains 40 line drawings graded in difficulty. We present normative data from 107 signers ranging in age (44-84 years) and data from five right-hemisphere damaged (RHD) signers and seven left-hemisphere damaged (LHD) signers. Performance of control subjects was highly accurate and stable across the age span (mean = 39 SD .44). Data from RHD subjects indicated normal performance from four subjects (mean = 39.5) however one subject showed impaired performance (30/40). Six of seven LHD subjects show no impairment on this measures (mean score = 40) with one subject showing impairment (27/40). The RHD patient with a middle cerebral artery stroke showed evidence of visual misperceptions of line drawings leading to erroneous naming responses (signed BRACELET for belt, GRAPEFRUIT for onion, TRUNK for tree etc.). In contrast the LHD signer with an ischemic stroke in the left putamen showed perseverative responses, anomia, lexical substitutions and off-target responses. We discuss these data in reference to cortical networks for visual and linguistic processing.

## C53

### EVENT-RELATED POTENTIAL (ERP) EFFECTS OF NEIGHBORHOOD DENSITY OF SPOKEN WORDS IN YOUNG AND OLDER ADULTS

Cynthia Hunter[1]; [1]State University of New York at Buffalo — Words that sound similar to many other words, or have high neighborhood density, are recognized more slowly and less accurately than words that sound similar to few other words, and this decrement in recognition for high-density words is more pronounced in older than young adults. The current project used event-related potentials (ERPs) as well as behavioral measures of response time and accuracy to examine density and age effects during recognition of spoken words and nonwords. Behavioral results showed equivalent density effects in the lexical decision task for young and older adults as well as main effects of age, with older adults responding more slowly and less accurately than young adults. ERP results for young adults showed an effect of neighborhood density on the N400, such that N400 amplitude was larger in high- than low-density conditions. Similar modulation of N400 amplitude by density has been reported for visual words and may reflect spreading activation to semantic representations of neighbors. Older adults had reduced N400 amplitudes compared to young adults and did not show an N400 density effect. Instead, older adults showed a late effect of neighborhood density, with greater positive amplitude for high- than low-density words between 800-1400 milliseconds after word onset. The functional significance of the late density effect is not clear, but could reflect compensatory processes involved in lexical access in older adults. Overall, the results are consistent with previous work and provide new insights into the time course of lexical access in both young and older adults.

## C54

### AN ERP INVESTIGATION OF CHINESE PHONOLOGICAL ACTIVATION DURING ENGLISH AND CHINESE WORD READING IN CHINESE-ENGLISH BILINGUALS

Yun Wen[1], Walter J. B. van Heuven[1], Ruth Filik[1]; [1]School of Psychology, The University of Nottingham, United Kingdom — Brain potentials have revealed that Chinese-English bilinguals automatically activate the sound of the corresponding Chinese translations when they read English words (Wu & Thierry, 2010). The phonological components of Chinese words consist of syllable segments (consonants and vowels) and lexical tone. It is, however, unclear whether the segmental (S) and/or tonal (T) information of the Chinese words becomes available when Chinese phonological information is activated. To investigate the time course of Chinese phonological activation during English and Chinese word reading, two ERP experiments were conducted with Chinese-English bilinguals reading English (N=32, Experiment 1) or Chinese (N=32, Experiment 2) word pairs. Experiments involved a semantic relatedness judgment task with word pairs in which the repetition of segmental (S) and tonal (T) information of the concealed Chinese translations (Experiment 1) or of the Chinese words (Experiment 2) was systematically manipulated in semantically and orthographically unrelated word pairs: +S+T e.g. media-rose [媒体–玫瑰 (mei2ti3-mei2gui4)]; +S-T e.g. tail–scarf [尾巴–围巾 (wei3ba1-wei2jin1)]; -S+T e.g. black-editor [黑色–编辑(hei1se4-bian1ji2)]; -S-T e.g. card-frog [卡片–青蛙(ka3pian4-qing1wa1)]. The data revealed that concealed +S+T repetition modulated ERPs between 400 and 600 ms (Experiment 1) and overt +S+T repetition (Experiment 2) modulated the ERPs between 300 to 350 ms in the right hemisphere. No repetition effects were found in the other conditions. These findings suggest that Chinese segmental and tonal information is activated during English and Chinese word reading.

## C55

### NEURAL CORRELATES OF VERB ARGUMENT STRUCTURE CHARACTERISTICS

Svetlana Malyutina[1], Dirk-Bart den Ouden[1]; [1]University of South Carolina — Verb argument structure (VAS) is pivotal to sentence construction, since it determines participant roles, as well as their grammatical form and syntactic position in a sentence. Neural correlates of VAS retrieval have mainly been studied in terms of the number of arguments, whereas data on other VAS characteristics and their respective impact on storage/retrieval vs. integration/structure-building load are limited. We used fMRI to investigate three understudied VAS characteristics: number of subcategorization frames, number of number-of-argument options and number of thematic options. Participants judged the well-formedness of sentences that differed on the above VAS characteristics of the verbs but had the same structure (e.g., The student completed the task; The actress sang a song). The number of subcategorization options was associated with increased activation in the left superior frontal gyrus and the temporo-parietal junction, extending to the middle temporal gyrus. The number of thematic options of the verb was associated with increased activation in the left cingulum and in white matter underlying pars orbitalis and triangularis of the left inferior frontal gyrus. No activation was specific to processing the number of number-of-argument options. The results indicate that several VAS characteristics, beyond the traditional measure of the number of arguments, are exhaustively accessed in verb processing even when not directly triggered by context. Specific areas of activation suggest that the number of subcategorization options and possibly the number of thematic options may be associated with greater storage/retrieval demands, rather than integration/structure-building demands.

## C56

### MORPHOLOGICAL PROCESSING OF ADULT DYSLEXICS: A STUDY OF VISUAL WORD RECOGNITION

Mailce Borges Mota[1,3], Janaina Weissheimer[2,4], Anna Belavina Kuerten[1,4], Angela Mafra de Moraes[1,4]; [1]Federal University of Santa Catarina - Brasil, [2]Federal University of Rio Grande do Norte - Brasil, [3]National Council for Scientific and Technological Development CNPq, [4]Coordination for the Improvement of Higher Education Personnel CAPES — The morphological processing of dyslexics is an issue of intense debate. The reason for this debate is that morphemes possess both form and meaning properties. While the form-driven hypothesis suggests that morphological processing is primarily based on form, the meaning-driven hypothesis proposes that semantic properties of morphemes are at stake. Here we address both hypotheses by investigating adult dyslexics, native speakers of Brazilian Portuguese, while processing written morphology. We address the question of whether adults diagnosed with dyslexia rely on morphemes during visual word recognition, and if so, whether this reliance is influenced by their semantic properties. Based on Quémart and Casalis (2013), we carried out a masked priming experiment in which participants performed a lexical decision task based on four conditions: morphological (e.g. livreiro – livro), pseudoderivation (e.g., vagão – vaga), orthographic control (e.g. corrida – cor) and semantic control (e.g., maçã – fruta). The participants were presented with words on a computer screen and were required to decide whether the words were real words in Brazilian Portuguese. Results showed that dyslexics relied on morphemes during visual word recognition, in line with the results in Quémart and Casalis (2013). Significant morphological priming effects, in the morphological condition

only, support the hypothesis that dyslexics are able to process larger units, i.e. morphemes, to decode words faster. These results are interpreted as evidence that dyslexics' morphological processing is more influenced by meaning than form, and that the mental lexicon of adult dyslexics is organized around morpheme units.

# LANGUAGE: Other

## C57

### ELECTROPHYSIOLOGY OF EXECUTIVE CONTROL IN SPOKEN NOUN-PHRASE PRODUCTION:DYNAMICS OF UPDATING, INHIBITING, AND SHIFTING

Katarzyna Sikora[1], Ardi Roelofs[1], Daan Hermans[1,2]; [1]Radboud University Nijmegen, [2]Royal Dutch Kentalis — Previous behavioral studies have provided evidence for an involvement of executive control in language production, but little is known about its electrophysiological basis. According to an influential proposal, executive control consists of updating, inhibiting, and shifting abilities. Previous studies showed that these abilities determine the response time (RT) of picture naming and description. In the present electroencephalography (EEG) study, we assessed noun-phrase production using picture description and a picture-word interference paradigm. We measured picture description RTs to assess length, distractor, and switch effects, which have been shown to reflect the updating, inhibiting, and shifting abilities, respectively. In addition, we measured event-related brain potentials (ERPs) to determine how length, distractor, and switch effects are reflected in ERP components, in particular the N200 and P300. Previous research has suggested that inhibiting and shifting are associated with modulations of anterior and posterior N200 subcomponents, respectively, and updating with modulations of the P300. Based on this, we expected that the distractor and switch effects would be reflected in the N200 subcomponents and the length effect in the P300. We obtained length, distractor, and switch effects in the picture description RTs, and an interaction between length and switch. Widely distributed across the scalp, there was a switch effect in the N200 followed by a length effect in the P300, whereas distractor did not yield any ERP modulation. Moreover, the effects of length and switch interacted in the posterior N200. These results provide electrophysiological evidence on the dynamics of executive control in noun-phrase production.

## C58

### IMPLICIT DETECTION OF POETIC HARMONY IN WELSH REVEALED BY ELECTROPHYSIOLOGY

Awel Vaughan-Evans[1], Robat Trefor[1], Llion Jones[1], Peredur Lynch[1], Manon Jones[1], Guillaume Thierry[1]; [1]Bangor University — T.S. Eliot famously argued that "genuine poetry can communicate before it is understood". Was this mere provocation or is it possible that some aspects of poetry may be processed implicitly by the human brain, independently of our ability to understand meaning? Here, we investigated electrophysiological brain responses elicited by the final word of sentences written in 'Cynghanedd', an ancient form of Welsh poetry constrained by subtle yet strict rules of alliteration and rhythm. Fluent Welsh speakers, who never received any formal education or training on Cynghanedd were presented with sentences ending in a word that either completed the sentence in conformity with the rules of Cynghanedd, violated its alliteration rule, violated its rhythmic structure, or violated both its alliteration and rhythmic requirements. Upon reading the last word of each sentence, participants indicated whether or not they considered the phrase to be well formed. Critically, participants were not given any explanation of the rules underlying Cynghanedd and, as expected, their accuracy was not significantly different from chance. Strikingly, however, event-related brain potentials elicited by correct completions displayed a classic P3a response of significantly greater amplitude than in all other conditions. This result demonstrates that fluent Welsh speakers implicitly accepted the orthodox Cynghanedd phrases to a greater extent than incorrect ones, despite having no explicit knowledge of the underlying rules. Our findings suggest that processing of poetry in the human brain is implicit and spontaneous.

## C59

### INVESTIGATING THE TIME COURSE OF LEXICALITY AND FREQUENCY EFFECTS IN SPANISH-ENGLISH BILINGUALS

Beerelim Corona Dzul[1], Walter van Heuven[1], Ruth Filik[1]; [1]University of Nottingham, United Kingdom — The BIA+ model (Dijkstra & van Heuven, 2002) assumes that the activation of second language codes is temporally delayed relative to first language codes in unbalanced bilinguals. Previous research has found these temporal delays in Event-Related Potentials (ERPs) components when manipulating lexicality (Proverbio, Adorni & Zani, 2009) and frequency (Liu & Perfetti, 2003). However, other studies have observed that frequency effects only occur in the target language and not in the non-target language (Rodriguez-Fornells et al., 2002). The present ERP experiment investigated the time course of word frequency and lexicality effects in Spanish-English late bilinguals (n=19) using dual-choice go/no-go tasks. Each of the tasks utilized high and low frequency Spanish and English words, pseudo-words, and letter strings. Participants were required to respond to words in the target language (which could be Spanish or English) and to withhold responses to non-target language items, pseudo-words, and letter strings. ERP results revealed a main effect of lexicality from 400-500ms that occurred earlier for Spanish than for English words in right central (30 ms) and centro-parietal (50 ms) brain regions. Behavioral data revealed a similar sized frequency effect in each language (Spanish: 92ms vs. English: 104ms, p=0.44), however, faster responses were observed for Spanish than for English words. ERPs revealed a frequency effect in target and non-target words in both languages, emerging between 400-600ms. In line with BIA+ model, these findings confirm delayed effects of lexicality and frequency in the second language irrespective of whether the second language is the target or non-target language.

## C60

### THE ROLE OF RIGHT TO LEFT HEMISPHERE CONNECTIVITY IN SENTENCE PROCESSING IN POST-STROKE APHASIA

Ronald Chu[1,2], Tali Bitan[2,3], Allen Braun[4], Jed Meltzer[1,2]; [1]University of Toronto, [2]Rotman Research Institute - Baycrest Centre, [3]University of Haifa, [4]National Institute on Deafness and Other Communication Disorders — Behavioral impairments in post-stroke aphasia are associated with disrupted connectivity within the language network. Studies have typically focused on the higher-level language areas like the inferior frontal gyrus (IFG) and the temporal parietal junction (TPJ). However, recent studies have shown that aphasia is also associated with modulations of connections to and from the primary auditory cortex (A1). A common hypothesis is that suppression from right to left homotopic brain regions is negatively associated with recovery from aphasia. The current study assessed effective connectivity of A1 connections in eight post-stroke aphasia patients during fMRI with a sentence-picture matching task. Specifically, we used DCM to assess effective connectivity between the IFG, A1 and TPJ across both hemispheres. Parameter estimates were computed using Bayesian Model Averaging (BMA) across 16 models. The results revealed excitatory reciprocal inter-hemispheric homotopic connectivity at the level of IFG and at the level of A1 for controls, but only at the level of TPJ in patients. Moreover, the connection RA1-LA1, which was excitatory in controls, was positively correlated with language performance in patients. In contrast two inter-hemispheric heterotopic connections were negatively correlated with language performance in patients: the feedback connection (LIFG-RA1) which was inhibitory in controls, and RA1-LTPJ, which was not significant in controls. Altogether these results do not support a model of homotopic right to left suppression in aphasia, but suggest an important role for inter-hemispheric connections with right A1 in both adaptive and non-adaptive language processing in aphasic patients.

## C61

### AN ERP STUDY OF INDIVIDUAL DIFFERENCES IN RESPONSE TO ORTHOGRAPHIC/PHONOLOGICAL CONFLICT

Suzanne Welcome[1]; [1]University of Missouri - St. Louis — In skilled readers, behavioral and electrophysiological measures have demonstrated that orthographic knowledge influences phonological decisions such that knowledge about a word's visual form intrudes upon decisions regarding its sound. While such effects are clear at a group level, it is less clear whether meaningful variation in this effect exists within the adult population. We used a visual rhyme task to investigate the interaction of orthographic and phonological information in

university students with varying reading skill. Word pairs that shared both orthography and phonology (e.g., throat/boat), differed in both orthography and phonology (e.g., snow/arm), shared only orthography (e.g., farm/warm), and shared only phonology (e.g., vote/boat) were visually presented. Behaviorally, phonological decoding skill was associated with the extent to which orthographic conflict impacted rhyme decisions such that individuals with worse nonword reading performance were more sensitive to orthographic conflict. When orthography and phonology did not conflict, ERP components did not significantly vary with reading skill. However, under conditions of orthographic conflict, relationships between reading skill and the size of early ERP components emerged. Specifically, individuals with lower phonological decoding scores showed more positive voltage differences between orthographically congruent and incongruent word pairs. These results suggest that university students with worse phonological decoding skill may differ from their peers either in the reading strategies they use or in the degree to which they automatically access word form information.

### C62

### ABSTRACT LETTER POSITION SENSITIVITY IN THE VWFA: REPRESENTATIONAL SIMILARITY ANALYSES IN EMEG SOURCE SPACE

Jana Klímová[1], Caroline M. Whiting[1,2], Samarth Varma[1,3], Barry Devereux[4], William D. Marslen-Wilson[1,2]; [1]Department of Psychology, University of Cambridge, UK, [2]MRC Cognition & Brain Sciences Unit, Cambridge, UK, [3]Donders Centre for Cognition, Radboud University Nijmegen, The Netherlands, [4]CSLB, Department of Psychology, University of Cambridge, UK — The early stages of reading engage basic visual object recognition processes in inferior occipitotemporal cortex, with the "visual word form area" (VWFA) thought to play a critical – though not fully understood – role in this process. Focusing on the VWFA, we investigate the spatio-temporal dynamics of the neural systems involved in mapping from visual input to orthographic representations, asking how visual (retinotopic) and more abstract orthographic properties relate over time to neurocomputational activity in the VWFA. Searchlight-based multivariate pattern analysis (Representational Similarity Analysis/RSA) was applied to combined magneto- and electroencephalography (EMEG) data, mapped into MNE source space. We analysed a set of visually-presented words to test: (a) visual models based on pixel-level overlap between word images and (b) orthographic models counting shared letters between words, contrasting position-specific with position-nonspecific models. A third set of letter-based models asked whether the VWFA is organized retinotopically (words aligned relative to a central fixation point) or whether it is sensitive to abstract letter position (left aligned). RSA delineated separate regions in the ventral processing stream, with left occipital cortex showing strong early fit to the visual model (70-180ms) and the 'retinotopic' letter model (50-130ms). The position-specific orthographic and the abstract letter position models (~160-400ms) activate left posterior fusiform gyrus including VWFA and pITG, extending into pMTG. The position-nonspecific model, in contrast, does not engage VWFA and adjacent areas. These results support the hypothesis that VWFA responses are independent of the visual field position but sensitive to abstract letter position in a word.

### C63

### LINKING GENES, BRAIN, AND BEHAVIOR IN A STUDY OF SECOND LANGUAGE LEARNING

Ping Mamiya[1], Todd Richard[1], Jeff Stevenson[1], Evan Eichler[1], Patricia Kuhl[1]; [1]University of Washington — Behavioral studies have shown that executive function (EF) skills are related to second language learning abilities in children. However, the brain and genetic mechanisms by which EF affects second language learning have not been studied. The goal of this study is to examine how the interactions between genes and the brain's fiber tract connectivity involved in EF can affect late adolescents experiencing English in an immersion program. Methods: We tested incoming Chinese students who entered an intensive 2-week English emersion experience prior to starting college. Fiber tract integrity was measured using non-invasive diffusion-tensor imaging technique. We identified the single nucleotide polymorphisms of the Catechol O-methyltransferase (COMT) gene and Serotonin transporter regulatory region (5HTTLPR) by using real-time polymerase chain reaction. Results: An individual's success at second language learning was significantly correlated with the integrity of the fiber tracks connecting Wernicke's area and prefrontal cortex areas important for EF. Moreover, our data indicate that this structure-function relationship differs significantly among individuals with different COMT and 5HTTLPR genotypes. Conclusions: Previous studies show that an individual's ability to learn a second language differs with age. The current study indicates that two other factors affect adolescent learners: (1) the structural integrity of fiber tracts related to EF, and (2) genetic variations related to EF. The interaction between these two factors is important. We believe this is the first evidence showing that the interaction between brain structure and genetic makeup can influence second language learning.

## LANGUAGE: Semantic

### C64

### STRATEGIC MECHANISMS OF PREDICTIVE LANGUAGE PROCESSING

Trevor Brothers[1], Matthew J. Traxler[1,2], Tamara Y. Swaab[1,2]; [1]UC Davis Department of Psychology, [2]UC Davis Center for Mind and Brain — While anticipation plays a critical role during online language comprehension, it is unclear to what extent this process is subject to top-down strategic control. In the current study, participants read two-sentence passages under different task instructions. In one block, participants read for comprehension, and in another participants were instructed to actively predict sentence-final words and report their accuracy on each trial. By comparing effects of sentence constraint across the two blocks, we assessed the influence of predictive strategies on online ERP measures of sentence processing. While both blocks showed an N400 effect of cloze probability at sentence final critical words, this effect was larger in the prediction block. A late frontal positivity, which has been linked to the costs of disconfirmed predictions, was also enhanced in amplitude. For words appearing earlier in the sentence, content words showed N400 facilitation in the prediction task, while function words instead showed an enhanced "ramp-like" negativity (400-700ms) at frontal electrode sites. Critically, the size of this frontal negativity was correlated with the degree of N400 facilitation observed later in the sentence at the final critical word ($r = 0.548$, $p < 0.01$). Based on these results, as well as previous work (Van Petten & Kutas, 1991), we argue that this neurophysiological response may index the generation of specific lexical predictions.

### C65

### CONCEPTUAL KNOWLEDGE ABOUT CONCRETE WORDS FORM A LARGE NETWORK IN THE BRAIN

Kaoutar Skiker[1], Mounir Maouene[2]; [1]University of Abdelmalek Essadi, Tangier, Morocco, [2]ENSAT, University of Abdelmalek Essadi, Tangier, Morocco — There is now strong evidence that concrete words denoting objects of various kinds (animal, tools, fruit/vegetables) evoke activation in perceptual and motor areas that are specialized to represent a particular kind of features (visual, auditory, gustatory, olfactory, action, tactile) (K. Patterson & al., 2007). For example, visual areas become active during the processing of animal words, motor areas become active during the processing of tool words and gustatory areas become active during the processing of food words. However, how these modality-specific areas work with each other in semantic tasks involving concrete words remain still unclear. In this study, we address this issue from a network perspective suggesting that modality-specific areas form a large network, where nodes correspond to brain areas and edges represent the functional and/or anatomical connectivity between them. This network, as indicated by neuroimaging studies, can be modulated by specific semantic tasks, with some areas increase their activity during some specific semantic tasks and decrease their activity in others (Binder & al., 2009). Furthermore, we hypothesize that this representation provides a powerful tool to explain the category specific activation extensively detected in functional MRI studies during the processing of concrete words. Finally, this representation can be helpful to account of some category-specific semantic deficits observed often in patients with semantic dementia and Alzheimer diseases (Grossman & al., 2013).

### C66

### PRONOUN RESOLUTION IS SENSITIVE TO THE COMPLEXITY OF THE ANTECEDENT: EVIDENCE FROM ERPS

Melissa Troyer[1], Philip Hofmeister[2], Marta Kutas[1]; [1]University of California, San Diego, [2]University of Essex — In behavioral paradigms, understanding displaced elements in relative clauses and resolving pronouns are contingent on an antecedent's

complexity. Here, we investigated electrophysiological differences in pronoun processing based on antecedent complexity, operationally defined as the number of adjectives modifying the antecedent noun. We used three-sentence discourses differing only in the number of adjectives (0-2; low-, mid-, and high-complexity conditions) modifying a critical noun in the first sentence. In the final sentence, a pronoun unambiguously referred to this antecedent, e.g.: "Outside the converted warehouse, a(n) (large and (intimidating)) BOUNCER prevented a couple from entering. They looked as if they had already had too much to drink. The couple cursed HIM as they went off in search of another bar." As expected, at the critical noun (BOUNCER), complexity was associated with N400 amplitude, indexing ease of semantic access: N400 amplitude was reduced for the high-complexity relative to the low-complexity condition, indicating facilitation for antecedent nouns preceded by multiple adjectives. Perhaps surprisingly, N400 amplitude likewise varied systematically at the pronoun in the third sentence with complexity of the antecedent: high-complexity antecedents were associated with reduced amplitudes in the N400 time window (300-500 ms) at centro-parietal sites compared to low-complexity antecedents, but only for pronouns in object position. Minimally, these results suggest the brain is sensitive to antecedent complexity when processing a subsequent pronoun. These effects emerged most clearly when the pronoun occurred in a syntactic position that likely made its occurrence more predictable and where subject-verb information may aid in the retrieval process.

## C67

### BUILDING A CORTICAL NETWORK OF SEMANTIC CONCEPTS IN A SECOND LANGUAGE: ERP EVIDENCE OF FAST LEARNING VIA COMPUTERIZED GAMES

Kiera O'Neil[1], Aurélie Lagarrigue[3], Aaron J. Newman[1], Cheryl Frenck-Mestre[2]; [1]NeuroCognitive Imaging Lab, Dalhousie University, [2]Centre National de la Recherche Scientifique, Aix-Marseille Université, [3]Brain and Language Research Institute, Aix-Marseille Université — What does it take to acquire a semantic network in a second language? The present ERP study shows extremely rapid instantiation of both learned words and related concepts, via computerized games ("LANGA"). Participants served as their own control. Electrical activity of the brain, recorded at the scalp, was examined prior to exposure to the second language and 8 days later, following a 6 day training session (preceded and followed by orientation and consolidation, respectively). Participants learned 12 words per day (nouns and verbs), for a total of 72 words over 6 consecutive days. Results show rapid changes in cortical activity, associated with learning. Prior to exposure, no modulation of the N400 component was found as a function of the correct match vs. mismatch of audio presentation of words and their associated images. Post training, a large N400 effect was found for mismatch trials compared to correctly matched audio-visual trials. More importantly, images that were semantically related to learned words (eg. for the learned word "horse" the image of a saddle was presented), produced a reduction of the N400 compared to mismatched pairs (eg. the same learned word "horse" paired with the image of a building). This semantic priming effect suggests that the words in the new language were rapidly integrated with existing semantic networks, rather than existing as an isolated second language lexicon. Our results attest to the plasticity of adult learners' brains and provide evidence for rapid onset of a semantic network in a late learned language.

## C68

### INDIVIDUAL SPATIO-COGNITIVE DIFFERENCES AND MENTAL SIMULATION OF LANGUAGE

Nikola Vukovic[1,2], John N. Williams[1]; [1]DTAL, University of Cambridge, Cambridge, UK, [2]Faculty of Psychology, Higher School of Economics, Moscow, Russia — Contrary to traditional theories, new research suggests that language meaning is 'embodied' and depends on mental simulation in sensory and motor brain systems. On this view, linguistic representations should ultimately end up being shaped by individual differences and experience. However, apart from assuming it, very little prior research has actually investigated the role that these differences have on perceptual simulation during sentence comprehension. For example, research on perspective taking in language has revealed many insights about simulation of visual features, but has largely focused on linguistic constraints, such as the role of pronouns in guiding perspective adoption. Here we describe a study where preferential usage of egocentric and allocentric reference frames in individuals (which we know is associated with behavioural changes, as well as structural brain changes) was assessed, following which the two participant groups were tested on a standard sentence-picture verification task. Across two experiments, we show that individual biases in spatial reference frame adoption observed in non-linguistic tasks influence visual simulation of perspective in language. Our findings suggest that typically reported grand-averaged effects may obscure important between-subject differences, and support proposals arguing for representational pluralism, where perceptual information is integrated dynamically in comprehension, and in a way that is sensitive to contextual and especially individual constraints.

## C69

### A NEUROSEMANTIC BEHAVIORAL FEATURE MODEL PREDICTS CONCEPTUAL REPRESENTATION IN THE BRAIN

Matthew E. Phillips[1], Jeff Phillips[2], Shannon M. Tubridy[3], Matthew R. Johnson[4], Svetlana V. Shinkareva[5], Rachel Millin[1], Todd Gureckis[3], Murray Grossman[2], Rajan Bhattacharyya[1]; [1]HRL Laboratories LLC, [2]University of Pennsylvania, [3]New York University, [4]Yale University, [5]University of South Carolina — Concepts are typically described within highly structured ontologies. At the same time, conceptual representations in the brain are organized within distributed and non-hierarchical networks. Although conceptually-evoked neural activity patterns can be classified in part by coarse features (e.g. ontological categories or sensorimotor activity), predictive models utilizing ontological and neural features as basis elements are lacking. Here, we report an fMRI experiment where participants (n=3) viewed single word concepts (e.g. "magazine") and neurosemantic features (e.g. has the quality of "visual appearance") presented in a block-design. Each block was organized around a central theme with presentations of 13-20 related words. At the end of each block participants were presented with two words and asked to indicate the more representative word. Words were selected from multiple sources: the highest rated words along each feature dimension from 619 words rated on Amazon Mechanical Turk, upper-ontology wordnet domains, the UMBC corpus, thesaurus synonyms, WordNet hypernyms, and other sources. Word-feature ratings were used in a weighted feature mixture model to predict conceptual representations. We found that the neurosemantic feature basis set outperformed other vector and statistics-based models of concept feature composition for predicting the neural activations of concepts in our set (Pearson's R = 0.133 p=0.02). In addition, the neural activity of single word concepts was better modeled by average ratings across people than by individual ratings (generated by the same participant). Furthermore, we found that neural activity patterns of features and concepts included heteromodal association areas previously associated with binding of distributed semantic feature representations.

## C70

### ENHANCED PUPILLARY RESPONSE TO UNEXPECTED WORDS IN SPEECH COMPREHENSION

Joseph Wachutka[1], Zane Zheng[2], Wesley Alford[1], Arthur Wingfield[1]; [1]Brandeis University, [2]Lasell College — How does the sentence "He mailed the letter without a stone" sound to you? You likely find the word 'stone' to be unexpected, as it does not fit your expectations for the sentence. Consequently, more cognitive effort may be required of you, as a listener, to decipher the intended message than if the sentence had unfolded as expected. In the present study, we sought to compare the levels of cognitive effort associated with word expectancy in a spoken sentence by measuring pupil sizes. Young adult participants (n = 17) listened to 63 sentences taken from high-expectancy sentence completion norms (Block and Baldwin, 2010). A random subset of these sentences had their final word changed to something unexpected prior to being played for participants. Participants' pupil size was recorded using an infrared camera, and the degree of pupil change following the expected or unexpected word was calculated. We observed that pupil dilation (% increase) in response to unexpected words (M = 5.13, SD = 2.68) was greater than that following highly expected words (M = 3.14, SD = 1.52); $t(16) = 2.92$, $p = .01$. The latency (in ms) to reach peak pupil size was also larger following unexpected words (M = 1225, SD = 371) than for expected words (M = 1001, SD = 244); $t(16) = 2.92$, $p = .01$. Therefore, our data suggests that pupillometry is able to reveal the enhanced level of cognitive processing required for unexpected words during speech comprehension.

### C71

### STRUCTURAL COMPLEXITY MODULATES "SEMANTIC P600" IN SENTENCE PROCESSING

Peiyun Zhou[1,2], Joseph Toscano[3], Susan Garnsey[1,2], Kiel Christianson[1,2]; [1]Unveristy of Illinois at Urbana-Champaign, [2]Beckman Institute for Advanced Science and Technology, [3]Villanova University — "Semantic P600" effects are observed in event-related brain potential (ERP) waveforms when a noun in a sentence is highly plausible for some role associated with the verb but not for the role it actually has in the sentence structure, leading to conflict between meaning-based and structure-based analyses. The ERP study reported here investigated meaning/structure conflict in sentences containing relative clauses. In English, subject relatives (SR: The parents that raised the twins...) are easier to understand than object relatives (OR: The twins that the parents raised…) Sentence versions were also included that reversed the roles of the two nouns (Rev-SR: The twins that raised the parents …; Rev-OR: The parents that the twins raised…), making the sentences globally implausible and similar to those producing semantic P600 responses. The goal was to investigate how differences in the difficulty of structural analysis would affect the development of conflict between meaning-based and structure-based analyses, as indexed by the semantic P600. The results showed a semantic P600 for the word making the sentence globally implausible only in the Rev-SR condition (the underlined second noun in the example above), not in the Rev-OR condition (the underlined verb in the example above). Thus, the conflict indexed by the semantic-P600 did not develop when structural analysis was more difficult. Instead, however, an Anterior Negativity in the implausible OR condition suggested that apparent implausibility may have led to uncertainty about the structural analysis and triggered a search in working memory to check on the order the nouns appeared in.

### C72

### COMPARING SEMANTIC REPRESENTATIONS OF ANIMALS AS INFERRED FROM BRAIN READING STUDIES VERSUS BEHAVIORAL STUDIES: THEMATIC AND TAXONOMIC ORGANIZATION

Andrew Bauer[1], Charles Kemp[1], Marcel Just[1]; [1]Carnegie Mellon University — The advent of neuroimaging and brain-reading techniques has enabled new approaches to the study of knowledge representations, based on multivoxel analysis of the brain activation patterns evoked by contemplation of concepts such as animal concepts. The present fMRI study characterized the content and organization of 30 animal concepts. A factor analysis of the multi-voxel activation patterns underlying the individual concepts indicated that the semantic building blocks of the brain's representations of the animals were ferocity, intelligence, and body size. These findings can be compared to behavioral studies of knowledge representation, which have typically collected pairwise similarity ratings between two concepts. The main semantic components inferred from the fMRI data generally resembled the semantic components inferred from the behavioral data from a prominent previous study of the same animal concepts (Henley, 1969). But despite the similarity in semantic content, hierarchical clustering analysis of the two datasets revealed differences in the semantic organization observed between the two paradigms. The behavioral similarity judgments indicated that the animals were organized into taxonomically defined groups (e.g. canine, feline, equine), consistent with other behavioral studies. By contrast, the neural representations of the animals were organized to a greater extent by thematic relations that cut across taxonomic groups (e.g. animal personality, body size, habitat). The difference in the results might derive from differences in cognitive processing during judging similarities versus contemplating one animal at a time. The results highlight the unique perspective afforded by neuroimaging, and suggest that knowledge is fundamentally more thematically organized than previously thought.

## LONG-TERM MEMORY: Episodic

### C73

### SPECIFIC MEMORY REACTIVATION PREVENTS RETROACTIVE INTERFERENCE AND GENERAL MEMORY REACTIVATION PROMOTES PROACTIVE INTERFERENCE

Joshua Koen[1], Michael Rugg[1]; [1]University of Texas at Dallas — Both proactive and retroactive interference can impair episodic memory. Here, we examined how memory reactivation during encoding influences these two forms of interference. During a scanned encoding phase, participants performed one of four tasks on each member of a word list. Interference words were presented twice, with a different encoding task at the first and second presentations, whereas Control words were presented once. Participants subsequently undertook a memory test where they recalled the tasks performed on each studied word. The behavioral results showed evidence for robust retroactive and proactive interference, such that memory for the encoding tasks was lower for Interference trials relative to Control trials. A logistic regression model was trained with the neural data to classify the four encoding tasks using Control trials, and was applied to the Interference trials to obtain a general memory reactivation measure. Specifically, we extracted the classifier evidence for the first encoding task during the second presentation of an Interference trial. Specific reactivation was measured by correlating the BOLD signal between the first and second presentation of an Interference trial, using the same voxel set as for the classifier-based analysis. A multilevel logistic regression model demonstrated that specific, but not general, reactivation positively predicted memory for the first task of an Interference trial. In contrast, memory for the second task of an Interference trial was negatively predicted by general, but not specific, memory reactivation. These results suggest that specific memory reactivation mitigates retroactive interference, whereas general reactivation increases the likelihood of proactive interference.

### C74

### MEMORY-AWARENESS DEFICITS IN AMNESTIC MILD COGNITIVE IMPAIRMENT

Anthony Ryals[1], Jonathan O'Neil[1], M.-Marsel Mesulam[1], Sandra Weintraub[1], Joel Voss[1]; [1]Northwestern University Feinberg School of Medicine — Self-awareness of memory is critical for allowing individuals to use knowledge of the current status of learning and memory to guide study decisions (i.e., memory monitoring and control). Brain regions crucial for memory awareness, such as frontopolar and medial temporal cortex, undergo pathophysiological changes early in Alzheimer's dementia. Indeed, some prior research suggests that disconnection between memory performance and self-awareness can occur in amnestic mild cognitive impairment (aMCI), which presages full Alzheimer's dementia. However, little is known regarding the specifics of memory awareness disruption in aMCI. We therefore assessed deficits of memory awareness using four types of judgments in both visual and verbal memory tasks in 14 patients with aMCI diagnoses and 15 age-matched healthy controls. Item-by-item memory awareness measures included prospective judgments of learning (JOLs), prospective "feeling of knowing" judgments (FOKs), and retrospective confidence judgments (RCJs). Global-level awareness was assessed using aggregate predictions and postdictions. Memory awareness accuracy was calculated as the correspondence between awareness judgments and objective memory performance. There were no significant group differences in JOL accuracy. FOK accuracy was significantly worse for patients than controls on the verbal task. RCJ estimates reliably discriminated patients from controls for both verbal and visual tasks. Further, global-level awareness was accurate for controls but not patients in the verbal task. We thus identified impairments of memory awareness in aMCI that were selective for judgment type and for material type. Implications for accounts of brain and memory impairments in aMCI and for sensitive test development for early aMCI will be discussed.

### C75

### THE ROLE OF THE HIPPOCAMPUS IN TEMPORAL INTEGRATION ACROSS BOUNDARIES

Sarah DuBrow[1], Brynn Sherman[1], Lila Davachi[1]; [1]New York University — Event boundaries have been shown to reduce memory for information presented across boundaries. Recent evidence suggests that the hippocampus is involved in bridging boundaries to link distinct events in memory. To address the necessity of the hippocampus in bridging events, we tested patients with hippocampal damage in two temporal estimation tasks. In the first task, participants made temporal distance judgments on pairs of images that were either studied within the same event or across an event boundary. Healthy participants (N=20) rated images presented across event boundaries as occurring farther apart than those presented within the same event. The second task assessed whether immediate temporal duration estimations varied as a function of perceptual changes. Critically, on half the trials, stimulus color was constant (single event), while on

the other half the color switched (boundary). Surprisingly, boundary trials were rated as significantly shorter than constant trials. Together, these data suggest that boundaries may have differential effects on memory depending on the interval length and the relational demands of the task. Importantly, to investigate the necessity of the hippocampus in temporal integration across boundaries, patients with damage to the medial temporal lobes performed the two tasks. Preliminary data (N = 8 right ATL, 3 left ATL and 2 bilateral) suggest that hippocampal damage is associated with reduced accuracy in temporal estimation. Medial temporal lobe volumetrics will be used to specify the relationship between the extent of hippocampal damage and temporal memory performance.

## C76

### ERRONEOUS RECONSTRUCTION OF PERCEPTUAL FRAGMENTS IN MEMORY IS CONTEXTUALLY-DEPENDENT

Manoj K. Doss[1], Tallinn E. Kiefer[1], David A. Gallo[1]; [1]University of Chicago — Recent research shows that presenting people with perceptually fragmented pictures can result in false recollections of intact object pictures that were not themselves seen (Doss, Bluestone, & Gallo, in prep). In the current experiment, we investigated whether manipulating background context modulates this effect in a time-dependent way. Inspired by hippocampal theory based on the binding of items in context (Diana, Yonelinas, & Ranganath, 2007), we manipulated context in a three-phase paradigm. During the study phase, participants viewed object labels and pictures overlaid onto scenes (target items), and they also viewed object labels without pictures (lure items, e.g., the word "lemon" on a beach). The misinformation phase aimed to distort participants' memories for which pictures they had actually seen. Fragments of perceptually similar exemplars to both targets and lures (e.g., orange, lime, and grapefruit) were overlaid onto either a congruent scene (e.g. beach) or an incongruent scene (e.g. forest). This phase took place either immediately after the study phase or 24 hours later, just prior to the cued recollection test. The test presented object labels as retrieval cues, and participants indicated whether they recollected seeing an intact object picture from the study phase. As predicted by hippocampal binding theory, we found that the presentation of perceptually similar fragments on congruent contexts selectively increased false recollection of nonstudied object pictures, compared to incongruent contexts. Moreover, this effect was only found when the misinformation was delivered on the first day, suggesting that perceptual recombination may be driven by hippocampal consolidation.

## C77

### NEURAL AND BEHAVIORAL MARKERS OF VALUATION ARE ASSOCIATED WITH ACTIVE-LEARNING BENEFITS.

Vishnu Murty[1], Sarah DuBrow[1], Lila Davachi[1]; [1]New York University — While much research has investigated the mnemonic benefits of active learning, relatively less research has investigated motivational and affective factors contribute to active learning. One such factor that differs between active and passive learning is an individuals' sense of agency, i.e. the ability to make choices and exert control over learning. Research has demonstrated that individuals value the opportunity to make choices, and perceived agency is associated with activation of the mesolimbic dopamine system. Given these literatures, we investigated whether behavioral and neural markers of valuation were associated with active-learning benefits. Participants encoded objects during a task that manipulated the opportunity to choose during the collection of fMRI data (n = 20). Participants were shown displays with two occluder screens that concealed to-be-encoded objects. Across conditions, we manipulated participants' opportunity to choose which occluder screen to reveal. Behaviorally, we found that memory was significantly greater for objects when individuals chose which screen to reveal ($p < 0.01$). To measure changes in valuation as a function of choice, participants rated how much they 'liked' occluder screens prior to and following encoding. Behaviorally, we found that change in valuation of occluder screens (post-pre ratings) significantly predicted the benefits of active learning ($p < 0.05$). FMRI connectivity analyses revealed that changes in intrinsic connectivity between the striatum and orbitofrontal cortex during the ratings task (i.e. functional coupling which is independent of task-related activation) predicted active-learning benefits. Together these findings suggest that active learning via choice may recruit valuation systems to promote better learning.

## C78

### THE INTERACTION BETWEEN EXPECTED REWARD AND EMOTION DURING ENCODING-RELATED BRAIN ACTIVITY

Yi-Jhong Han[1], Flávia Schechtman Belham[1], Leun J. Otten[1]; [1]University College London (UCL) — Brain activity before an event can predict whether the event will later be remembered. Such encoding-related activity has been demonstrated to be sensitive to two factors: anticipated reward and emotional valence of an upcoming event. In separate experiments, the prospect of a high monetary reward or unpleasant event elicited widespread, positive encoding-related activity in event-related potentials (ERPs). Here, we investigated how reward and emotion interact during memory encoding. Scalp-recorded electrical brain activity was acquired from healthy adults while they memorized unpleasant and neutral pictures. A cue presented 1.5 s before picture onset indicated the upcoming valence and amount of money that could be earned if the picture was remembered in a later recognition test. People were more likely to remember high than low reward pictures, and neutral than unpleasant pictures. Frontally-distributed ERP activity before and after picture onset predicted later confident recognition. Surprisingly, a negative modulation was observed before picture onset, which did not differ across conditions. In contrast, the usually-observed positive subsequent memory effect appeared after picture onset. For neutral pictures, this effect did not differ across reward value. For unpleasant pictures, a subsequent memory effect was found in the low, but not high, reward condition. These findings suggest that (i) reward and emotion only interact once a picture has been perceived, and (ii) the anticipatory processes observed here differ qualitatively from those seen when reward and emotion are studied in isolation. One possibility is that participants focus on the meaning of an upcoming picture in the current circumstances.

## C79

### DO OLD/NEW EFFECTS VARY WITH DIFFERENTIAL REACTION TIMES TO NEW AND OLD ITEMS IN MEMORY EXCLUSION TASKS?

Timm Rosburg[1], Mikael Johansson[2], Axel Mecklinger[1]; [1]Saarland University, Germany, [2]Lund Unversity, Sweden — In memory experiments, participants often are requested to response as fast and as accurately as possible. This might contribute to interindividual differences in response behavior that in turn might also affect functional correlates of episodic retrieval. In our study, data collected in three previous experiments using memory exclusion tasks were re-analyzed in order to investigate whether retrieval accuracy and old/new effects, as measured by event-related potentials, vary with differential reaction times (RTs) to correctly identified old items (target hits) and to correctly rejected new items. Across all experiments, the RTs to correct rejections were shorter than the RTs to hits. The sample was divided into participants with small and large mean differences between the two kinds of RTs, with test conditions and the response hands being balanced across the two subsamples. Behaviorally, participants with small RT differences identified significantly more targets than participants with large RT differences. This effect was, however, offset by an increased false alarm rate to nontargets. From 600 to 900 ms, old/new effects particularly over right-frontal and right-central electrodes were significantly diminished (or even reversed) in participants with large RT differences, as compared to participants with small RT differences. Similarly, from 1200 to 1500 ms, differential RTs affected the topography of old/new effects, with diminished right frontal old/new effects and increased late posterior negativities in participants with large RT differences. The findings indicate that differential RTs to new and old items in memory exclusion tasks need to be considered when interpreting the aforementioned old/new effects.

## C80

### EFFECTS OF SUBJECTIVE VIVIDNESS ON THE NEURAL CORRELATES OF MEMORY RETRIEVAL

Jaclyn Ford[1], John Morris[1], Elizabeth Kensinger[1]; [1]Boston College, MA — Successful memory for an image can be supported by retrieval of one's personal reaction to the image (i.e., internal vividness), as well as retrieval of the specific details of the image itself (i.e., external vividness). It is unclear whether these two measures of vividness rely on the same neural processes. The current study examined the neural recruitment and hippocampal connectivity associated with enhanced vividness during retrieval of emotional and neutral events. Participants (ages 18-85) encoded complex visual images paired with verbal titles. During a

scanned retrieval session, they were presented with the titles and asked whether each had been seen with an image during encoding. Following retrieval of each image, participants were asked to rate internal and external vividness. Controlling for age, increased hippocampal activity was associated with higher vividness ratings for both scales, supporting prior evidence implicating the hippocampus in retrieval of memory detail. However, different patterns of hippocampal connectivity related to enhancing external and internal vividness. External vividness was associated with greater increases in hippocampal connectivity with ventral visual regions than was internal vividness, while internal vividness was associated with increased connectivity between the hippocampus and medial and lateral prefrontal regions. Further, hippocampal connectivity with medial prefrontal regions was associated with increased ratings of internal vividness, but with decreased ratings of external vividness. These findings suggest that the hippocampus may contribute to increased internal and external vividness via distinct mechanisms and that external and internal vividness of memories should be considered as separable measures.

## C81

### CORTICAL REINSTATEMENT OF RECENT AND REMOTE SOURCE MEMORIES

J Tyler Boyd-Meredith[1], Anthony D Wagner[1,2], Melina R Uncapher[1]; [1]Department of Psychology, Stanford University, [2]Neurosciences Program, Stanford University — Remembering details associated with a retrieval cue is known to elicit reinstatement of patterns of cortical activity present during encoding, but it is unclear how this reactivation may change as a function of study-test delay. Here we tested the prediction that levels of cortical reinstatement would remain constant across delay for accurate source judgments. To investigate this question, we conducted a long-term, longitudinal study of source memory in which participants encoded word-image associations (i.e., a word paired with an object, face, or scene) at 8 months, 2 months, and 1 hour prior to a scanned memory test. At test, participants were cued with words in order to retrieve associated source information: all 120 old words from each delay were interspersed with 120 lures, and participants indicated either memory for the source (object, face, scene), memory for the word, or novelty. Behavioral analyses revealed that participants were most likely to make accurate source memory judgments for recently encoded words, and univariate analyses revealed that, contrary to our predictions, only recent source memories elicited significantly greater activity in medial temporal lobe (MTL) and ventral temporal cortex (VTC) when compared to item memories (accurate memory with no accompanying source judgment). However, a linear pattern classifier trained on an independent, category localizer in VTC revealed that source hits demonstrated levels of cortical reinstatement that did not vary across delay, suggesting that equivalent levels of source evidence are present during accurate source judgments, regardless of the age of the source memory.

## C82

### THE RELATIONSHIP BETWEEN SLEEP AND NEURAL AND BEHAVIORAL MARKERS OF MEMORY CONSOLIDATION

Emily Cowan[1], Anli Liu[2], Sanjeev Kothare[2], Orrin Devinsky[2], Lila Davachi[1]; [1]New York University, [2]NYU Langone School of Medicine — Memory consolidation is hypothesized to confer upon memory a resistance to forgetting that may be one consequence of those memories becoming more distributed throughout the cortex. Sleep has been linked with successful memory consolidation. In particular, features in the architecture of sleep have been demonstrated to be related to sleep-dependent memory enhancements (Gais & Born, 2004; Takashima et al., 2006). However, it remains unknown what aspects of sleep architecture are related to the distribution of memory traces and the effect this has on behavioral measures of forgetting. In a first behavioral experiment (N= 23), we asked subjects to encode sets of word-image pairs, with an intervening period of overnight sleep (Sleep List) or a brief wakeful period (Awake List), thus differing in the opportunity for potential consolidation. Cued source recall was probed both immediately after the second presentation and 24-hours later, providing a measure of forgetting. Behavioral analyses revealed that the information learned before sleep was better stabilized; subjects showed greater associative memory and less forgetting for the Sleep List stimuli than the Awake List. To investigate the relationship between that night's sleep, behavioral measures of forgetting and neural measures of brain connectivity, we collected overnight polysomnography, and scanned subjects with fMRI while encoding the word-image pairs for the second time (N=10). Further analyses will correlate specific oscillatory features of sleep with neural and behavioral markers of memory consolidation.

## C83

### THE HIPPOCAMPUS IS PREFERENTIALLY ASSOCIATED WITH SPATIAL MEMORY FOR ITEMS IN THE LEFT VISUAL FIELD

Brittany M. Jeye[1], Jessica M. Karanian[1], Scott D. Slotnick[1]; [1]Boston College — The hippocampus has long been known to play a role in processing spatial information. For instance, place cells in the rat hippocampus code for specific spatial locations (O'Keefe & Dostrovsky, 1971). Although the human hippocampus has been associated with memory for context, coding for different spatial locations has not, to our knowledge, been reported. In the present functional magnetic resonance imaging (fMRI) study, we evaluated whether the hippocampus was differentially associated with the memory for items presented in the left visual field or the right visual field. During encoding, participants maintained central fixation and viewed abstract shapes in the left or right visual field. During retrieval, the same shapes were presented at fixation and participants classified each shape as previously on the "left" or "right". Activity associated with accurate spatial memory for shapes in the left visual field was isolated by contrasting "left"/left > "right"/left (i.e., hits > misses), while activity associated with accurate spatial memory for shapes in the right visual field was isolated by contrasting "right"/right > "left"/right. Preliminary analysis revealed that accurate spatial memory for shapes in the left visual field produced activity in the hippocampus ($p < 0.001$, corrected for multiple comparisons to $p < 0.05$). However, accurate spatial memory for shapes in the right visual field did not produce activity in the hippocampus, even at a reduced threshold ($p < 0.01$, uncorrected). The present results suggest that the hippocampus may be preferentially associated with spatial memory for items in the left visual field.

## C84

### MEMORY FOR SONGS FOLLOWING UNILATERAL TEMPORAL LOBE EXCISION INCLUDING THE HIPPOCAMPUS

Irene Alonso[1,2,3,4], Virginie Lambrecq[2,3], Sophie Dupont[2,3], Séverine Samson[1,2]; [1]Laboratoire de Neurosciences Fonctionnelles et Pathologies (EA 4559), Université Lille-Nord de France, [2]Hôpital de la Pitié-Salpêtrière, Paris, [3]Centre de Recherche de l'Institut du Cerveau et de la Moelle Épinière (ICM), UPMC - UMR 7225 CNRS - UMRS 975 INSERM, Paris, [4]Department of Psychology, New York University — To remember a song, lyrics and melodies need to be bound into a unified mental representation. A vast number of studies have shown that memory-binding processes are related with hippocampal function. However, the role of the hippocampus in the binding of songs remained to be established. We conducted a neuropsychological study to investigate the effects of unilateral temporal lobe lesions including the hippocampus on binding lyrics with melodies in memory. Patients with right (RTL) or left (LTL) temporal lobe lesions were tested in a song recognition task, in which target songs had to be recognized among mismatch songs (wrong combination of old melodies and old lyrics), and new-lyrics songs (with old melodies). Given that both old lyrics and old melodies were presented in target and mismatch songs, this paradigm allows for the specific examination of binding by comparing recognition of these two types of songs. Our study confirms a deficit in memory for lyrics in LTL patients. Although RTL patients recognized lyrics better than LTL, they showed a deficit in lyrics recognition as compared to controls, suggesting an additional contribution of RTL when the text is sung. The main finding of this study is that binding recognition is similarly impaired following both LTL and RTL lesions. This is the first evidence supporting that bilateral hippocampus are necessary for song memory-binding process. Results are discussed in light of previous neuroimaging findings and theoretical contexts in favor of the specific contribution of the hippocampus in binding lyrics and melodies in songs.

## C85

### REMOTE SPATIAL MEMORY IN DEPRESSION

Dhawal Selarka[1,3], R. Shayna Rosenbaum[2,3], Brian Levine[1,3]; [1]University of Toronto, [2]York University, [3]Rotman Research Institute at Baycrest Hospital — Where verbal memory is recognized as having episodic and semantic components, spatial memory is also considered to have detailed (episodic-like) and schematic (semantic-like) components. When examining remote spatial memories (familiar

routes or environments), several studies have noted that the detailed component seems to be impaired in patients with hippocampal damage, while the schematic component remains relatively preserved. Spatial memory in depression, another group found to have compromised hippocampal function, has rarely been studied. The aim of this study was to examine remote spatial and episodic memory in depression using a novel internet paradigm that was composed of spatial and autobiographical memory measures. Items in the spatial memory measures incorporated a set of Toronto landmarks that were found to be familiar to participants in a previous study. Initial results suggest that the novel internet battery was both feasible and valid, indicating that the internet is a viable platform to test remote spatial and autobiographical memory. No differences between depressed and non-depressed participants were found on measures of schematic spatial memory, suggesting that this process is preserved in depression. There was evidence for altered processing of detailed spatial memory in depression. These preliminary results suggest that detailed, but not schematic spatial memory is disrupted in depression.

## C86

### DOES SPATIAL CONTEXT COME FIRST? EXAMINING THE TEMPORAL DYNAMICS OF AUTOBIOGRAPHICAL MEMORY

Melissa Hebscher[1,2], Brian Levine[1,2], Asaf Gilboa[1,2]; [1]Rotman Research Institute, Baycrest, [2]University of Toronto — Autobiographical memory (AM) unfolds over time, but little is known about the temporal dynamics of its retrieval. A small number of studies have identified early hippocampal activity during AM construction, and early hippocampal activity has been shown to reflect spatial context reinstatement during memory retrieval in virtual reality environments. Taken together, these findings suggest that spatial representations are reinstated early in the construction of AM, however no studies to date have examined this from a behavioural perspective. The present study aimed to examine the temporal dynamics of AM and the role spatial information plays in retrieval. Using a novel paradigm, we cued participants with personalized stimuli consisting of location and non-location cues, and assessed the time taken to recall a memory, the first thing that came to mind when recalling the event, and the vividness of the memory. We found that: (1) Location cued memories were recalled more quickly than non-location cued memories; (2) Participants were more likely to select a location as the first thing that came to mind when recalling events cued by non-locations; (3) The likelihood of selecting a location as the first thing that came to mind was associated with better self-reported trait memory functioning as measured by the survey of autobiographical memory (SAM). These findings demonstrate that spatial information plays an early and fundamental role in memory retrieval and recollection, and that the experience of remembering can be manipulated by using different cues.

## C87

### VULNERABILITY TO OBJECT INTERFERENCE IN EARLY MILD COGNITIVE IMPAIRMENT

Celia Fidalgo[1], Alana Changoor[1], Morgan Barense[1,2], Andy Lee[1,2]; [1]University of Toronto, Toronto, ON, Canada, [2]Rotman Research Institute, Baycrest, Toronto, ON, Canada — Persons with early mild cognitive impairment (MCI) show atrophy in medial temporal lobe (MTL) brain regions known to process objects, while scene processing regions are left relatively intact. The MTL is believed to protect visual memories by preventing irrelevant visual stimuli from intruding upon memory content. The current study examined whether older adults at-risk for MCI would show impaired recognition for objects compared to controls, and whether this would be exacerbated by visual interference consisting of distracting objects. Participants were classified as at-risk for MCI or healthy controls according to the Montreal Cognitive Assessment (MoCA, Nasreddine et al., 2005). Each trial began with the presentation of a study image of an object overlaid on a scene. Participants then viewed distracting images: a stream of five objects, scenes, or numbers. Finally, memory for the studied item was tested with a forced-choice recognition decision for either the study object (object recognition) or study scene (scene recognition). An analysis of variance revealed a significant group difference on object recognition, with post-hoc tests revealing that this was driven by the at-risk group performing significantly worse than controls on object recognition following object interference. Additionally, accuracy in this condition was significantly correlated with MoCA scores. By contrast, there were no group differences for scene recognition, nor were there effects of interference on scene recognition. The results support the view that MTL atrophy damages object representations, which leads to a vulnerability to visual interference that is especially detrimental to visual memory for objects.

## C88

### ALTERED RECOLLECTIVE EXPERIENCE OF EPISODIC MEMORY IN POSTPARTUM COGNITIVE DEFICIENCY

Yoonjin Nah[1], Na-Young Shin[2], Sehjung Yi[1], Soo-Young Park[1], Seung-Koo Lee[2], Sanghoon Han[1]; [1]Yonsei University, Seoul, Korea, [2]Yonsei University College of Medicine, Seoul, Korea — Several studies have suggested women's subjective cognitive deficiency after giving birth, so called 'momnesia', may result from hormonal change, stress, or depression. To investigate whether there are qualitative alterations in recognition memory, 26 females on 3rd month after parturition (Postpartum, PP) and 24 females who do not have any experience of pregnancy (Healthy controls, HC) were recruited for Remember-Know decisions. Behaviorally, there was an interaction between main effects of groups (PP, HC) and hit rates in response types (Remember, Know), showing PP responded to old items as 'Know' more often while 'Remember' less compared to HC. Contrasting Remember versus Know responses in each group for fMRI data revealed medial/lateral PFC, hippocampus, angular, parietal, and precuneus were significantly more activated in HC, while PP showed decreased activity within these regions; a direct comparison of two groups also confirmed the difference. Since hippocampus and precuneus play crucial roles in episodic memory, we selected these two regions as ROIs and conducted psycho-physiological interaction analysis to measure task-based functional connectivities. Group comparisons revealed DLPFC, VLPFC, and temporal gyrus showed relatively decreased connectivities with hippocampus in PP during recollection, whereas precueneus has attenuated connectivities with PFC (BA 10, 47). Resting-state intrinsic functional connectivity analysis with the same seeds similarly revealed these regions were functionally less connected with PFC (BA 11, 47), frontopolar (BA 10), middle frontal gyrus (BA 46), and temporal gyrus. These findings suggest diminished process of recollective memory in PP is reflected in neuronal level, especially in functional connectivities within core cognitive networks.

## C89

### THETA OSCILLATIONS TRACK THE CONTENT OF REPRESENTATIONS RETRIEVED FROM LONG TERM MEMORY

David W. Sutterer[1], David E. Anderson[1], John T. Serences[2], Edward K. Vogel[1], Edward Awh[1]; [1]University of Oregon, [2]University of California - San Diego — Recent work has demonstrated that it is possible to reconstruct orientation selective channel tuning functions (CTFs) during the encoding and delay period of a working memory (WM) task using a forward encoding model and electroencephalography (EEG). Specifically these CTFs can be derived from the distribution of alpha-band (8-12hz) activity across the scalp (Anderson et al. 2014), providing a high temporal resolution measure of the content and quality of WM representations. The goal of the present work was to determine whether we could employ a similar approach to track the content of representations retrieved from long term memory (LTM). Subjects (n = 24) learned randomly assigned colors for a collection of 120 unique shapes, with the color selected from a continuous 360 degree space. Twenty four hours after the initial learning session, subjects were presented with shape cues and asked to retrieve the associated color while EEG was recorded. We found that robust color-selective CTFs could be obtained from the distribution of evoked theta-band (4-7 hz) activity during the first 400 ms of the shape cue onset. Thus, while sustained activity in the alpha frequency band has been shown to track the active contents of visual WM, the content of representations retrieved from LTM is tracked by phasic activity in the theta-frequency band. These findings dovetail with the longstanding consensus that low frequency activity in the theta band is integral to LTM function, and they provide a powerful new method for measuring the temporal dynamics of LTM retrieval.

## C90

### SLEEP AFTER REACTIVATION PREDICTS EPISODIC MEMORY UPDATING

Natalie Bryant[1], Lynn Nadel[1], Richard R. Bootzin[1], Rebecca L. Gomez[1]; [1]The University of Arizona — Memory reconsolidation occurs when a previously-stabilized memory trace is reactivated, updated with novel experiences, and restabilized in its new form. While sleep has been inves-

tigated in memory consolidation in general, and procedural memory updating in particular, its role in episodic memory reconsolidation remains unknown. We hypothesized that sleep facilitates episodic memory updating. Twenty-five undergraduates tracked their sleep using actigraphy and self-report during a week of testing. At Session 1, participants learned 20 objects. At Session 2, they were reminded of Session 1 (reactivation) and learned 20 new objects. At Session 3, they were tested on their memory for the day each object was learned (Session 1 or 2). In prior studies, learners frequently attributed Session 2 items to their Session 1 memory (intrusions), demonstrating updating of a prior memory with later learning. Total sleep time (TST) significantly predicted number of these intrusions, $R2=.34$, $F(2,22)=5.75$, $p<.01$. Less sleep after Session 1 ($\beta=-.52$, $p<.05$) and more sleep after Session 2 ($\beta=.52$, $p<.05$) predicted the number of Session 2 objects attributed to Session 1. No relationships were found between TST and Session 1 items misattributed to Session 2. Our findings show that sleep facilitates reconsolidation of a prior memory after reactivation and new learning. Interestingly, memories not fully consolidated by sleep are more susceptible to reactivation and updating. Sleep's effect was specific to reconsolidation; sleep did not affect misattributions in the other direction. These results are an important first contribution to understanding how sleep contributes to episodic memory reconsolidation.

## C91

### PREPARATORY EVENT-RELATED POTENTIALS (ERPS) PREDICT EPISODIC RETRIEVAL ACCURACY.

Jane E. Herron[1], Edward L. Wilding[1], Lisa H. Evans[1]; [1]Cardiff University — ERPs recorded from frontal electrodes are more positive-going when participants are preparing to retrieve episodic information than when preparing to complete a baseline task with no episodic demand. This activity has been characterised as a correlate of retrieval mode, a tonically maintained mental state which ensures stimuli are processed primarily as cues for episodic retrieval. This preparatory neural activity has not yet been linked directly, however, with subsequent retrieval accuracy. It is important to do this in order to understand the functional role played by preparation in episodic memory retrieval. Here, participants were presented with words and were cued prior to each test word to prepare to complete an episodic memory task (retrieve left/right screen location of the word at study) or a perceptual task (top/middle/bottom screen location judgment). Each cue-type was presented for two consecutive trials, and averaged ERPs were formed both for the first (switch) and second (stay) trials. In keeping with common findings in the task-switching literature, participants responded more quickly on stay than on switch trials. ERPs associated with the episodic preparatory cue diverged from ERPs associated with the perceptual cue on switch trials only. This difference comprised a sustained positivity over frontal scalp for episodic cues, resembling closely previous results. ERPs elicited by the preparatory episodic cues were also reliably different on switch trials when separated according to the accuracy of the subsequent study location judgment, indicating, for the first time, that preparatory retrieval potentials predict the accuracy of episodic memory decisions.

## C92

### ASSOCIATIVE NOVELTY BINDING IN YOUNG AND OLDER ADULTS

Elise P. Gagnon[1], Donna J. Bridge, Joel L. Voss; [1]Northwestern University Feinberg School of Medicine — Episodic memories are constantly evolving to adapt to ever-changing contexts and circumstances. One mechanism important for memory modification is associative novelty binding (ANB), whereby existing memory representations are updated to incorporate new information. We have previously shown that the hippocampus is selectively involved in behavioral and eye-movement patterns associated with ANB. Here, we evaluated the effects of cognitive aging on ANB, with the hypothesis that age-related memory impairment could involve disruption of ANB. Young (n=16) and older (n=18) adults studied object-locations on context background scenes. Then, subjects completed a refresh task with new context backgrounds, in which they either actively recalled the object-locations or passively placed objects in predetermined locations. Finally, subjects completed recognition tests in which they attempted to choose each object's associated location among the original location, the updated refresh location, and a new lure location. ANB occurred to a similar extent in both age groups, such that subjects chose the updated location following active retrieval, and the original location following passive refresh. However, older adults demonstrated an overall impairment on the recognition test following passive refresh, in that the new lure location significantly interfered with memory of the original location. Interestingly, although behavior differed significantly across groups in the passive condition, eye movements showed similar memory effects. These results suggest preservation of ANB in aging, as well as disconnect between explicit memory judgments and eye-movement memory measures in older adults. These findings have implications for understanding memory and hippocampal impairment in healthy aging.

## C93

### THE EFFECT OF REWARD ON MEMORY SPECIFICITY

Malia Anderson[1], MaryJo Talley[1], Brock Kirwan[1]; [1]Brigham Young University — Recognition memory performance is often better when a reward is offered in exchange for good memory performance than when no reward is offered. However, it is unclear if reward per se modulates memory encoding or if reward acts indirectly on memory performance by increasing participant motivation to remember. In this study, participants were given a two-card selection task and informed that their memory would be tested for the objects depicted on the cards. In the immediate condition, participants were informed that they were being rewarded immediately for selecting a subset of stimuli. In the delayed condition, participants were informed that they would be rewarded for remembering a subset of the stimuli. Consistent with previous literature, we hypothesized that memory for subsequently rewarded stimuli would be better in the delayed condition. Further, we hypothesized that memory performance would be better for stimuli that were rewarded in the immediate condition, even though participants had no overt reason to differentially encode the rewarded items. We found that recognition (as measured by hit rates) was higher in the delayed condition for both rewarded and non-rewarded stimuli compared to the immediate condition. However, we found that memory specificity (as measured by correct rejection rates) was improved in the immediate condition relative to the delayed condition, particularly as target-foil similarity increased. These results indicate that reward may enhance memory specificity.

## C94

### EXPLORE TO LEARN – LEARN TO EXPLORE: INFLUENCES OF PASSIVELY OBSERVED EXPLORATION STRATEGIES ON SELF-GENERATED EXPLORATION AND LEARNING

Lakshmi Karuparthy[1], Jane X. Wang[1], Joel L. Voss[1]; [1]Northwestern University Feinberg School of Medicine — Optimal learning requires exploration for relevant information. Therefore, exploration strategies and learning are interdependent. We have previously shown that learning is enhanced when subjects utilize strategies that maximize information intake via prolonged exploration of specific information sources early during learning (Wang & Voss, Neuron 2014). However, it is unclear whether exposure to exploration strategies can bias the strategies subjects implement. In the current experiment, subjects (N=24) passively observed optimal or suboptimal strategies before being given the opportunity to generate their own exploration strategies in an active condition. Optimal strategies involved persistent sampling of information to maximize information intake early during learning, whereas suboptimal strategies involved random sampling of information. Learning was particularly influenced by the type of strategy observed first, with the greatest improvements in later memory for viewing the optimal strategy first. Importantly, this improvement was associated with adoption of the optimal learning strategy, whereby subjects who viewed this strategy first actively performed it when given control of exploration, relative to subjects who viewed the suboptimal strategy first. These findings suggest that subjects are sensitive to the initial presentation of exploration patterns during learning, and that simple observation of optimal strategies can provide templates for behavior that are subsequently followed when given control over the learning process, leading to improved learning. Relevance to theories of memory monitoring and control as well as to the development of effective instructional settings will also be discussed.

## C95

### MODIFYING THE QUALITY OF EPISODIC MEMORY VIA INTERFERENCE WITH RECONSOLIDATION

Liat Pell[1], Yadin Dudai[1]; [1]Weizmann Institute of Science, Israel — Reconsolidation refers to an amnesia-susceptible consolidation process that is initiated by cued reactivation of long-term memory. Modification of declarative memory through reconsolidation in

humans has been shown mainly by updating the previous retrieved knowledge with new information that is related to the older one. We investigated whether episodic memory could be modified via reconsolidation by new learning which does not involve apparent updating. Subjects studied and were tested on narrative movie clips, which 48h later were allocated to three conditions: cued-reactivation, cued-reactivation followed by learning new clips unrelated to the reactivated ones, or no reactivation. The final memory performance relative to the initial one was lower for clips that were not reactivated and for clips of which the reactivation was followed by new learning, compared with clips of which the reconsolidation was uninterrupted. Moreover, the new learning following cued-reactivation resulted in a qualitative impairment of memory, rendering it less detailed and preserving its gist. Thus, interference with reconsolidation by new learning can impair memory performance even if the new memorandum does not update the original one. Furthermore, the main effect of this kind of interference is decreasing the quality of memory in terms of richness and accuracy, even to a greater extent than the decay of memory without reactivation does. This effect may be interpreted in the context of the transformation that episodic memory traces undergo over time, from memories which are rich in details, to semantic, gist-only versions.

### C96

### MODULATION OF MEMORY PROCESSING BY ATTENTIONAL GOALS

Lynn Lohnas[1], Lila Davachi[1]; [1]New York University — Encoding and retrieval of episodic memories depend not only on the information being processed, but also on how that information relates to previously formed memories and task demands. In a continuous recognition paradigm, memory processing requires switching between encoding novel representations and retrieving prior representations. We examined the neural correlates of such switches in processing using a continuous recognition paradigm, while recording electrocorticography (ECoG) activity (n=5). Specifically, participants performed two versions of the paradigm in a blocked design. In the 'details' task, participants indicated whether they had seen this exact image before ('old'), whether they had seen a similar but not identical version of this image ('similar') or whether the item was entirely new ('new'). In the 'generalize' task, participants only distinguished between 'old' and 'new' items; a 'similar' item was considered 'old' inasmuch as it shared a majority of features with a previously presented item. We examined how attentional goals modulated episodic memory processing by comparing ECOG activity based on (1) bottom-up goals reflecting the stimulus type and the participant's response; (2) top-down goals that required distinguishing between the generalize task and the (more challenging) details task. In the details task, gamma power in the hippocampus and ventrolateral and dorsolateral prefrontal cortex was significantly greater during presentation of similar items than old items. In addition, gamma power in prefrontal cortex was significantly greater for similar than new items. Our results dissociate between the hippocampus and prefrontal cortex based on episodic memory processing demands.

### C97

### FUNCTIONAL SUBDIVISIONS OF THE HUMAN ENTORHINAL CORTEX

Anne Maass[1,2], David Berron[1,2], Laura Libby[3], Charan Ranganath[3,4], Emrah Düzel[1,2]; [1]Institute of Cognitive Neurology and Dementia Research, Otto-von-Guericke-University, Germany, [2]German Center for Neurodegenerative Diseases (DZNE), Site Magdeburg, Germany, [3]Department of Psychology, University of California at Davis, [4]Center for Neuroscience, University of California at Davis — The entorhinal cortex (EC) is a major gateway between the neocortex and the hippocampus. Evidence from studies in rodents suggests a functional distinction between the lateral and medial EC, based on differential connectivity with perirhinal (PRC) vs parahippocampal cortex (PHC) and differential connectivity with hippocampal subfields (i.e. subiculum and CA1) along the proximo-distal (transverse) axis. However, anatomical studies have not reported such a distinction in nonhuman primates, and virtually nothing is known about the connectivity structure of the human EC. If there are functional subdivisions of the human EC, available evidence suggests that the primary differences could lie along the anterior-posterior (longitudinal) axis. To identify functional subdivisions of the human EC, we used ultra-high field functional magnetic resonance imaging at 7 Tesla (with 0.8 mm isotropic resolution), and analyzed intrinsic functional connectivity within the EC. In two independent samples (N1 = 15, N2 = 14), we found stronger connectivity of PRC with anterior-lateral EC, whereas PHC showed higher connectivity with posterior-medial EC. Moreover, anterior-lateral and posterior-medial EC subregions showed preferential connectivity with proximal vs. distal subiculum, respectively. Our data provide the first evidence that the human EC can be divided into functional subdivisions along the anterior-posterior and lateral-medial axis whose patterns of functional connectivity closely parallel the known anatomical connectivity patterns of the lateral and medial EC in rodents. The present results have implications for neurobiological theories of memory and for understanding the clinical impact of localized EC damage in the early stages of neurodegenerative conditions such as Alzheimer's disease.

## NEUROANATOMY

### C98

### NEURAL COORDINATES OF FATIGUE IN MILD TRAUMATIC BRAIN INJURED WAR VETERANS

Kris Knutson[1], Michael Tierney[1], Jeffrey Lewis[1], Eric Wassermann[1]; [1]National Institute of Neurological Disorders and Stroke, National Institutes of Health, Bethesda, Maryland — Objectives: Fatigue is a debilitating condition affecting quality of life. It has frequently been conceptualized as comprising mental fatigue and physical fatigue. We wished to determine the brain regions whose volumes correlated with subjective measures of mental and physical fatigue following mild TBI in 24 recently deployed military service members. Methods: High-resolution MRI images were segmented, normalized, modulated, and smoothed (8x8x8) using SPM12. The resulting volumes, along with measures of mental and physical fatigue from the Multidimensional Fatigue Inventory (MFI; Smets, 1995), were analyzed. MFI mental fatigue is a measure of the inability to concentrate, while MFI physical fatigue is a measure of self-reported strength and conditioning. Age was included as a covariate of no interest. Results: Correlations were found between increased MFI mental fatigue and decreased normalized, modulated brain volume in left inferior frontal and right middle frontal regions. Physical fatigue was also correlated with a decrease in the right middle frontal region, along with clusters in the lingual and middle occipital gyri. Conclusions: Both mental and physical fatigue were associated with brain volume loss in mTBI veterans in right middle frontal regions. Cognitive fatigue scores, similar to mental fatigue, were previously shown to be associated with cortical thicknesses of superior, middle, and inferior frontal gyri in MS patients (Calabrese et al., 2010). The middle frontal region is considered part of an attentional network (Calabrese et al., 2010). Fatigue can cause significant distress and has detrimental impacts on daily functioning and overall well-being (Ouellet, 2006).

### C99

### SYNERGISTIC VOLUME CHANGES IN GREY AND WHITE MATTER NETWORKS ACROSS CHILDHOOD AND ADOLESCENCE

Signe Bray[1], Mark Krongold[1], Cassandra Cooper[1]; [1]University of Calgary — Magnetic resonance imaging (MRI) studies have shown that cortical development is non-linear, that different regions exhibit unique maturational trajectories, and that grey matter contraction across adolescence is accompanied by an increase in white matter volume. Across the adult population, properties of cortical grey matter co-vary within networks, which may also represent organizational units for development and degeneration. However, the relationship between network development of cortical grey matter and volume changes in white matter remains poorly characterized. To address this question we used T1-weighted MR images from 360 unique participants from the NIH MRI study of normal brain development, aged 4.8-18.5y. Images were processed through a voxel-based morphometry pipeline using a custom DARTEL template. Linear effects of age on grey and white matter volume were modeled within four age bins, each including 90 participants (45 male): 4-8y, 8-10.5y, 10.5-14y, 14-18.5y. Grey and white matter age-slope maps were separately divided into clusters using k-means, to identify regions with similar age-slopes across the four age-bins. This procedure identified posterior, fronto-insular, sensorimotor and cerebellar grey matter networks with corresponding white matter networks. While from ages > 8y white matter age-slopes were generally positive and grey matter generally negative, within adjacent grey and white matter networks age-slopes followed parallel trajectories. This suggests that grey matter contraction with age is accompanied by white matter volume expansion

within specific networks, and that white matter volume networks could be a target for studying patterns of atypical brain development in clinical populations.

# LONG-TERM MEMORY: Episodic

## C100

### THE RELATIONSHIP BETWEEN HIPPOCAMPAL VISCOELASTICITY AND RELATIONAL MEMORY PERFORMANCE IN HEALTHY YOUNG ADULTS: A MAGNETIC RESONANCE ELASTOGRAPHY STUDY

Hillary Schwarb[1], Curtis L. Johnson[1], Matthew D. J. McGarry[2], Neal J. Cohen[1]; [1]Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, [2]Thayer School of Engineering, Dartmouth College

— Investigation of the structure-function relationship between hippocampus and memory has a long and rich history, with multiple lines of evidence demonstrating the importance of hippocampal integrity in successful memory performance. The introduction of a novel neuroimaging technique – magnetic resonance elastography (MRE) – allows us, for the first time, to explore the mechanical properties of brain tissue as an index of brain health in vivo. Until recently, however, MRE methods lacked sufficient resolution necessary to accurately examine specific neuroanatomical structures in the brain, and thus precluded the ability to use this method to further explore structural relationships with function. In this study, we took advantage of developments in MRE spatial resolution to measure the stiffness and viscosity of the human hippocampus, and investigated how these properties contribute to hippocampal function. In this study, we acquired structural MRI and high-resolution MRE scans from twenty right-handed male (ages 18-33) participants. Participants also completed both standard neuropsychological assessments of memory as well as sensitive experimental measures of relational memory performance. Hippocampal volume did not correlate with either standard neuropsychological measures or experimental measures of relational memory. Relative hippocampal viscosity, however, showed a strong relationship with relational memory performance, but not with standard neuropsychological measures of memory. This study demonstrates, for the first time, that we can extract reliable measures of viscoelasticity in the hippocampus using MRE, and it shows that these measures of brain health are significantly associated with memory performance using sensitive behavioral tasks.

# NEUROANATOMY

## C101

### NEUROANATOMICAL CORRELATES OF PERFORMANCE IN STATE-WIDE TEST OF MATH ACHIEVEMENT

Eric D. Wilkey[1], Gavin R. Price[1], Laurie E. Cutting[1]; [1]Peabody College, Vanderbilt University, Nashville, Tennessee

— This study investigates the relation between gray matter density and mathematical ability as measured by a statewide test of math achievement in typically developing children. Previous research suggests that increased functional activation of parietal brain regions (e.g. Angular Gyrus, Intraparietal Sulcus) during numerical processing tasks is related to higher math competence. Despite mounting evidence regarding the functional relevance of these regions, relatively little is known about the relation between their structural architecture and math competence. Studies that have related structural brain features to numerical and mathematical competence have used either basic number processing or standardized math batteries as outcome variables. This study is the first to assess the relation between grey matter density and math achievement using a measure administered in school at the state-wide level. In a sample of 51 typically developing students (mean age = 11.3, grade = 5.8) we tested for differences in grey matter density according to performance on the end-of-year TCAP test (Tennessee Comprehensive Assessment Program). After controlling for age, global brain volume, and verbal IQ, results showed that those student who score "proficient" or "advanced" (n = 34) had increased grey matter density in the left Angular Gyrus and left Superior Frontal Gyrus compared to those student who scored "basic" or "below basic" (n = 17) ($p < .001$, uncorrected, minimum cluster extent 138 voxels). These results are the first to reveal differences in structural brain mechanisms associated with performance on a state-wide standardized math test that has significant implications for an individual's ongoing education.

## C102

### APPETITE MODULATES INSULA FUNCTIONAL CONNECTIVITY

Hazel Wright[1], Xiaoyun Li[1], Nicholas B. Fallon[1], Rebecca Crookall[1], Timo Giesbrecht[2], Anna Thomas[2], Jason C.G. Halford[1], Joanne Harrold[1], Andrej Stancak[1]; [1]University of Liverpool, [2]Unilever R&D

— Insula cortex activation is repeatedly observed in appetite studies. It contains receptor sites for peptides and hormones controlling energy balance, and encompasses multi-functional subregions which display differential anatomical and functional connectivities with the rest of the brain. Our study aimed to analyse the effect of fasting and satiation on the functional connectivity profiles of left and right anterior, middle, and posterior insula subregions. We hypothesised that the profiles would be altered alongside changes in homeostatic energy balance. 19 healthy participants with a normal body mass index underwent two 7-minute resting state fMRI scans, one when fasted and one when satiated. Functional connectivity between the left posterior insula and cerebellum / superior frontal gyrus was stronger during fasting, while functional connectivity between the right middle insula and default mode structures (left and right posterior parietal cortex, cingulate cortex) was stronger during satiation. Differences in blood glucose levels between the scans contributed to increased functional connectivity between the left posterior insula and superior frontal gyrus during fasting, and between right middle insula and cingulate cortex during satiation. Left posterior insula seems to form part of a circuit prompting eating when there is an acute deficit in the homeostatic energy balance, whilst right middle insula contributes to the default mode network during satiety.

## C103

### VIRTUAL DISSECTION OF A SUBCORTICAL PATHWAY BETWEEN THE SUPERIOR COLLICULUS AND AMYGDALA WITH DTI TRACTOGRAPHY: CONNECTIVITY STRENGTH CORRELATES WITH A BIAS TO ORIENT TOWARD THREAT

Kristin Koller[1], Robert Rafal[1]; [1]Bangor University

— DTI tractography has demonstrated connections between the superior colliculus (SC) and pulvinar, and between the pulvinar and amygdala (Tammietto, Pullens, De Gelder, Weiskrantz & Goebel, 2012) that could represent a putative subcortical pathway allowing fast and unconscious responses to threat. Here we used probabilistic tractography to virtually dissect an isolated streamline connecting the SC with the amygdala through the pulvinar, and show that the connectivity strength of this streamline correlates with a bias to orient toward threatening stimuli. In twelve healthy human adults, DTI tractography dissections were achieved with seed masks drawn in the amygdala, and waypoint masks drawn in the pulvinar and SC. In a temporal order saccade choice task, participants were presented pairs of pictures in left and right visual fields (one threatening and one pleasant) and were instructed to look at the stimulus that onset first across three stimulus onset asynchronies; 17ms between left-first/right-first stimulus onset, and simultaneous stimulus onset. Streamlines connecting the superior colliculus, pulvinar and lateral amygdala were successfully demonstrated bilaterally in all twelve participants. In the critical forced-choice simultaneous stimulus onset condition, an overall bias to saccade toward threat was observed. Finally, stronger pathway connectivity in the right hemisphere SC-pulvinar-amygdala streamline (indexed by fractional anisotropy) correlated with a stronger threat bias across individuals. This is the first direct evidence supporting the functional veracity of a subcortical threat-mediating pathway in healthy humans.

## C104

### PRELIMINARY ANALYSIS OF CONTRALESIONAL HIPPOCAMPAL VOLUME AS A PREDICTOR FOR SURVIVAL IN A SUBSET OF GLIOBLASTOMA MULTIFORME PATIENTS

C. Paula de los Angeles[1], Joshua Jacobs[1], Kristin Swanson[1], Lei Wang[1]; [1]Northwestern University Feinberg School of Medicine

— Background: Patients with glioblastoma multiforme (GBM) brain tumors provide a clinical population for studying the brain structural response to a lesion. GBM patients survive a median of 15 months with a small subset living longer than five years. However, little is known about what brain and tumor factors relate to survival length and function-

ing. This study assesses cognitive neural compensation by examining the contralesional hippocampus in GBM patients. Methods: Pre-treatment T1 with contrast images from 20 GBM patients with left-hemisphere tumor were analyzed. Contralesional (i.e., right) hippocampal volume was determined using Freesurfer-Initiated Large-Deformation Diffeomorphic Metric Mapping. Pre-treatment Karnofsky Performance Status (KPS) scores, a measure of patient functioning, as well as days of survival were correlated with hippocampal volumes. Statistical analyses were done in SPSS. Results: Volume of the right hippocampus was negatively correlated with days of survival (r=-0.63, p=.003, n=20), even after controlling for intracranial volume (p=.004). Pre-treatment KPS score negatively correlated with right hippocampal volume (r=-0.50, p=.030, n=18). Volume of the left hippocampus was negatively correlated with days of survival (r=-0.55, p=.012, n=20), even after controlling for intracranial volume (p=.015). Pre-treatment KPS score did not correlate with left hippocampus volume (r=-0.39, p=.11, n=18). Conclusion: This preliminary analysis shows that reduced contralesional, and to a lesser degree, ipsi-lesional, hippocampal volume was correlated with increased survivorship and functioning in patients with GBM. Inclusion of GBM tumor size and growth rate characteristics would be an important next step in understanding the factors affecting plasticity in unaffected brain regions in GBM patients.

### C105

**AN ANALYSIS OF TEMPORAL LOBE PROJECTION FIBERS IN TRAUMATIC BRAIN INJURY** Vatche G. Baboyan[1], Emily L. Dennis[1], Yan Jin[1], Liang Zhan[1], Talin Babikian[2], Christopher C. Giza[3], Robert Asarnow[4], Paul M. Thompson[1]; [1]Imaging Genetics Center, Institute for Neuroimaging and Informatics, USC Keck School of Medicine, Los Angeles, [2]Department of Psychiatry and Biobehavioral Sciences, Semel Institute for Neuroscience and Human Behavior, UCLA, [3]UCLA Brain Injury Research Center, ChildrenDept of Neurosurgery and Division of Pediatric Neurology, Mattel's Hospital, Los Angeles, [4]Department of Psychiatry and Biobehavioral Sciences, Semel Institute for Neuroscience and Human Behavior, UCLA, Los Angeles, CA, USA — Temporal lobe white-matter fibers are vulnerable to damage following traumatic brain injury (TBI). In the present study, we analyzed neuropsychological and diffusion weighted (HARDI sequence, 65-directions) data for 35 post-acute TBI participants (26 males, avg age=13.94±2.9) and 31 controls (20 males, avg age=15.18±3). Multi-atlas based fiber clustering was performed on whole-brain tractography data to extract major temporal projection fibers, a method recently developed by our lab. We examined the Uncinate Fasciculus (UF), Inferior Fronto-Occipital Fasciculus (IFOF), Inferior Longitudinal Fasciculus (ILF), and Cingulum Fibers (CF), bilaterally. Only the left Arcuate fasciculus (L-ArcF) was included. We performed between-group comparisons examining tract-wise fractional anisotropy (FA) measures (aim 1) as well as overall relationships between cognitive function and white matter structure (aim 2). To facilitate regression analyses between neuropsychological scores and microstructural properties (FA), 4 primary cognitive domains were extracted from the data: Language, Processing Speed, Executive Functioning, and Verbal Memory. Element-wise linear regression was used to test for group differences in tract-wise FA (aim 1) and for testing the relationship between tract structure and cognitive function (aim 2), while covarying for age and gender in both analyses. Significant ($p<0.001$, FDR corrected) group differences in mean FA were found in the IFOF, ILF, and UF exclusively in the left hemisphere. The right hemisphere UF was the only contralateral tract showing between-group differences. Only the Left UF showed significant associations with both Executive Functioning and Memory Scores ($p<0.001$, corrected). Together, this data implicates the involvement of temporal lobe projections in TBI and its neuropsychological sequelae.

# PERCEPTION & ACTION: Audition

### C106

**GRAPH THEORY AND BEHAVIORAL STUDIES ON AUDITORY INTEGRATION** Mary Kathryn Abel[1,2], Hui Charles Li[2,3], Gottfried Schlaug[2,3], Psyche Loui[4]; [1]Harvard College, [2]Beth Israel Deaconess Medical Center, [3]Harvard Medical School, [4]Wesleyan University — In this study, we asked how individual differences in pitch perception relate to audiovisual processing abilities, and to small-world network properties of the brain. 10 tone-deaf (TD) subjects and 10 matched controls underwent resting-state functional MRI. Graph theory analyses were performed on pairwise functional correlations. Results showed that TD subjects had lower degrees, clustering, strength, and local efficiency of functional correlations across the whole brain compared to controls. Notably, TD subjects showed significantly increased clustering scores ($p=0.048$) and local efficiency ($p=0.047$) in the right occipital lobe, suggesting a potential visual compensatory mechanism. We then examined the effect of pitch perception in audiovisual processing, as moderated by factors including age of onset and years of musical training. Given point-light displays of singers producing sung intervals, 55 subjects with a range of pitch perception abilities made subjective ratings of the size of sung intervals. Subjects were given audiovisual, audio-only, and visual-only stimuli of the sung intervals. Additionally, the audiovisual stimuli were divided into "congruent" (auditory and visual stimuli were unchanged) and "incongruent" (auditory and visual stimuli were mismatched) stimuli. Multiple regression revealed that age of onset was the only independent predictor of incongruent audio scores ($p=0.027$). These results suggest that while pitch discrimination plays a role in audiovisual integration, age of onset is the most reliable predictor of the use of auditory information in resolving audiovisual incongruence. These findings open the door for future research concerning audiovisual integration and the effects of the critical period of musical training on this integration.

### C107

**CORTICAL OSCILLATIONS IN THE AUDITORY SYSTEM TRACK IRREGULAR FREQUENCY MODULATION WITH A 1/F MODULATION SPECTRUM** Xiangbin Teng[1], David Poeppel[1]; [1]Department of Psychology, New York University — The auditory system operates on different timescales to extract acoustic information from natural sounds, such as speech and music, with a 1/f modulation spectrum. The neural mechanisms underlying this multi-scale processing are debated. Previous studies mainly used sounds having a modulation rate within a specific frequency range and found that cortical oscillations of the corresponding frequency band in the auditory system can track acoustic dynamics. Such data may not reflect an intrinsic auditory processing mode. Here we use stimuli having 1/f modulation spectra with exponents at 0.5, 1, 1.5 and 2, which correspond to modulation spectra of environmental noise, music, speech, and some vocalizations (Singh & Theunissen, 2003; Voss & Clarke, 1978). To track these stimuli, the auditory system may use cortical oscillations of multiple frequency bands and may reflect multi-scale processing. While undergoing magnetoencephalographic (MEG) recording, participants listened to stimuli. MEG results show that theta band oscillations (3 – 7 Hz) track the stimulus with an 1/f exponent of 1 even if the temporal modulation is not regular. There is no phase tracking in the theta band when the 1/f exponent is 0, and moderate phase tracking when the 1/f exponent is 2. The results also show moderate phase tracking in the gamma band (25 – 40 Hz) when the 1/f exponent is 1. The study suggests that multi-scale processing is a basic property of audition.

### C108

**A VOXEL-BASED MORPHOMETRY STUDY OF RHYTHM PERCEPTION AND SYNCHRONIZATION** H. Charles Li[1,2], Shinya Fujii[1,2,3], Psyche Loui[4], Gottfried Schlaug[1,2]; [1]Beth Israel Deaconess Medical Center, [2]Harvard Medical School, [3]University of Toronto, [4]Wesleyan University — Rhythmic synchronization to complex external stimulus, such as music, involves a network of brain regions that subserve temporal analysis and entrainment including the cerebellum, basal ganglia, and auditory-motor mapping regions. The present study investigates structural neural correlates of rhythm perception and production using combined behavioral and voxel-based morphometry methods. Forty subjects performed a series of rhythm-related tasks in the Harvard Beat Assessment Test (HBAT; Fujii & Schlaug, 2013). The battery consists of three rhythm perception tasks, where subjects have to judge whether a rhythmic pattern is getting faster or slower, and four rhythm production tasks, where subjects have to synchronize to a rhythmic pattern by tapping their index finger on a drum pad. Results from behavioral testing provided a range of rhythm perception and production threshold scores for subjects. Subsequently, subjects underwent a structural MRI (T1) scan, and voxel-based morphometry analysis was done in SPM8 to assess correlations between gray matter signal and rhythm perception and production threshold scores. Results showed a correlation between rhythm

production scores and gray matter in the right posterior middle temporal gyrus (pMTG): superior behavioral performers had higher gray matter signal in this cluster. These results suggest that beat synchronization integrates sensory information over time and that this process might involve more right than left temporal regions, in particular for the time intervals that were part of our test battery. Our findings are also in agreement with the asymmetric sampling in time hypothesis (Poeppel, 2003) attributing different time integration functions to both temporal lobes.

## C109

### THE PHASE OF NEURAL OSCILLATIONS TRACKS IMAGINED SINGING AT DISTINCT FREQUENCIES

Xing Tian[1,2], Huo Luo[3], Gregory B. Cogan[2], David Poeppel[2,4]; [1]New York University Shanghai, [2]New York University, [3]Chinese Academy of Science, [4]Max Planck Institute (MPIEA) — Strong evidence indicates that the timing of neural oscillations reflects the processing of exogenous stimuli, but the mechanisms, for example regarding phase coherence, are debated: does consistent stimulation alone drive oscillatory coherence across trials, or do intrinsic oscillations actively interact with the external stimulation, by way of some internal representation? The question is difficult to answer in canonical stimulus-response paradigms, because of the interaction between the properties of the stimuli and the subsequent neurocognitive processes. To address this issue, we use mental imagery, which is a purely top-down process that avoids external stimulation, to investigate whether the phase of neural oscillations tracks completely internally induced representations. We asked participants to imagine singing familiar songs while recording neural responses using magnetoencephalography (MEG). Analyses in source space revealed that the phase of neural oscillations reflected the syllabic rate of singing imagery (1-3 Hz) in a distributed motor-sensory network. More interestingly, phase tracking also occurred in right early auditory cortices and superior temporal sulcus in the theta band (4-8 Hz), outside the syllabic rate of imagery. Using a mental imagery paradigm to dissociate the contributions of physical stimulation and subsequent neural representation, we provide the first evidence suggesting that top-down induced representations can induce reliable and specific temporal patterns in neural oscillations. Moreover, phase coherence in the absence of a driving frequency supports the active role of theta band neural oscillations in the formation of speech related representations.

## C110

### TONE-LANGUAGE SPEAKERS SHOW HEMISPHERIC SPECIALIZATION AND DIFFERENTIAL CORTICAL PROCESSING OF CONTOUR AND INTERVAL CUES FOR PITCH

Wei-Lun Chung[1], Gavin M. Bidelman[1]; [1]University of Memphis — Electrophysiological studies demonstrate that the neural coding of pitch is modulated by language experience and the linguistic relevance of the auditory input; both rightward and leftward asymmetries have been observed in the hemispheric specialization for pitch. In music, pitch is encoded using two primary features: contour (patterns of rises and falls) and interval (frequency separation between tones) cues. Recent evoked potential studies demonstrate that these "global" (contour) and "local" (interval) aspects of pitch are processed automatically (but bilaterally) in trained musicians. Here, we examined whether alternate forms of pitch expertise, namely, tone-language experience (i.e., Chinese), influence the early detection of contour and intervallic deviations within ongoing pitch sequences. Neuroelectric mismatch negativity (MMN) potentials were recorded in Chinese speakers and English-speaking nonmusicians in response to continuous pitch sequences with occasional global or local deviations in the ongoing melodic stream. This paradigm allowed us to explore potential cross-language differences in the hemispheric weighting for contour and interval processing of pitch. Chinese speakers showed larger MMNs for both pitch contour and interval deviants than English-speaking nonmusicians across the board. However, Chinese speakers also showed differential pitch encoding between hemispheres not observed in English-speaking nonmusicians; Chinese speakers' MMNs revealed a rightward bias for contour processing but a leftward hemispheric laterality for interval processing. In contrast, no asymmetries were observed in English-speaking nonmusicians. Collectively, our findings suggest tone-language experience sensitizes auditory brain mechanisms for the detection of subtle global/local pitch changes in the auditory stream and exaggerates functional asymmetries in pitch processing between cerebral hemispheres.

## C111

### THE AUDITORY SYSTEM MAY TEMPORALLY SUB-SAMPLE ITS INPUTS, BUT ONLY ON A HIERARCHICALLY HIGH LEVEL OF PROCESSING

Benedikt Zoefel[1,2], Naveen Reddy Pasham[3], Rufin VanRullen[1,2]; [1]Université Paul Sabatier, Toulouse, France, [2]Centre de Recherche Cerveau et Cognition, CNRS, Toulouse, France, [3]Indian Institute of Technology, Bhubaneswar, Odisha, India — Recent research suggests that the visual system does not continuously monitor the environment, but rather samples it, cycling between 'snapshots' at discrete moments in time. Interestingly, most attempts at discovering discrete perception in the auditory system failed. These failures could reflect a crucial difference between vision and audition: whereas vision mainly relies on spatial information, time might be the most important factor for audition. Thus, directly subsampling the auditory environment might prove detrimental for the brain, as essential information for the extraction of auditory features would be lost. There is, however, an alternative: auditory subsampling might exist, but on a hierarchically higher level of processing, after the extraction of auditory features has been completed. To underline our assumption, we constructed speech stimuli that were subsampled at different frequencies, either directly in the time domain (input waveform) or after the level of auditory features (obtained by a vocoder using linear predictive coding). We then tested auditory recognition of our stimuli by randomly presenting them to ten subjects, asking them to indicate any snippet that matched the one presented two snippets ago (2-back task). We show that auditory recognition is more robust to subsampling on a relatively high level of auditory processing than to subsampling in the time domain. Although our results do not prove discrete perception in audition, they (1) show that subsampling is possible without critically disrupting temporal information and (2) suggest that, if subsampling exists, it should operate on a relatively high level of auditory processing.

## C112

### ISOLATING THE EFFECTS OF ACOUSTICS AND INTELLIGIBILITY IN THE PERCEPTION OF DEGRADED SPEECH

Kurt Steinmetzger[1], Stuart Rosen[1]; [1]University College London — The spectro-temporal properties of cortical EEG signals in response to degraded speech have been examined by several studies in the recent past. Unambiguously attributing the results to particular acoustic manipulations is complicated by the fact that such manipulations tend also to produce decreased intelligibility. We attempted to separate out these two effects by presenting normal-hearing listeners with different types of acoustically degraded vocoded speech that varied with respect to their amount of source periodicity (i.e., voicing) while recording the EEG signal along with spoken responses. Sorting the single trials according to the behavioural responses allowed us to examine a) acoustic effects while controlling for intelligibility and b) effects of intelligibility while controlling for acoustic differences. EEG waveforms were found to be consistently more negative with more voicing and, to a slightly lesser degree, in response to speech that is intelligible. An analysis of the power spectra of the EEG responses during the stimulus interval showed the same pattern of results in the delta band (1-4 Hz). These power differences were absent during the preceding baseline window but interestingly we instead found more alpha power (7-12 Hz) for unintelligible speech there. In summary, our analyses suggest that both the acoustic properties and intelligibility of speech are reflected by similar neural correlates, but that both factors contribute independently. Additionally, we found that the amount of alpha power in the silent baseline interval seems to be a factor that influences the intelligibility of the speech that follows.

## C113

### ON SCREAMS AND ROUGHNESS: SPECTROTEMPORAL SPECIFICITY, BEHAVIOURAL SENSITIVITY, AND NEURAL DRIVE

Luc Arnal[1,2], Adeen Flinker[1], David Poeppel[1,3]; [1]Department of Psychology, New York University, [2]Department of Neuroscience, University of Geneva, Switzerland, [3]NYUAD Institute, New York University Abu Dhabi — Screams are arguably the most relevant communication signal to promote survival, both in humans and non-humans. To date, the literature has focused mainly on high-order aspects of alarm signals, e.g. referential calls in monkeys, or prosodic cues for fear in human speech. Despite their theoretical significance as innate, primitive and universal communication signals, remarkably few

studies provide a detailed characterization of screams. A comprehensive perspective linking acoustic, behavioural, and neural approaches to investigate arguably the most elementary, non-referential form of communication is missing. Using a neurally-informed characterization of sounds that is increasingly used in speech research, the modulation power spectrum (MPS), we first show that screams exploit a specific, restricted portion of the modulation spectrum between ~30–150 Hz that corresponds to a well-known perceptual attribute, roughness. In contrast to the received view that roughness rates are irrelevant for communication, our data suggest that the roughness regime constitutes a privileged 'acoustic niche' for alarm signals that is segregated from other communication signals such as speech. We then show that roughness is exploited in both natural and artificial alarm signals and improves performance in various tasks, suggesting that roughness confers an advantage to react rapidly and efficiently. Moreover, we assess the neural processing of roughness using fMRI and find that these sounds are routed in a privileged manner to the amygdala, a structure critical to assess danger. The results suggest constraints on theories of the evolution of communication signals in which con-specific vocalizations evolved to fit specific neural and biomechanical constraints.

### C114

### NEURAL CORRELATES OF MUSICIANS' COMPENSATORY TIMING ADJUSTMENTS FOLLOWING ALTERED AUDITORY FEEDBACK DURING PERFORMANCE

Brian Mathias[1], Guido Guberman[1], William J. Gehring[2], Caroline Palmer[1]; [1]McGill University, [2]University of Michigan, Ann Arbor — In order to produce auditory sequences such as language and music quickly and accurately, individuals plan upcoming sequence events while monitoring the auditory feedback of their productions. According to future-oriented models of planning, altered feedback that corresponds to future events may create more interference than feedback corresponding to past events. The current study investigated electrophysiological correlates of performers' planning processes by presenting future- and past-oriented auditory feedback during musicians' performances. Pianists memorized isochronous melodies and then performed the melodies from memory at a cued tempo in a synchronization-continuation task while the electroencephalogram was recorded. Auditory feedback contained occasional altered tones that matched either a Future pitch (next intended event) or a Past pitch (preceding event). The timing of pianists' key presses slowed following Future feedback, and greater slowing was associated with larger N100 amplitudes one tone after the Future feedback. In contrast, no slowing was observed in the Past condition, and N100 and FRN amplitudes that occurred immediately following the altered feedback pitch were larger in the Past condition than the Future condition. These findings suggest roles of both sensory processing (N100) and evaluation (FRN) of altered feedback that accompanies compensatory timing adjustments during music performance, with the neural processing of Past feedback showing an earlier time-course than the processing of Future feedback. Anticipatory planning of future events may modulate influences of auditory feedback on the production of auditory sequences, consistent with models that preferentially weight the future and suppress the past in accounting for planning processes during sequence production.

## PERCEPTION & ACTION: Multisensory

### C115

### TITLE: VISUAL SEARCH ASYMMETRY REDUX: SEARCH THROUGH TIME IS LIKE SEARCH THROUGH SPACE.

Elizabeth Blundon[1], Lawrence Ward[1]; [1]University of British Columbia — We observed behavioural and electrophysiological evidence of search asymmetry in auditory and sequential visual search tasks using oddball stimuli consisting of two different types of five-item patterns. One type, called the flat pattern, consisted of 5 identical items, while the other type, called the change pattern, consisted of 4 identical items, with the fifth item differing in frequency (auditory), colour, contrast or shade (sequential visual) from the previous 4. Behavioural results were consistent with those of typical simultaneous visual search asymmetry (Treisman & Souther, 1985): because of the salient feature difference in the change pattern that was not present in the flat pattern, participants were faster to identify rare (20%) change patterns among sequences of common (80%) flat patterns than to identify rare flat patterns among common change patterns. Also, P300 ERP's to change pattern oddballs were earlier, larger, and sharper than P300 ERP's to flat pattern oddballs, which were much later, smaller, and broader. These results are consistent with those observed by Luck and Hillyard (1990) in a conceptual replication of Treisman and Souther's (1985) original visual search asymmetry study. Together, these behavioural and electrophysiological results suggest that search asymmetry may not be limited to simultaneous visual search but that such a phenomenon can be observed using auditory stimuli and sequentially-presented visual stimuli. Thus, "search" through time may employ processes, possibly based on stimulus salience arising from feature differences, similar to those used in search through space.

### C116

### SYNESTHESIA AND SENSORY CONFLICT: AN EVENT RELATED-POTENTIAL STUDY OF COLOR-GRAPHEME ASSOCIATIONS

Danielle N. Lordo[1], John Carney[1], Summer Issa[1], Deepa Patel[1], Eliana L. Sudikoff[1], David A. S. Kaufman[1]; [1]Saint Louis University — Synesthesia is a condition that involves the blending of two or more senses. The present study was designed to investigate the neural correlates of synesthesia, using event-related potentials (ERPs) to measure brain processes associated with color-grapheme processing. A color-grapheme synesthete was recruited to complete a Stroop-like task in which letters were presented in congruent and incongruent colors. The stability of synesthesia associations was also tested with a learning task in which specific color-letter pairs were viewed for an extended period of time. Healthy controls without synesthesia completed the same experimental procedures, in order to determine if extended viewing of specific color-letter pairs would mimic the effects of synesthesia. The synesthete exhibited Stroop-like alterations in behavioral task data, with enhanced accuracy and faster reaction times for congruent trials and significantly greater errors and slower reaction times for incongruent trials. Healthy controls demonstrated congruency effects from the learning task, such that congruent trials yielded greater accuracy. ERP results showed congruency effects in the synesthete that were amplified following the learning task and demonstrated an association of faster reaction times with larger P3 amplitudes for congruent trails. Healthy controls showed no ERP effects of congruency following the learning task. These results suggest that enhanced processing occurs through repeated exposure of congruent color-letter pairs for synesthetes, while conflict processing occurs for incongruent color-letter pairs. The identified inability of non-synesthetes to learn synesthetic associations may highlight the differences in the neural correlates of color-grapheme processing in synesthesia. Further research is needed to expand these findings.

### C117

### SPEAKING IN NOISE AND THE ROLE OF "FEEDBACK"

Sophie Meekings[1], Samuel Evans[1], Nadine Lavan[2], Sophie Scott[1]; [1]University College London, [2]Royal Holloway University of London — We talk over background noise on a daily basis- so how complicated can it be? Previous studies have framed the problem of speaking in noise as one of impaired auditory feedback. That is, noise "masks" speech, causing a mismatch between feedback and auditory targets. Increased activity in the superior temporal gyrus (STG), found when speaking in noise compared to quiet, has been interpreted as encoding this mismatch (Christoffels et al, 2007). However, noise is often a source of information in its own right- and behavioural evidence suggests we use it. For example, when talking over a competing speaker, subjects are better at retiming their speech to take advantage of gaps in noise, compared to similar maskers with no semantic content (Cooke & Lu, 2010). This study used sparse fMRI to record neural responses as participants read sentences aloud in the presence of four different masking conditions, varying in both informational and energetic content—clear speech, rotated speech, speech modulated noise, and continuous white noise. There were three baselines- speaking in quiet, listening to noise, and silent reading. Analysis revealed increased activity in STG when speaking in noise, compared with speech in quiet. If this resulted from a feedback mismatch, the strongest response should have been to speaking in white noise (the most effective energetic masker). Instead, activation increased with the amount of informational content, with speaking over a competing talker eliciting the greatest response. This pattern remained even when the effect of hearing the different maskers was factored out.

## C118

### EFFECTS OF LEARNING ON SOMATOSENSORY AND AUDITORY DECISION-MAKING AND EXPERIENCES: IMPLICATIONS FOR MEDICALLY UNEXPLAINED SYMPTOMS

Akib Ul Huque[1,2], Ellen Poliakoff[1], Richard J. Brown[1]; [1]The University of Manchester, UK, [2]The University of Dhaka, Bangladesh — The phenomenon of medically unexplained symptoms (MUS), where patients experience disabling physical symptoms in the absence of medical pathology, is a striking example of how perception often misrepresents sensory input. Recent theory likens MUS to somatic false alarms (FAs) and suggests that training to reduce somatosensory FAs more generally might result in decreased symptom reporting. We sought to test this idea in two studies investigating (i) whether the FA rate in a somatosensory signal detection task (SSDT) could be altered with operant conditioning; and (ii) whether this learning would transfer to other sensory decisions as measured by spontaneous sensation (SPS) and voice detection tasks (VDT). In Study 1, non-clinical participants (n = 34) were rewarded for hit responses and punished for misses on the SSDT, with a view to increasing their FA rate. In study 2, participants (n = 39) were rewarded for correct rejections and punished for false alarms, with a view to decreasing their FA rate. Control participants underwent pseudo-training procedures. All participants completed the VDT and SPS before and after the SSDT training to study perceptual transfer. As predicted, operant conditioning increased (study 1) and decreased (study 2) FAs on the SSDT; this effect transferred to FAs on the VDT in study 1 only. Neither study showed transfer on the SPS. The results suggest that it is possible to train perceptual distortion and that this may generalize to other perceptual decisions under some circumstances. This has potential implications for the mechanisms and management of MUS.

## C119

### MODALITY-GENERAL CATEGORIZATION IN PARIETAL CORTEX

Seth M Levine[1], Jens Schwarzbach[1]; [1]Center for Mind/Brain Sciences, University of Trento — Perceptual decision making is the cognitive process of converting stimuli into an abstract format that allows further cognitive or motor processes to engage appropriately. In categorization tasks, perceptual decisions result in the classification of sensory information into discrete, abstract categories. Various studies in the field of perceptual decision making have demonstrated some level of category-specificity within parietal regions of both humans and monkey. However, nearly all of these studies have investigated the matter through the visual domain, leaving the question of domain-general categorization in parietal cortex open to speculation. Using functional magnetic resonance imaging on healthy humans, we tasked participants with categorizing the direction of low-level auditory and tactile frequency-modulated (FM) sweeps in a delayed match-to-category paradigm, which is designed to disentangle overt responses from stimulus categorization. To detect cortical representations of FM sweep directions, irrespective of the sensory domain, we used whole-brain multivariate pattern analysis implemented through support vector machine (SVM) classification. By removing confounds related to higher-level semantics and predictable motor outputs, the SVM was able to decode such categorical representations for both sensory modalities within only the intraparietal sulcus. These findings offer a new view that the parietal lobes play a domain-general role in abstractly representing task-relevant categories.

## C120

### MAPPING SHAPE TO SOUND: EARLY SOUND SYMBOLISM FOR CONSONANTS

Melissa Holman[1], Ferrinne Spector[1]; [1]Edgewood College, Madison, WI — Children and adults reliably map sound to shape in a non-arbitrary way. Nonsense words with rounded vowels (e.g., bobo) are consistently mapped to rounded shapes and nonsense words with non-rounded vowels (e.g., kiki)) to angular shapes (e.g., Spector & Maurer, 2013; Maurer, Pathman & Mondloch, 2006). Such associations have been accredited to the roundedness of the vowel sound, with recent evidence elucidating the influence of the consonant sound (Grulke & Spector, 2014). In order to dissociate the learned versus naturally biased influences on these associations, in the present study, we investigate the influence of consonant sounds on sound-shape matching in pre-literate children (30-36 months). During each trial, participants heard a nonsense word and made a forced choice between an angular and rounded shape. Stimuli were nonsense words with reduplicated syllables that contained consonants which show a strong shape bias in adults. Importantly, the nonsense words were presented in standardized video format in order to ensure that each participant received identical stimuli. Preliminary results confirm previous evidence that consonant sounds have a systematic influence on shape choice. These results add to a body of research suggesting that sound-shape mapping may result from the joint influence of learning and natural biases linking language across sensory systems. Such links may reflect inherent neural organization that is modifiable with learning and that can manifest as sound symbolic associations. This non-arbitrary sound shape mapping could help facilitate early language learning in a world where sound may be mapped to objects in a meaningful way.

## C121

### HEARING SHAPES: ERPS REVEAL CHANGES IN PERCEPTUAL PROCESSING AS A RESULT OF SENSORY SUBSTITUTION TRAINING

Christian Graulty[1], Orestis Papaioannou[1], Phoebe Bauer[1], Makaela Stephens[2], Johnathan Sheiman[1], Michael Pitts[1], Enriqueta Canseco-Gonzalez[1]; [1]Reed College, [2]Pomona College — The present study measured event-related potentials (ERPs) to visual shape stimuli and auditory 'soundscapes' in sighted individuals (N=31) one day before and one day after sensory substitution training. The soundscapes were generated from the visual shapes using the Meijer image-to-sound conversion algorithm, which was used to train the experimental group for 2 hours on these shape-soundscape pairs. Control participants were trained with the exact same stimuli and performed the same task but crucially, the shapes/soundscapes were randomly paired. Behavioral measures confirmed that both groups were able to learn the shape-soundscape pairs, but only the experimental group was able to generalize this learning to novel stimuli (68% accuracy). ERPs elicited by the soundscape stimuli revealed an anterior positivity in the post-minus-pre-training difference waves (380-480ms post-stimulus) that was unique to the experimental group. In a second study with 32 new subjects, this post-vs-pre-training effect replicated even when the shape-soundscape pairings were made task-irrelevant. We interpret this anterior positivity as reflecting early automatic cross-modal transfer (before the 500ms soundscape was complete) brought-on by relatively brief sensory substitution training with the Meijer algorithm.

## C122

### EXPERIENCING THE PAIN OF OTHERS: THE LINK BETWEEN SOMATOSENSORY CORTEX HYPERACTIVITY AND CONSCIOUS MIRROR-PAIN EXPERIENCES

Thomas Grice-Jackson[1], Hugo Critchley[2], Jamie Ward[1]; [1]University of Sussex, [2]Brighton and Sussex Medical School (BSMS) — For most individuals the observation of others in pain, or vicarious pain, does not elicit a conscious experience of pain in the observer; however, some individuals regularly experience vivid conscious vicarious pain (known here as mirror-pain responders), and a significant portion of the general population report these experiences occasionally. Through the development of an online screening questionnaire the current study presents a method for identifying and profiling the experiences of mirror-pain responders. These individuals and a group of controls were recruited for a follow-up EEG experiment which assessed suppression of somatosensory cortex alpha oscillations, Mu-suppression (known to reflect somatosensory cortex activity), during the observation of painful and neutral images. The findings display significant Mu-suppression during the observation of pain images for both controls and pain responders. Additionally, pain responders displayed greater Mu-suppression during pain observations relative to controls indicating that their experiences may be manifested in hyperactivity of the somatosensory cortex. Correlations between Mu-suppression and measures from the online questionnaire indicate a link between increased somatosensory activity and an increased tendency to localise conscious vicarious pain experiences to a particular point on the individual's own body (as opposed to generalised bodily pain). Mirror-pain responders report less tendency to engage in perspective taking on a questionnaire measure of empathy and, in this group, less perspective taking is linked to more increased somatosensory activity for painful images. Although experiencing the pain of others is, at one level, 'empathic' it may paradoxically result in less tendency to put oneself in others shoes.

### C123

**NEURAL BASIS OF ASSOCIATIONS BETWEEN VISUAL STIMULI AND AUDITORY PITCH** Kelly McCormick[1], Randall Stilla[1], Simon Lacey[1], Sara List[1], Lynne Nygaard[1], K Sathian[1]; [1]Emory University — Extensive behavioral research has demonstrated systematic cross-sensory mappings for a number of perceptual domains (e.g. pitch-object size, pitch-vertical spatial position, waveform-object shape). Although such mappings are fundamental to diverse cognitive processes such as iconic symbol use, language, multisensory integration, and object recognition, the underlying neural mechanisms are not well understood. We examine the contributions of three putative systems hypothesized to mediate these mappings: 1) multisensory integrative systems, which support the combination and integration of information from multiple sensory channels; 2) the magnitude system which enables comparison and alignment of different sensory stimuli in a supramodal, quantitative format, 3) the semantic system, encompassing language and conceptual systems. In a functional neuroimaging study, we examined the correspondence between acoustic pitch and visual stimuli. Participants were presented simple perceptual stimuli (e.g. a high-pitched tone and a small circle), in unisensory and multisensory (audio + visual) conditions. A congruency effect for the multisensory conditions was observed bilaterally in the superior temporal sulcus (STS), left inferior frontal gyrus, and right anterior insula. Using three functional localizers, we identified systems recruited for multisensory integration, magnitude, and semantic processing, then assessed the extent to which multimodal congruency engages these systems. Within congruency-sensitive regions, right anterior STS showed a semantic effect, left posterior STS showed effects for magnitude, semantic, and multisensory localizers, and right anterior insula showed multisensory and magnitude effects. Our findings suggest that the neural basis of these cross-sensory mappings is functionally and spatially distributed, with a common locus in the left posterior STS.

# THINKING: Decision making

### C124

**LIBERAL PARTISANSHIP AFFECTS INFORMATION GATHERING IN POLITICAL CHOICE AS ASSESSED BY EYE MOVEMENTS** Sekoul Krastev[1], Dietlind Stolle[1], Elisabeth Gidengil[1], Lesley K Fellows[1]; [1]McGill University — The mechanisms that support voting are a central topic in political psychology and have recently begun to be studied using the methods of cognitive neuroscience. The attentional Drift Diffusion Model (aDDM) has been used to study the neural correlates of information processing during economic value-based choices. We asked whether this same methodology could be applied to measure evidence gathering in voting and explored the effect of partisanship on this process. We adapted procedures used in past aDDM experiments to study hypothetical voting choices. Twelve Canadian Liberal partisans and twelve non-partisans made binary choices between photographs of unknown political candidates in the presence and absence of party information. Choice behavior and eye movements were tracked throughout the experiment. As predicted by the aDDM, final fixations were significantly shorter than middle fixations and were predominantly toward the chosen item across all groups and conditions. Both groups made fewer fixations in the presence of party information. Partisans made significantly faster decisions with fewer fixations even in the absence of party information. This is preliminary evidence that the aDDM can be used to describe information gathering in political choice. Partisanship has unique prominence in political decision making. These findings suggest that either specific party affiliation or partisanship in general influences decision making behavior, even in the absence of party information. This work offers a new approach to investigating the neural basis of political decision making.

### C125

**TASK IRRELEVANT FEATURE-VALUE ASSOCIATIONS ELICIT NEURAL REWARD PREDICTION ERROR SIGNALS** Timothy Vickery[1], Kyle Friedman[1], Rachel Bristol[2]; [1]University of Delaware, [2]University of California, San Diego — Many decisions depend on learned associations between option features and value. Reinforcement learning (RL) models of such decisions often implicitly assume that only relevant, attended feature-value associations are tracked, updated via reward prediction errors (RPEs), and employed in decisions. How well are humans able to selectively attend to a given visual feature dimension to learn appropriate feature-value associations, while ignoring irrelevant feature-value associations? Using model-based fMRI, we examined neural responses during a simple reward-learning task (4-armed bandit), in which participants (N=26) selected one of four options represented by colored squares on each trial. After selecting, participants either received a reward or no reward. Reward was independently and probabilistically associated with each of the four colors, and the probability of reward varied independently for each color over time. Thus, participants were encouraged to actively learn the values of each color throughout the experiment. Importantly, locations of the colored items were randomly determined on every trial and were completely unrelated to value. Consistent with prior work, RPE based on color was correlated with activity in several regions of the brain, including ventral striatum. However, we additionally estimated irrelevant location-value associations and related prediction errors. Neural activity in several regions, including ventral striatum, was additionally correlated with location RPE, implying latent value signals related to the irrelevant feature. Humans may track multiple feature-value associations in parallel, even when they are not presumed to be relevant to action. Such latent signals may serve to guide exploratory actions, or actions taken under high uncertainty.

### C126

**NEUROFUNCTIONAL EVIDENCE FOR THE DUAL PROCESS THEORY ON VALUE-BASED DECISIONS** Chun-Wei Hsu[1], Joshua Goh[2]; [1]Plymouth University, UK, [2]National Taiwan University — Dual process theory proposes two cognitive systems underlying human decision-making. Specifically, there is a set of explicit and rational processes involving working memory neural circuitry and a set of implicit and automatic processes generally involving more limbic systems. However, the neural correlates of how these two systems coincide when evaluating choices and processing related feedback during decision-making remain unknown. To investigate the extent to which neural activity engaged during value-based decision-making overlaps with controlled and automatic processing, respectively, twenty participants completed three tasks (lottery choice (LC), arithmetic and emotion decision-making) in the same format but with different goals in this functional magnetic resonance imaging study. We found that, during the choice period, the emotion task strongly shared common areas with the LC task in the right inferior frontal gyrus (IFG) and bilateral parietal areas. By contrast, the arithmetic task overlapped with the LC task more in bilateral striatal areas. During feedback, the emotion task overlapped with the LC task in left IFG, middle frontal and middle temporal areas, and bilateral angular gyri. By contrast, arithmetic-LC task overlap was more extensive additionally involving the right hemisphere homologues of these areas. These novel findings delineate the neural loci of cooperative or competitive input from explicit arithmetic and implicit emotion subsystems during value-based choice evaluation and updating during feedback. This is the first study to investigate neural evidence for the dual process theory in which we are able to directly compare how these two systems are involved in rational or irrational value-based decision-making.

### C127

**VENTRO-MEDIAL PREFRONTAL CORTEX AND STABILITY IN ART PREFERENCE** Steven Weisberg[1], Melissa Beswick[1], Anjan Chatterjee[1]; [1]University of Pennsylvania — The ventro-medial prefrontal cortex (VMPFC) is a critical part of the human reward circuitry and has been implicated in encoding value and judging preferences. Fellows and Farah (2007) reported instability in VMPFC lesion patients', compared to age- and IQ-matched controls' and non-VMPFC lesion patients', preferences for food, color, and faces of famous people, despite stable perceptual judgments. We investigated preference stability in VMPFC lesion patients using famous paintings, in part, because the VMPFC is activated when participants view paintings they judge as beautiful (Kawabata & Zeki, 2004). We selected 12 paintings from a set of 24, normed in a previous study (Chatterjee, Widick, Sternschein, Smith, & Bromberger, 2010). Thirteen VMPFC patients and 24 age-matched controls made three judgments about each pair of paintings: a) preference, b) representational accuracy, and c) color warmth. We measured stability by determining the number of intransitivities (i.e., A>B, and B>C, but C<A) participants exhibited in their judgments. We predicted greater instability for patients in their preference judgments, but not

accuracy and color. Results indicated, if anything, the opposite: patients exhibited greater rigidity than controls, p = .07. There were no differences between the groups for accuracy or color. Exploratory analyses revealed a relationship between stability for preference judgments with representational accuracy judgments for patients, r = .37, but not for controls, r = -.15. Our data suggest that VMPFC damage might make people more rigid than normal in their preferences for complex non-appetitive objects like paintings.

## C128

### AGE-RELATED DIFFERENCES IN DECISION MAKING: EXPLORING NEURAL CORRELATES OF FEEDBACK PROCESSING DURING IOWA GAMBLING TASK.

Elisa Di Rosa[1], Sami Schiff[1], Daniela Mapelli[1]; [1]University of Padua — The presence of age-related differences in learning and decision making has recently been reported during Iowa Gambling Task (IGT; Bechara et al., 1994), where performance increases from childhood to adulthood and declines in older adults (Beitz et al., 2014). Aim of the present study is to explore neural correlates of these age-related differences. We recorded event related potentials (ERPs) during IGT in a group of healthy young adults (N=18; age 25.5 years) and in a group of healthy older adults (N=15; age 60.7 years) to explore P2, feedback related negativity (FRN) and P3. Results show that while the valence sensitivity of both P2 and FRN is preserved in the two groups, with greater P2 and FRN amplitude respectively after positive and negative feedback, both components are significantly attenuated in older adults ($p<.05$). More interestingly, opposite trends were found in the valence-modulation of P3: adults present a significantly higher P3 after negative feedback, while older adults show greater P3 after the positive ones. Additionally, within group analysis reveals that the difference in P3 amplitude after positive and negative feedback was higher in young adults, respect to older adults ($p<.0001$). Our results are in line with literature concerning diminished P2 and FRN amplitude in older adults as compared to younger adults (West et al., 2014); moreover, our data about the inverted trend in P3 valence modulation could be interpreted as the presence of an "age-related positivity effect" and suggest the presence of age-related differences in the sensitivity to rewarding and aversive stimuli.

## C129

### NOVEL TYPE OF DOPAMINE NEURONS ENCODING STABLE OBJECT VALUE MEMORY.

Hyoung Kim[1], Ali Ghazizadeh[2], Okihide Hikosaka[3]; [1]Laboratory of Sensorimotor Research, National Eye Institute – National Institutes of Health, Bethesda, MD, USA, [2]Laboratory of Sensorimotor Research, National Eye Institute – National Institutes of Health, Bethesda, MD, USA, [3]Laboratory of Sensorimotor Research, National Eye Institute – National Institutes of Health, Bethesda, MD, USA — Midbrain dopamine (DA) neurons are thought to be critical for reward-value based learning by modulating synaptic transmission in the striatum. Using macaque monkeys, we recently showed that visual object-value learning occurred slowly and the value memory was retained stably in neurons in caudate tail (CDt), unlike neurons in caudate head (CDh) (Kim & Hikosaka, Neuron 2013). We then found that CDt receives DA inputs exclusively from caudal-dorsal-lateral region of substantia nigra pars compacta (cdlSNc), which is segregated from rostral-ventral-medial SNc (rvmSNc) projecting to CDh (Kim et al., Front Neuroanat 2014). These data suggest that cdlSNc-DA neurons guide learning of stable object values in CDt. To test this hypothesis, we examined DA neuronal activity in two stages: 1) object-value learning, followed by 2) passive viewing with no reward feedback. Both rvmSNc neurons and cdlSNc neurons learned to discriminate high- and low-valued objects. However, they behaved completely differently in the passive viewing task: rvmSNc neurons stopped responding to the objects, whereas cdlSNc neurons continued to respond to the objects differentially: excited by high-valued objects and inhibited by low-valued objects. rvmSNc and cdlSNc neurons showed similar spike shapes and firing patterns, which are characteristic of DA neurons. We then histologically reconstructed recording sites of cdlSNc neurons and found them within a cluster of tyrosin hydroxylase-positive neurons, suggesting that they are dopaminergic. Our data suggest that the two groups of DA neurons contribute to the different time courses of object value learning in CDt and CDh by conveying different reward-related signals.

## C130

### DIVERGENT NEURAL ACTIVITY BETWEEN GOVERNMENT AND BUSINESS LEADERS IN RESPONSE TO MONETARY GAINS AND LOSSES: A MONETARY INCENTIVE DELAY (MID) PILOT STUDY

Bruce L. Jones[1], Neena K. Rao[1], Francesca Mapua Filbey[1], John Hart[1,2], L. Douglas Kiel[1]; [1]The University of Texas at Dallas, [2]The University of Texas Southwestern Medical Center — Scholars have long been interested in the differing reward preferences between government and business leaders. The present study explored the differential neural underpinnings using fMRI of incentive anticipation and outcome during a monetary incentive delay (MID) task in executive-level leaders from government and business organizations. Seven male non-elected government leaders (Assistant City Managers to Federal GS-15s) (M age = 58.43 years, SD = 11.01) and seven male business leaders (Vice President to CEO level) (M age = 50.43 years, SD = 6.78) were presented with a visual cue indicating whether they could potentially gain or avoid losing money upon a button press. Overall, the main effect of anticipation for both gain and loss trials across all amounts elicited greater neural activity for business leaders than government leaders in the left middle temporal gyrus, left parahippocampal gyrus, and bilateral middle frontal gyrus. Overall, the main effect of feedback for both gain and loss trials across all amounts elicited greater neural activity for business leaders than government leaders in the right thalamus, left parahippocampal, and left superior frontal gyrus. Both anticipation and feedback effects were differentially characterized by valence in which business leaders elicited greater neural activity for gains than losses while government leaders elicited greater neural activity for losses than gains. These data suggest that the divergent reward preferences of government and business leaders at anticipation and feedback are identifiable at the neural level, and that government leaders are more attendant to losses while business leaders appear more focused on gains.

## C131

### SEPARABLE, YET COMMUNICATING, NEURAL SYSTEMS UNDERLYING UPDATING UNDER AMBIGUITY

Kenji Kobayashi[1], Ming Hsu[1]; [1]University of California, Berkeley — The question of how people update their beliefs under ambiguity, i.e. when probabilities of potential outcomes are unknown or partially known, based on environmental signals has important implications for our understanding of neural mechanism of decision-making. Updating of beliefs may lead to, but not necessarily equal to, implications for outcome predictions and values of choices. Furthermore, since uninformative, yet unpredictable, sensory signals are abundant in the environment, belief updating is not necessarily driven by the degree to which the signals violate prior expectancy (surprise), but such separation has not been clear in the field of decision neuroscience. Here we adopted a modified paradigm of Ellsberg's three-color gamble to isolate and dissociate neural systems involved in updating of beliefs, calculating implications for values, and detection of mere surprise of the signals, all quantified under a rational Bayesian model. Behaviorally, we show that, even under systematic aversion to ambiguous settings, subjective values of gambles can be robustly approximated by the rational model. Next, using model-based fMRI, we showed that frontoparietal regions represented updating of beliefs, while medial prefrontal and cingulate cortex represented value implication, and anterior insula represented mere surprise. Lastly, using dynamic causal modeling (DCM), we found evidences for task-dependent effective connectivity between belief-updating regions and value-implication regions. Taken together, these results suggest that separable sets of cortical regions encode different aspects of updating under ambiguity, and constitute a large network to enable sophisticated adjustment of behavior.

## C132

### UNDERSTANDING CONTROL AND PROCESS-LEVEL ACTIVATION DURING MULTI-ATTRIBUTE DECISION MAKING

Jaymes Durriseau[1], Jarrod Moss[1], Jonathan Cagan[2], Pinzhi Chen[2]; [1]Mississippi State University, [2]Carnegie Mellon University — Decision making has been hypothesized to be made up of process-level and control-level operations. The process level integrates decision-relevant information, whereas, the control-level evaluates this information and allows a decision to be made. Previous studies have found that different brain regions are involved in the control-level

and process-level operations. This study investigated the possible differences in process-level and control-level activity when making multi-attribute preference decisions between two vehicles with different visual and performance characteristics. The conflict hypothesis predicted that decisions with higher amounts of conflict would elicit higher control-level activation. The multi-representational hypothesis predicted that control level activity would differ for inter-representational conflict (conflict between visual and functional information) and intra-representational conflict (conflict within functional information). To test these hypotheses, participants made two-alternative preference decisions based on: (a) vehicle visual form information, (b) vehicle function information, or (c) a combination of both form and function. Sometimes one alternative was clearly superior (clear winner); sometimes there was not a clearly superior alternative (non-clear winner). In support of the conflict hypothesis, decisions with conflict (non-clear winner) showed significantly more control-level activation in areas related to decision conflict monitoring when compared to decisions without conflict (clear winners). These areas included the dorsolateral prefrontal cortex, anterior cingulate cortex, and the left anterior insula. In support of the multi-representational hypothesis, decisions based on visual information showed more neural activity in the fusiform gyrus and the right middle occipital gyrus, which are areas associated with visuo-spatial processing, when compared to decisions based on functional information.

# Poster Session D

## ATTENTION: Nonspatial

### D1

**THE EFFECTS OF DISTRACTION ON THE BRAIN PROCESSES UNDERLYING SIGNAL DETECTION** Elise Demeter[1], Daniela De Albuquerque[1], Marty G. Woldorff[1]; [1]Duke University — The dSAT (distractor Sustained Attention Task) is a translational paradigm used to investigate the neural mechanisms underlying signal detection and attentional control (e.g., Demeter et al., 2011; 2013; St. Peters et al., 2011). In the no-distraction condition (SAT), participants monitor for the occurrence of a brief, variable-duration signal (17, 33 or 50 ms), while the dSAT condition increases the attentional control demands though the introduction of a global, flashing distractor. Here, we recorded electrical brain activity (EEG) while participants performed the SAT and dSAT to examine how distraction and signal duration modulated the neural cascade of processes related to signal detection. Behaviorally, distraction and signal duration interacted, with the largest detection impairments from distraction occurring at the shortest duration. Event related potentials to detected signals revealed effects on a cascade of components. Distraction abolished an anterior N2 component and reduced and delayed an occipital N2 for all durations (latency 150-200 ms). Anteriorly, the P3a increased in amplitude as duration increased, but was reduced and delayed with distraction (200-300 ms). Posteriorly, the subsequent P3b (350-700 ms) also increased in amplitude with duration. While distraction did not affect P3b amplitude for detected signals for the shortest duration, it was significantly larger during distraction for longer durations. These data suggest increasing signal salience by increasing duration enhances brain activity related to signal detection and processing. Distraction disrupts early detection-related components, while the enhancement of the longer-latency P3b at longer durations suggests the engagement of compensatory processes to maintain performance under attentionally challenging conditions.

### D2

**CONFIGURAL AND FEATURAL FACE PROCESSING ARE DIFFERENTLY MODULATED BY ATTENTIONAL RESOURCES AT EARLY STAGES: AN EVENT-RELATED POTENTIAL STUDY WITH RAPID SERIAL VISUAL PRESENTATION** Hailing Wang[1], Pei Sun[1], Cheng Teng IP[1], Xin Zhao[1], Shimin Fu[1]; [1]Tsinghua University — It is widely reported that face recognition relies on two dissociable mechanisms, the featural and the configural processing. However, it is unclear whether these two processing types involve different neural mechanisms and are differently modulated by attentional resources. Using the attentional blink (AB) paradigm, we aimed to investigate the effect of attentional resources (deficient vs. sufficient) on configural and featural face processing by recording event-related potentials (ERPs). The amount of attentional resources was manipulated as deficient or sufficient by presenting the second target (T2) in or out of the AB period, respectively. We found that in addition to a traditional P300 attention effect, the amplitude of N170/VPP was also sensitive to attentional resources, suggesting that attention affects face processing at an earlier perceptual processing stage. More importantly, configural face processing elicited a larger P1 compared to featural face processing, but only when the attentional resources were sufficient. In contrast, the anterior N1 was larger for configural relative to featural face processing only when the attentional resources were deficient. These results suggest that early stages of configural and featural face processing are differently modulated by attentional resources. Therefore, attentional resources have a different influence on configural and featural face processing, and this modulation begins at early perceptual stages with different underlying mechanisms.

### D3

**TOP-DOWN CONTROL OF ALPHA PHASE AS A MECHANISM OF TEMPORAL PREDICTION** Jason Samaha[1], Phoebe Bauer[2], Sawyer Cimaroli[1], Bradley R. Postle[1]; [1]University of Wisconsin - Madison, [2]Reed College — The phase of prestimulus oscillations in the alpha band (9-13 Hz) of the EEG has been show to predict subsequent visual perception, effective connectivity, BOLD response magnitude in visual cortex, and variability in visual short-term memory performance, leading many to suggest that alpha oscillations implement phasic windows of cortical inhibition and excitation. Given the importance of alpha phase for subsequent processing, we investigated whether it is under attentional control. Specifically, we asked is knowledge about when a stimulus will appear could improve visual processing by biasing alpha at the predicted moment towards an optimal phase. We collected EEG recordings while participants completed an orientation discrimination task in which some targets appeared at a predictively cued latency, while others appeared at an unpredictable latency. Results reveal an improvement in discrimination accuracy and subjective visibility following predictive, relative to unpredictive cues. This was accompanied by modulation of the phase of posterior alpha just prior to target onset. Phase also differed between correct and incorrect trials, revealing an optimal phase for discrimination in the task. Importantly, the phase during attended time points was significantly biased towards this optimal phase. These data suggest that alpha-band oscillations may not only reflect purely spontaneous fluctuations in cortical excitability, but may also serve as a mechanism for the implementation of volitional control over visual perception.

### D4

**MECHANISMS OF RESOURCE ALLOCATION IN RHYTHMIC CONTEXTS: REVISITING THE ROLE OF INCIDENTAL OSCILLATORY ENTRAINMENT** Assaf Breska[1], Leon Y. Deouell[1]; [1]The Hebrew University, Israel — Rhythmic input dynamics are common in our environment (e.g. speech, biological motion), and can be used to facilitate performance through forming temporal predictions. It was suggested that such facilitation is achieved through entrainment of ongoing brain oscillations to the external rhythmicity. In two EEG studies, we investigated the cognitive and neural mechanisms of synchronization to visual rhythms. The first study examined whether rhythm effects can be explained by repeated interval timing rather than by rhythm-specific mechanisms. Participants detected targets appearing either rhythmically, or arrhythmically in pairs with a predictable intra-pair interval that could be intentionally memorized. Phase-locking of slow neural activity did not differ between conditions, suggesting that it is not a unique signature of rhythm-induced entrainment but could reflect intentional formation of temporal predictions based on memorized intervals. However, rhythm-based predictions still resulted in larger behavioral costs of temporally unexpected targets and earlier resolution of the contingent negative variation (CNV), indicating a unique effect for a rhythmic mode of processing. The second study examined whether peaks of responsiveness and slow brain activity could be shifted away from time-points that coincide with rhythms. Participants viewed rhythmic stimuli and detected targets which appeared with high probability at off-beat times. We found that when participants were provided with accurate temporal representation of the new expected time-point, both peaks of performance and the CNV were shifted in time away from the rhythm and towards the expected off-beat times. We suggest that these results are not commensurate with a straightforward neural entrainment account.

### D5

**PRECONSCIOUS, CONSCIOUS, AND POST-PERCEPTUAL PROCESSING OF VISUAL WORD FORMS IN AN INATTENTIONAL BLINDNESS PARADIGM** Kathryn Schelonka[1], Enriqueta Canseco-Gonzalez[1], Michael Pitts[1]; [1]Reed College — A sustained inattentional blindness paradigm was adapted to record ERPs elicited by word forms that were or were not consciously perceived. In the first phase, participants performed a difficult tracking task overlaid on a background of changing line segments. In 45% of trials, the line segments changed from one scrambled configuration to another, while on 55% of trials, the line segments changed to form words and nonwords (random consonant strings) at fixation. At the end of the first phase participants' awareness of the word forms was assessed and participants who failed to notice the word forms were considered inattentionally blind (~30% of participants). In the second phase, participants

repeated the same tracking task after being cued to the existence of the words and nonwords. In the third phase, participants were instructed to ignore the tracking task and attend to the word forms in order to detect target stimuli (animal words). In all phases of the experiment, including inattentional blindness, ERPs recorded over the posterior scalp from ~110-170ms differed in amplitude between word forms and scrambled lines, possibly reflecting preconscious perceptual processing. A subsequent ERP component recorded over bilateral occipital-parietal areas (~250-370ms), along with a frontally-biased N400 effect, appeared only when subjects were aware of the word forms, but regardless of task-relevancy. Finally, a frontal selection positivity (~190-360ms) and a broadly distributed P3 component (~450-650ms) were evident only when the word forms were task-relevant. Overall, these results help distinguish brain activity associated with conscious perception from pre- and post-perceptual processing.

### D6

### ISOLATING NEURAL CORRELATES OF CONSCIOUS PERCEPTION FROM NEURAL CORRELATES OF REPORTING ONE'S PERCEPTION: A 2X2 MANIPULATION OF VISUAL AWARENESS AND TASK-RELEVANCE

Michael Pitts[1], Stephen Metzler[1], Steve Hillyard[2]; [1]Reed College, [2]University of California San Diego — To isolate neural correlates of conscious perception (NCCs), a standard approach has been to contrast neural activity elicited by identical stimuli of which subjects are aware versus unaware. Because conscious experience is private, determining whether a stimulus was consciously perceived requires subjective report: e.g., button-presses indicating detection, verbal reports, etc. This reporting requirement introduces a methodological confound when attempting to isolate NCCs: The neural processes responsible for accessing and reporting one's percept are difficult to distinguish from those underlying the conscious percept itself. Here, we attempt to circumvent this issue via a backward masking experiment in which task-relevance and visual awareness were manipulated in a 2x2 crossed design. Based on an initial behavioral experiment that determined appropriate masking SOAs, shape and color stimuli were rendered visible or invisible while subjects performed a shape or color discrimination task. Stimuli that were consciously perceived yet not immediately accessed for report (visible, task-irrelevant condition) elicited a mid-latency posterior ERP negativity (~200-240ms), while stimuli accessed for report (visible, task-relevant condition) elicited additional components including a robust P3b (~380-480ms) subsequent to the mid-latency negativity. These results suggest that some of the NCCs identified in previous studies may be more closely linked with accessing and maintaining perceptual information for reporting purposes than with encoding the conscious percept itself. An open question is whether the remaining NCC candidate (ERP negativity at 200-240ms) reflects neural activity uniquely dedicated to conscious visual processing, or alternatively, an interaction between attentional mechanisms and perceptual representations in the ventral visual stream.

### D7

### THE P300 AMPLITUDE PREDICTS TEMPORAL DILATION IN AN ODDBALL TASK

Benjamin Ernst[1], Simon M. Reichard[1], Regina F. Riepl[1], Sarah F. Zimmermann[1], Marco Steinhauser[1]; [1]Catholic University of Eichstätt-Ingolstadt — Our experience of time is often subject to distortions. For instance, time appears to slow down when unexpected events occur. Previous research has shown that the duration of infrequent, task-relevant stimuli - so-called oddballs - is commonly overestimated, an effect referred to as temporal expansion. Importantly, oddballs are also known to cause a pronounced event-related potential (ERP) component, the P300. Both, temporal expansion and the P300, have been associated with attentional processes and increased transmission of information to working memory. Therefore, we hypothesized that the P300 amplitude can be used to predict whether the duration of an oddball will be overestimated or not. To this end, we recorded ERPs during an oddball task with pseudo-words of varying duration. Infrequent red target oddballs were embedded within a series of frequent white distractor stimuli. Participants were asked to memorize the target oddballs and to estimate whether their duration had been longer or shorter than the duration of the preceding distractor. In addition, participants were also asked to estimate the duration of distractors on infrequent catch trials. As expected, the duration of target oddballs, but not of distractors, was overestimated and overestimations were associated with larger P300 amplitudes than correct estimates. Because the P300 peaked before stimulus offset, this effect was independent from actual oddball duration. Moreover, P300 amplitudes as well as time estimation performance predicted oddball recognition performance in the subsequent recognition task. Together, our results suggest that the processes underlying the generation of the P300 contribute to the temporal expansion effect.

### D8

### FUNCTION IN DYSFUNCTION: DISSOCIATION AS A COGNITIVE STRATEGY IN DIVIDED ATTENTION CONDITIONS

Jenn Lewis[1,2], Katia Krane[1,2], Mary-Ann Dobrota[1,2], Don Tucker[1,2]; [1]University of Oregon, [2]Electrical Geodesics, Inc. — Defined by a lack of integration between thoughts, feelings, identity, and or experiences, dissociation is a mechanism, often recognized as a learned or habituated dysfunctional response to environmental experiences, particularly those of stress and threat. However, a small body of behavioral research has suggested that dissociative tendencies may hold a cognitive advantage in specific situations, such as divided attention conditions. Despite having a potential effect on multiple domains of cognition, little is known about the neural mechanisms behind dissociation, and less is clear on how dissociation may affect overall executive functioning. The current experiment explores dissociation's effect on neural responses to highly charged stimuli and their relation to behavioral measures of executive processes. In particular, the study seeks to explore in what situations dissociation may hold an advantage for an individual and act adaptively. Using dense array EEG to record neural responses, researchers examined event-related potentials (ERPs) in participants ranking high or low on dissociation during a divided attention emotional Stroop task. Distinct between group differences were identified in ERPs related to attention and meaning processing, including medial frontal negativity (MFN) and the P300, where high dissociators presented with particularly attenuated ERPs compared to low dissociators. Despite presenting with seemingly blunted neural responses, high dissociators performed at a higher capacity in several behavioral domains compared to low dissociators. These results indicate that high dissociators are employing an alternative cognitive strategy, which is not only effective in divided attention conditions and responses to charged stimuli, but potentially advantageous.

## ATTENTION: Other

### D9

### ATTENTIONAL CONTROL OF UNCONSCIOUS SEMANTIC PROCESSING DEPENDS ON ESTABLISHMENT OF DYNAMIC FUNCTIONAL BRAIN NETWORKS

Markus Kiefer[1], Martin Ulrich[1], Sarah C. Adams[1]; [1]University of Ulm, Germany — In classical theories of automaticity and attention, unconscious automatic processes are thought to be independent of higher-level attentional influences. However, in our attentional sensitization model we propose that unconscious automatic processing depends on attentional enhancement of task-congruent processing pathways. We assume that attentional sensitization is achieved by dynamically establishing functional brain networks depending on the active task set. Here, we investigated the functional neuroanatomical architecture of attentional sensitization of unconscious semantic processing with a modified masked semantic paradigm in a functional magnetic resonance imaging study. In our induction task paradigm, participants attended before masked prime presentation in a classification task either to semantic or perceptual stimulus features, which should activate a semantic and perceptual task set, respectively (induction task). Thereafter, a subliminal semantic priming task was presented. Brain activity was modulated by semantic priming only after the semantic but not after the perceptual induction task in left ventral occipito-temporal cortex (VOT), a brain area known to be involved in semantic processing. Functional connectivity analyses of left VOT as seed region revealed different functional networks depending on the active task set: During a semantic task set, VOT was more strongly coupled with a frontal region involved in semantic retrieval, whereas during a perceptual task set a stronger coupling of VOT with visual perceptual brain regions in occipital cortex was found. Most importantly, functional connectivity patterns predicted the magnitude of subliminal priming. Hence, attentional control modulates unconscious processing in semantic pathways by a dynamic integration of brain areas into different functional networks.

### D11

**NEURAL ACTIVATION ABNORMALITIES UNDERLYING FACIAL EMOTION PERCEPTION IN SCHIZOPHRENIA PATIENTS AND FIRST-DEGREE RELATIVES** Michael J. Spilka[1], Aiden E. Arnold[1], Vina M. Goghari[1]; [1]University of Calgary — A core feature of schizophrenia is impairment in social cognition, including deficits in perceiving emotional information from faces. Recent evidence of similar impairments in healthy relatives of schizophrenia patients suggests that impaired facial emotion perception may be a marker of genetic vulnerability for the disorder. Abnormalities in brain functioning associated with facial emotion perception are reported in schizophrenia; however, findings are inconsistent regarding the extent to which abnormalities include visual areas and/or regions involved in emotion processing. One explanation is that traditional facial emotion tasks recruit a variety of additional cognitive mechanisms (e.g., context processing) that influence the neural activation patterns reported. Moreover, few studies have included unaffected relatives, reducing the ability to answer questions concerning the genetic basis of this deficit. The current study aims to 1) clarify the neural basis of impaired facial emotion perception in schizophrenia through a simple passive viewing task of facial emotion perception, and 2) investigate the genetic risk for neural activation abnormalities related to facial emotion by using a family study design. Twenty-eight schizophrenia patients, 27 unaffected relatives, and 27 healthy controls underwent a functional magnetic resonance imaging (fMRI) scan while viewing images of different facial emotions. Region-of-interest and whole-brain analyses revealed hypoactivation in face processing areas for both schizophrenia patients and unaffected relatives compared to controls, and hyperactivation in relatives for frontal regions implicated in emotion processing. Results suggest that activation abnormalities during facial emotion perception represent genetic vulnerability markers for schizophrenia, and may be accompanied by compensatory mechanisms in relatives.

### D12

**ATTENUATED VISUAL N1 FOLLOWING ERRORS** Liesbet Van der Borght[1], Hanne Schevernels[1], Boris Burle[2], Wim Notebaert[1]; [1]Ghent University, [2]Aix-Marseille Université — Errors are typically followed by a series of behavioural changes. While slowing down following an error is a robust phenomenon, adaptations in accuracy proved more elusive. Recently Houtman and Notebaert (2013) demonstrated, using a rapid serial visual presentation task, that participants showed worse target detection following an error in an unrelated flankertask. These findings support the idea that the occurrence or processing of unexpected error-like events interfere with subsequent information processing (Notebaert et al., 2009: Jentzsch & Dudschig, 2009). Following these results, we investigated the effect of errors on early visual ERP components. For this purpose we combined a flanker and a visual oddball task. Additionally we manipulated the intertrial interval between both tasks to investigate the duration of these negative after-effects. In an effort to discern these early ERP components more clearly we applied Laplacian transformation on the monopolar averages. Interestingly the results show no influence of previous accuracy on both the P1, measured at PO7 and PO8, and N1, measured at Oz. However, the amplitude of a slightly later N1, at PO7 and PO8, was significantly smaller following an error than following a correct response, irrespective of the intertrial-interval. Interestingly the visual N1 has been related to endogenous attention (Hopfinger & West, 2006). These results are in line with the finding of an attentional dip following errors, providing evidence for the idea that low-level attentional processing following an error is impaired.

### D13

**DYSREGULATED FUNCTIONAL CONNECTIVITY OF ATTENTION AND VALUATION NETWORKS: IMPLICATIONS FOR DECISION MAKING IN AUTISM** Merage Ghane[1], John A. Richey[1], Ralph-Axel Müller[2]; [1]Virginia Polytechnic Institute and State University, [2]San Diego State University — Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder affecting multiple levels of socio-communicative functioning. Slowed switching of attention also characterizes individuals with ASD. Lower-level attention processes, like orienting towards salient stimuli, play a role in higher-order functions. In a social environment, efficient attention is crucial for value-based decision-making. Visual-attention brain-regions were found to modulate signals in areas involved in valuation and decision-making. As such, we predict that social-functioning may be driven by altered functional--connectivity between visual-attention and valuation networks in ASD. Individuals with ASD were predicted to show decreased functional-connectivity between attention and valuation network regions. Our sample included 16 children with ASD (M=12.86 years) and 13 control (M=12.67 years) participants. We used seed-based resting-state functional-connectivity to evaluate the relationship within-and-between the attention and valuation networks. Imaging analyses were performed using AFNI software (Cox, 1996). Data were slice-time and motion corrected, scrubbed for artifacts, and co-registered to a standardized MNI-152 T1-weighted 1 image. Regions-of-interest (ROIs) were based on peak-activation coordinates from the results of a study by Litt and colleagues (2011). Averaged ROI time-series were correlated with each other to assess network connectivity. Thirty-eight connections within and between attention and valuation-networks were different in ASD (all ps≤.05 corrected). Of these thirty-eight, thirty-two were instances of overconnectivity in ASD. Diffuse between-network overconnectivity may signify decreased network independence, resulting in increased cross-talk between functionally-related, but independent networks. Also, dysregulated connectivity was found across all regions of each network, including key lower and higher-order regions involved in visual-attention, self-referential thought, and reward learning.

### D14

**PASSENGERS: THE DRIVING DISTRACTION WE CAN'T LIVE WITHOUT** Michelle Chan[1], Simbarashe Nyazika[1], Anthony Singhal[1]; [1]University of Alberta — The human attention system is limited in capacity, and when performing two concurrent tasks there is competition for cognitive resources. This is particularly important in dangerous scenarios, such as driving a car in heavy traffic where deficits in performance can be caused by various sources of distraction, including the presence of passengers in the vehicle. In the present study, 20 participants performed a dual-task paradigm to examine the nature of attentional limits while operating a driving simulator under cognitive load. The primary driving task had two levels of difficulty, and we had conditions with and without a passenger present. We also collected event-related potentials (ERP) from a secondary competing task. Our primary hypothesis was that the presence of a passenger would consume more attentional resources, reflected in the morphology of the P300, particularly in the more difficult driving conditions. The results showed that operators drove faster in the easy driving conditions, and that the dual-task conditions compared to single task were associated with slower driving speeds. As expected, we observed a decrease in P300 amplitude and an increase in its latency from single to dual-task conditions. Importantly, the presence of a passenger was associated with smaller P300 amplitudes in both the easy and difficult driving conditions. Taken together, these data show that in-car passengers may bleed away valuable resources in driving situations that require more attentional focus in the first place.

## EMOTION & SOCIAL: Emotion-cognition interactions

### D15

**TASK-EVOKED BRAIN ACTIVITY AFTER NEGATIVE INDUCTION PREDICTS ENHANCEMENT OF MEMORY FOR NEUTRAL MATERIAL** Morenikeji Adebayo[1,2], Joseph Andreano[1,2], Alexandra Touroutoglou[1,2], Bradford Dickerson[1,2], Lisa Feldman Barrett[1,2,3]; [1]Harvard Medical School, [2]Massachusetts General Hospital, [3]Northeastern University — Previous research has shown that activity in regions of the salience network (SN) during the encoding of negative stimuli predicts later successful subsequent memory (LaBar & Cabeza, 2006). Behavioral experiments have also shown that arousing experiences temporally adjacent to the encoding of neutral stimuli enhance memory (Anderson et al., 2006). We tested the hypothesis that task-related activation of salience regions during a negative affect induction would predict enhancement of memory for neutral material on an encoding task immediately following induction. 41 young adults each completed two scan sessions, approximately 1 week apart. In the first session participants underwent a negative affect induction, then completed a neutral paired associate memory task. The second session was identical, except a neutral pre-encoding affect induction was used. We measured memory

enhancement (Δd′) by subtracting the signal detection score under neutral induction from the signal detection score under negative induction. We measured SN reactivity by contrasting activity during negative vs. neutral affect induction. Linear regression was used to examine the relationship between salience reactivity and Δd′ due to affect. A significant relationship between induction activity and Δd′ was found in two major SN nodes (anterior insula & anterior cingulate cortex). A similar trend approaching significance was also observed in the amygdala. These findings confirm previous research that shows the motivational relevance of neutral material can be enhanced by affect. They are the first to demonstrate that activity in the SN during affect induction, prior to encoding, predicts the magnitude of memory enhancement for neutral material.

## D16

### THE INTERPLAY OF CHOICE AND EFFORT ON OUTCOME PROCESSING

Holly Sullivan-Toole[1], Christina Bejjani[1], Elizabeth Tricomi[1]; [1]Rutgers University-Newark — Both the level of effort expended and the provision of choice can influence reward processing, either positively or negatively, depending on the context. While previous work has begun exploring these influences, little is known about the interactive effects of choice and effort on reward valuation. To examine the neural underpinnings of this potential interaction, we designed a physical effort task for use with fMRI involving free- and forced-choice (Choice and No Choice) trials of varying effort levels (Low- and High-Effort), disguised as a video game in which subjects fight aliens using "blasters" charged manually by quick, repeated button presses. Choice and effort conditions were not explicitly labeled but were represented by blasters of different color categories. A 2x2 ANOVA of subjects' preference for the blaster stimuli revealed a main effect of effort such that subjects preferred Low- compared to High-Effort blasters ($p < .0001$). While there was no significant main effect of choice, the preference for Low-Effort blasters was marginally greater when subjects got to choose them than when these blasters were provided without choice ($p = .062$). Neuroimaging results showed increased activation in regions within the brain's "reward" network, including the ventromedial prefrontal cortex and ventral striatum, for outcomes following Low-Effort compared to High-Effort trials, in line with the ratings showing a preference for Low Effort. Our results suggest that although both choice and effort may modulate preferences, this modulation may be more salient for effort than for choice in the context of a physical effort task.

## D17

### THE TIME-COURSE FOR THE CAPTURE AND HOLD OF VISUOSPATIAL ATTENTION BY FEARFUL FACES

Erin Wylie[1], Robert Torrence[1], Karen Reinke[2], Joshua Carlson[1]; [1]Northern Michigan University, [2]University of Illinois Springfield — Fearful facial expressions are important social signals of potential environmental threat, which automatically capture observers' attention. Fearful faces both facilitate the orienting of attention to their location as well as delay the disengagement of attention from their location. However, little is known about the time-course for these orienting and disengagement effects. To address this knowledge gap we ran two dot-probe studies in which we systematically varied the time-point in which attention was sampled. Both experiments began with a central fixation point followed by two laterally presented faces. After which a dot was presented on the left or right side of the screen. In Experiment 1, dots occurred 133ms, 266ms, and 532ms post-face onset and in Experiment 2, dots occurred 84ms, 168ms, 336ms, and 672ms post-face onset. Participants were told to locate the dot as quickly as possible. Directed attention trials contained one fearful and one neutral face. Dots occurring behind a fearful face were labeled "congruent" and dots appearing behind the neutral face were labeled "incongruent". Undirected baseline trials contained two neutral faces. In Experiment 1, for both 133ms and 266ms conditions, reaction times were fastest for congruent trials and slowest for incongruent trials with reaction times for baseline trials falling between the two. The same was found for the 84ms and 168ms conditions in Experiment 2. For the later times in both experiments there was no significant difference between reaction times. Overall, the results suggest that attention is captured and held by fearful faces at times earlier than 300ms.

## D18

### EFFECTS OF ANXIETY ON NEURAL SIGNATURES OF EMOTION CONFLICT PROCESSING IN OLDER ADULTS

Jill D. Waring[1,2], Ruth O'Hara[1,2], Amit Etkin[1,2]; [1]Stanford University School of Medicine, [2]VA Palo Alto Healthcare System — The literature has shown an age-related decline in performance on classic 'cognitive' executive function tests, like the traditional color-word Stroop task. However, healthy older adults do not differ from younger adults in distraction by task-irrelevant emotional stimuli, and they experience lesser effects of emotional distraction across trials. There is also a strong correspondence between poor emotion regulation and impaired cognition in late life. The present study was designed to examine the relationship between neural mechanisms of control over responses to emotional distractors and measures of psychological wellbeing in healthy older adults. Participants completed a face-word emotion conflict task (fear, happy) during functional magnetic resonance imaging, as well as several neuropsychological measures of cognition and wellbeing. Facilitated emotion conflict processing was observed on face-word incongruent trials following another incongruent trial (i.e., emotional conflict adaptation), as reflected in faster reaction times. There was no significant correlation between accuracy or reaction times for emotion conflict adaptation and reported trait anxiety (STAI). However, there were significant differences in the neural signatures of emotion conflict adaptation as a function of anxiety. Results showed significant positive correlation between amygdala activation for emotional conflict adaptation and trait anxiety. These results further clarify the relationship between psychological wellbeing and effective control over responses to emotional distractors in late life.

## D19

### IMPACT OF DAMAGE TO HIPPOCAMPUS, AMYGDALA, AND VENTROMEDIAL PREFRONTAL CORTEX ON SOCIAL NETWORK SIZE

Janelle Beadle[1], Melissa C. Duff[1]; [1]University of Iowa — Medial temporal lobe damage has been associated with subtle effects on social networks—patients report network sizes comparable to healthy adults, but these relationships are primarily with family, with few friends acquired after brain damage (Davidson et al., 2012). Here, we replicate this finding in patients with hippocampal damage and anterograde amnesia (5 HC patients) and extend this line of work by examining social network size in patients with damage to neural systems critical for socioemotional processing, including ventromedial prefrontal cortex (4 vmPFC patients) and amygdala (2 HC+AMY patients) in comparison to healthy adults (NC=16). Using the National Social Life, Health, and Aging Project questionnaire, we examined social networks in the four participant groups. Consistent with previous findings, HC patients reported social networks of similar size to NC participants (HC: M=6.80; NC: M=5.25). HC patients reported comparable numbers of family members among their close friends to NC participants (HC: M=52.38%; NC: M=55.10%). Interestingly, memory severity did not modulate social network size. HC patients with mild (N=2) and severe amnesia (N=3) reported similar numbers of close relationships (HC mild=6.50; HC severe=7.00). Patients with vmPFC damage and HC+AMY damage reported having fewer close relationships than HC participants (vmPFC=4.25; HC+AMY=2) and a greater proportion of those close relationships were with family members (vmPFC=70.00%; HC+AMY=100%). Damage to neural systems critical for memory and/or socioemotional processing may alter components of social networks differentially. Future research further characterizing the relative contributions of memory function and socioemotional processing for social network size and quality is warranted.

## D20

### ERP EVIDENCE FOR DISTINCTIONS IN PROCESSING SEMANTIC ASSOCIATIVE AND A VALENCE RELATIONSHIPS

Nathaniel Delaney-Busch[1], Anne Choong[1], Barbara Storch[1], Jennifer Kurzrok[1], Gina Kuperberg[1,2]; [1]Tufts University, [2]Martinos Center for Biomedical Imaging, Massachusetts General Hospital — "Semantic priming" denotes the faster response to "target" words preceded by "prime" words that are semantically associated than to target words preceded by prime words that are semantically unassociated. Affective priming denotes the faster response to emotional words preceded by words of the same versus opposite emotional valence. A large event-related potential (ERP) literature suggests that semantic priming

results in facilitated semantic processing, reflected by an attenuation of the N400 to targets preceded by associated (vs. unassociated) primes. The ERP signatures of affective priming, however, have been more mixed, and most studies have not fully controlled for semantic association. We carried out two ERP studies that fully crossed semantic (associated vs. unassociated) and affective (same valence vs. opposite valence) relationships between prime and target (SOA: 250ms). In Experiment 1, participants judged whether each word pair was semantically related or unrelated, and in Experiment 2, a separate set of participants judged whether each word pair had the same (or opposite) valence. In both experiments, we saw clear N400 effects of semantic priming, as anticipated. However, we saw no effects of affective priming on either the N400 or the late positivity ERP components. Moreover, the effects of semantic priming on emotional and neutral words were similar. These results provide evidence that the neural mechanisms engaged in computing semantic relationships are distinct and independent from those engaged in computing valence relationships.

### D21

### DOMAIN SPECIFICITY IN COGNITIVE FATIGUE IN TRAUMATIC BRAIN INJURY: AN FMRI STUDY

Glenn Wylie[1,2,3], Helen Genova[1,2], Nancy Chiaravalloti[1,2]; [1]Kessler Foundation, [2]Rutgers University - Medical School, [3]The Department of Veterans' Affairs

— Cognitive fatigue, or fatigue resulting from cognitive activity rather than physical exertion, is a pervasive and persistent problem for individuals who have sustained a Traumatic Brain Injury (TBI), affecting between 60 and 90% of persons with TBI in both the acute and chronic phases. Despite this, cognitive fatigue has proven difficult to study because objective measures of performance, such as response time, routinely fail to correlate with subjective reports of cognitive fatigue. In the current study, we used functional magnetic resonance imaging (fMRI) to study cognitive fatigue. We used a fatigue induction paradigm in which cognitive fatigue was induced by a working memory task (the n-back working memory task) and a processing speed task (the modified symbol-digit modalities test [mSDMT]). We anticipated that the n-back task would induce fatigue because working memory is known to be affected in individuals who have sustained a TBI. Our results supported this hypothesis: individuals with TBI reported more fatigue during the n-back task than healthy controls (HCs), and they had more fatigue-related brain activation in the basal ganglia (the caudate) than HCs. However, during the processing speed task, this was not the case: individuals with TBI did not report more fatigue during the mSDMT than HCs, and they did not show increased fatigue-related brain activation during the mSDMT than HCs. These results suggest that fatigue in TBI is process specific and that this can be objectively measured with fMRI.

### D22

### THE EMOTIONAL CONTEXT MODULATES THE PROCESSING OF THE MNEMONIC INSTRUCTIONS IN INTENTIONAL FORGETTING: AN ERP STUDY

Tzu-Ling Liu[1], Daisy L. Hung[1], Ovid J.-L. Tzeng[1,2], Shih-kuen Cheng[1]; [1]Institute of Cognitive Neuroscience, National Central University, Taiwan, [2]Institute of Linguistics, Academia Sinica, Taiwan

— Emotional materials are usually better remembered than neutral ones. However, it is not yet clear whether and how valenced memories resist to intentional forgetting. The current study addressed this issue by examining the event-related brain potentials (ERPs) elicited by the Remember and Forget cues to neutral words that were embedded in a neutral or a negative context. At study, participants were asked to associate a neutral word with a preceding negative or neutral picture. A Remember or a Forget cue was then presented to signal whether the word was to be remembered or forgotten. In the following test, participants made old/new judgments to the studied old words and unstudied neutral words without the presentation of emotional contexts. Behavioral data revealed interaction between emotions of backgrounds and memory cues, showing a lower recognition rate for to-be-remembered words paired with negative backgrounds. The analysis of the ERPs time-locked to the study word found a significant emotional effect on early attention-related and later word processing components. In addition, the mnemonic cues presented in the neutral backgrounds elicited a more positive-going waveform than those in the negative backgrounds. Interactions between emotion of context and memory cues were found during 325-400ms and 500-550ms post cue presentation, showing greater posterior positive RF effect and frontal-central negative RF effect for neutral condition respectively. We consider that emotional state may affect both selective rehearsal to TBR words and inhibition to TBF words, however, the behavioral index may not be sensitive enough and showed only modulation on TBR words.

### D23

### EFFECT OF A VIRTUAL REALITY TSST ON FOOD CHOICE AND RISK TAKING

David Fraser[1], Michal Gould[1], Tammy Schaeffer[1]; [1]Chatham University

— Stress plays a significant role in shaping many behaviors related to choice and consumption of food. In this experiment, behavioral and physiological measures were collected to test hypotheses about the relationship between stress and two behaviors: food choice and risk taking. Salivary cortisol was measured from subjects that participated in a psychosocial stress task followed by food choice and risk taking tasks. The stress task was a modification of the Trier's Social Stress Test (mTSST) that used a virtual reality system to simulate an audience. The food choice task was constructed using individual pre-test ratings of food items. The hypothesis was that the mTSST would elicit a sufficient cortisol release to both; a) bias subjects towards choosing high-fat, high-sugar foods and b) more risk taking behavior. The results support the conclusion that the virtual reality mTSST evoked a mild stress response (as measured by cortisol change from baseline), which encouraged healthier food choices without the expected concurrent changes in risk-taking behavior. While this is in contrast to much of the published literature, it is proposed that mild increases in cortisol levels may have a beneficial (healthy) effect on food choices, much in the same way that mild cortisol increases benefit a multitude of cognitive functions. In this sense, a little stress is a good thing.

## EMOTION & SOCIAL: Emotional responding

### D24

### HUMAN AMYGDALA STIMULATION EFFECTS ON EMOTION PHYSIOLOGY AND EMOTIONAL EXPERIENCE

Stephan Hamann[1], David Bass[1], Cory Inman[1], Robert Gross[1], Jon Willie[1]; [1]Emory University

— The amygdala is a key structure mediating emotional processing. Few studies have used direct electrical stimulation of the amygdala in humans to examine stimulation-elicited physiological and emotional changes, and the nature of such effects remains unclear. We stimulated the amygdala in epilepsy patients undergoing iEEG monitoring. Stimulation of amygdala contacts was contrasted with sham stimulation and lateral contact stimulation along the same electrode. Frequency (50 Hz) and pulse width (300 μsec) were held constant, while amplitude varied between lower (4 ≤ mV) and higher (>4 mV) amplitudes in a stepwise fashion, with subjects blinded to stimulation condition. Skin conductance, respiration, and heart rate were recorded while behavior was videotaped. Higher-amplitude amygdala stimulation (but not lateral control or sham stimulation) elicited rapid and substantial heart rate deceleration and increased skin-conductance, paralleling stimulation findings with animals and consistent with orienting/defensive physiological responses observed with aversive visual stimuli. However, no significant changes in mood or subjective emotional responses were observed, suggesting that amygdala stimulation can produce physiological changes associated with emotion without eliciting simultaneous changes in subjective emotional state. Ongoing emotional responses to emotional videos were also not interrupted by amygdala stimulation. More intense stimulation may be required to elicit subjective emotional responses such as fear that have been reported previously. In summary, these findings suggest that acute amygdala stimulation in humans is safe and can reliably elicit changes in emotion physiology without significantly affecting subjective emotional experience, providing a useful paradigm for investigation of amygdala-mediated modulatory effects.

### D25

### SECTION-SPECIFIC ASSOCIATIONS BETWEEN CINGULUM BUNDLE AND UNCINATE FASCICULUS MICROSTRUCTURAL PROPERTIES AND POSTTRAUMATIC STRESS SYMPTOM SEVERITY

Tong Sheng[1,2], Keith L. Main[1,2], Linda Isaac[1,2], Jordan Nechvatal[1,2], J. Kaci Fairchild[1,2], Salil Soman[1,2], Ansgar J. Furst[1,2], J. Wesson Ashford[1,2], Maheen M.

Adamson[1,2]; [1]Palo Alto VA Medical Center, [2]Stanford University School of Medicine — In posttraumatic stress disorder (PTSD), cognitive and affective processes that enable appropriate behavior during stress become dysregulated, resulting in unwanted and unwarranted experiences of fear, anxiety, and/or aggression. Abnormalities in the cingulum bundle and uncinate fasciculus, two limbic system fiber tracts, have been shown to be associated with PTSD. However, a precise mapping of section-specific relationships between fiber tract microstructure properties and PTSD symptom severity is currently lacking. In the current study, Veterans (N=81; age: 23-71 yrs) underwent diffusion tensor imaging and completed a questionnaire assessing current (i.e., last-month) PTSD symptom severity. White matter microstructural properties (i.e., fractional anisotropy (FA), mean diffusivity (MD)) of the cingulum bundle and uncinate fasciculus were calculated using automated fiber quantification in individual sections along the entire length of each fiber tract. Tract- and section-specific multiple regression analyses, with FA and MD as predictors, were used to predict PTSD symptom severity. White matter microstructural properties in middle-posterior right cingulum and posterior and anterior-middle right uncinate predicted PTSD symptom severity. No sections of the left cingulum or right uncinate predicted PTSD symptom severity. These findings offer a detailed, section-specific mapping of the relationships between limbic system fiber tracts and PTSD symptoms. However, the modest effect sizes observed (adj.-R^2: .050-.059) suggest that PTSD symptomology cannot be fully accounted for by these two fiber tracts alone, and that additional networks should be considered.

## D26

## EMOTIONAL PROCESSING BIASES FACE IDENTITY PERCEPTION

Regina C Lapate[1], Alison Austermuehle[1], Richard J Davidson[1]; [1]University of Wisconsin-Madison — It is known that the processing of negative facial expressions modulates encoding in ventral visual cortex and biases assessments of subsequently presented faces in a valence-congruent manner (e.g., by reducing likeability judgments). However, the extent to which such emotional processing goes beyond influencing subjective appraisals to bias face perception in objective domains, such as identity recognition, is unknown. To examine this, we conducted a two-phase experiment comprised of an evaluative-conditioning task with two facial identities followed by an identity-recognition task embedded in an affective-priming procedure. During evaluative conditioning, one facial identity was associated with repulsive actions (CS+) and the other with agreeable actions (CS-). Six morphs of these two identities were created to probe facial-identity recognition (55%, 58% and 61% per identity). Next, in the identity-recognition task, disgust and happy facial expressions were presented for 16.7ms and followed by a morphed face (CS+ or CS-) for 2s, and participants were asked to indicate morph identity as accurately as possible in a 2-alternative forced choice (2AFC) task. In half of the trials, prime awareness was prevented via backward masking. A significant two-way interaction between prime valence and CS type on 2AFC accuracy ($F(1,75)= 5.8$, $p = .018$) indicated that recognition performance for the CS+ identity was improved when primed by disgust (relative to happy) facial expressions ($p = .008$), regardless of prime awareness or morph level. Thus, this study shows that emotional misattribution effects on face processing extend beyond subjective appraisals into the domain of identity perception.

## D27

## MUSIC ANHEDONIA FOLLOWING FOCAL BRAIN INJURY: A SELECTIVE LOSS IN MUSICAL PLEASURE

Amy Belfi[1], Erin Evans[1], Daniel Tranel[1]; [1]University of Iowa — Listening to music is often a highly pleasurable experience. Pleasurable music activates brain regions important for other highly rewarding experiences, such as food, sex, and drugs. Therefore, a loss of this pleasurable response to music is both notable and rare. A selective loss of musical pleasure has been termed "music anhedonia." Currently, three isolated cases of music anhedonia have been reported, although no group-level investigation into the neural structures underlying music anhedonia has been undertaken. Here, we present a systematic investigation of music anhedonia in patients with focal brain damage. Two-hundred neurological patients with focal brain lesions were solicited to fill out questionnaires that evaluate changes in musical preferences, experiences, and behaviors after brain injury. An additional questionnaire was included to collect information about the participant's changes in musical behaviors from a close friend or family member. Seventy individuals completed all questionnaires. We identified eight individuals who showed a significant decrease in their enjoyment of music following their brain injury. These patients were identified as exhibiting 'music anhedonia.' Notably, these individuals did not show anhedonia for other pleasurable experiences, such as spending time with friends or enjoying a good meal. The individuals exhibiting music anhedonia post-brain lesion tended to have lesions in emotion-related brain regions, such as the striatum, insula, and vmPFC. Our results indicate a dissociation between a loss in enjoyment of music and enjoyment of other pleasurable experiences.

## D28

## MOODIFY: A MOBILE HEALTH APP TO ASSESS CURRENT MOOD STATE

Mor Nahum[1], Tom Van Vleet[1,2], Vikram Rao[3], Julie Mirzabekov[3,4], Vikaas Sohal[3], Annika Rose[1], Edward Chang[3]; [1]Posit Science, [2]Veterans Administration, Martinez, [3]UCSF, [4]UC Berkeley — Assessment of current depressive and/or anxious mood states may prove beneficial for clinical populations with mental health challenges. Here, we report the development and initial testing of an ecological momentary assessment strategy called 'Moodify'. This mobile health app incorporates both explicit and implicit measures of cognitive-emotional processes to determine current mood states. Specifically, Moodify includes: (1) validated questionnaires (PHQ-9, GAD-7, Rumination scale); (2) Immediate Mood Scaler: an assessment task in which participants are required to rate their current mood on a continuum (e.g. distracted-focused; sleepy-alert, etc.); and (3) implicit behavioral assessments designed to capture attentional biases typical of depression and anxiety (e.g., biased responses to sad, happy or neutral facial expressions). We have pilot-tested Moodify in 30 healthy and depressed participants with depression scores ranging from minimal to severe. Participants completed at least one Moodify session, including all assessments described above. We found that remotely-deployed (iPad) versions of the standardized measures of depression (PHQ-9) and anxiety (GAD-7) were highly correlated ($r=.89; p<.00001$) with each other. Similarly, the correlation between the PHQ-9 score and the novel IMS was high ($r=.75; p<.00001$). In addition, participants with moderate or severe depression were as accurate as non-depressed participants in identifying sad expressions, but their reaction time (RT) to sad faces was longer (670±15.8ms vs. 621±23.2ms; $p<.007$), indicating attentional bias to sad affect. RT for sad expressions also correlated with the severity of depression (PHQ-9; $r=.44$, $p <.03$). These data provide initial validation of Moodify as a mobile health tool that accurately captures mood states in individuals.

## D29

## FUNCTIONAL ROLE OF AMYGDALA SUBNUCLEI: A HIGH-RESOLUTION FUNCTIONAL MAGNETIC RESONANCE STUDY OF EMOTIONAL PROCESSING.

Stanislau Hrybouski[1], Arash Aghamohammadi[1], Andrea Shafer[1], Christopher Madan[1,2], Corey Baron[1,3], Peter Seres[1], Fraser Olsen[1], Nikolai Malykhin[1]; [1]University of Alberta, [2]Boston College, [3]Stanford University — The neuroanatomical substrate of emotional processing has been studied using functional magnetic resonance imaging (fMRI) for a number of years. While much of this research has focused on the amygdala, most studies have not had the spatial resolution required to isolate the individual amygdala subnuclei. In the present study we developed a high-resolution fMRI protocol aimed at elucidating the functional significance of the amygdala subnuclei in emotional processing. Healthy volunteers rated images of varying levels of emotional arousal in an event-related fMRI task. T2*-weighted axial EPI volumes were acquired on a Varian Inova 4.7T scanner (30 axial slices, TE = 19 ms, TR = 2000 ms, 74 volumes, resolution = 1.5 mm × 1.5 mm ×1.5 mm). An ultra-high resolution structural T2-weighted 2D Fast Spin Echo (FSE) scan (90 coronal slices, TE = 39 ms, TR = 11000ms, resolution = 0.52 mm × 0.68 mm × 1.0 mm) was acquired for high-precision manual segmentation of the amygdala into centromedial (CeM), basal (Ba), and lateral (La) subnuclei groups. Activation results showed that the CeM group experiences the greatest modulation of BOLD response based on the emotional content of a stimulus. Furthermore, the CeM BOLD response peaked significantly later compared to BOLD response of the other subnuclei. And because our intra-amygdala functional connectivity results showed that there is little communication between La and CeM sucnuclei,

we propose that emotional processing pathway in the human amygdala flows from La to Ba to CeM, with the latter subnucleus group being most sensitive to emotion.

## D30

### SOCIAL ANXIETY DISORDER IS ASSOCIATED WITH IMPAIRED PSYCHOPHYSIOLOGICAL DISCRIMINATION LEARNING DURING FEAR GENERALIZATION

Lea M. Ahrens[1], Andreas Mühlberger[2], Andreas Reif[3], Gernot Langs[4], Paul Pauli[1], Matthias J. Wieser[1]; [1]University of Wuerzburg, [2]University of Regensburg, [3]Goethe University, Frankfurt am Main, [4]Schoen Clinic, Bad Bramstedt — Meta-Analyses found generalization of conditioned fear to be a robust marker in the pathology of several anxiety disorders, such as panic disorder, posttraumatic stress disorder and generalized anxiety disorder. As there exist no conditioning studies assessing overgeneralization in social anxiety disorder (SAD), the current study examined whether it also plays a role in SAD. Twenty-six patients with a diagnosis of SAD and thirty healthy controls (HC) were conditioned to two neutral female faces serving as conditioned stimuli (CS+: reinforced; CS-: non-reinforced) with a fearful face paired with a loud scream serving as unconditioned stimulus (US). Fear generalization was tested by presenting morphs of the two faces (GS: generalization stimuli) which varied in their similarity to the original faces. During the whole experiment self-report ratings and skin conductance responses (SCR) were recorded. Results revealed that SAD patients rated all CS and GS as less pleasant and more arousing, and overestimated the occurrence of the US compared to HC. Moreover, ratings indicated that both groups generalized their acquired fear from the CS+ to intermediate GS as a function of their similarity to the CS+. Interestingly, only HC showed the same pattern in the SCR, while SAD patients did not distinguish among the GS on a psychophysiological level. The findings point to impaired discrimination learning in SAD patients, which may contribute to the maintenance of SAD. Discrepancies between behavioral and psychophysiological measures might be explained by different underlying learning mechanisms (signal learning vs. evaluative conditioning).

## D31

### CORTICAL ACTIVATION DURING PHASIC FEAR AND SUSTAINED ANXIETY – EVIDENCE FROM STEADY-STATE VEPS

Anna K. Kastner[1], Paul Pauli[1], Matthias J. Wieser[1]; [1]University of Würzburg, Germany — Predictable aversive events evoke a phasic fear response, while the unpredictability of an aversive event can lead to a sustained anxiety response due to the chronic expectation of threat. The present study aimed at differentiating the electrocortical responses elicited by predictable and unpredictable threat, using steady-state VEPs (ssVEPs) with frequency tagging, in a paradigm with three different rooms and three associated persons to manipulate predictability. In one room, an aversive noise burst was cued by the appearance of a person, in the second room the aversive noise was presented unpredictably, independently of the person's appearance, while in a neutral control condition no aversive sound was presented. SsVEPs and explicit ratings in response to context and cue stimuli in all three conditions were recorded. A fear response with enhanced ssVEP-amplitudes in response to the predictable cue compared to the neutral cue and an anxiety response indicated by enhanced ssVEP-amplitudes in response to the context in the unpredictable condition compared to the neutral condition were observed. Interestingly, the context of the predictable condition elicited augmented ssVEP-amplitudes as well. On the explicit level, increased arousal and anxiety ratings and decreased valence ratings for both context and cue in the predictable and unpredictable condition were found. Results suggest that both predictable and unpredictable threat similarly receive increased attentional resources, even when not signaling any immediate threat as for the context in predictable condition. This indicates that in the presence of a threat cue, attentional resources are also devoted to processing of the environment.

## D32

### ANTICIPATION TO EMOTIONAL STIMULI AND PSYCHOPATHY: AN ERP STUDY

Elvira Kirilko[1], Amy Medina[1,2], Ellen Reinhard[1], Edward Bonfiglio[1], Jill Grose-Fifer[1,2]; [1]John Jay College of Criminal Justice, CUNY, [2]The Graduate Center, CUNY — We examined the neural correlates of anticipation to emotional images in college students with high and low psychopathic traits. ERPs were recorded from adult males with either high or low levels of psychopathic traits while they viewed pleasant, unpleasant, and neutral IAPS images. In a previous study (Medina et al., 2014), we found that students with high psychopathic traits showed attenuated LPPs in response to these emotional stimuli. Therefore, we predicted that anticipation responses to emotional stimuli (indexed by the stimulus-preceding negativity [SPN]) would be smaller in the high than in the low psychopathic trait group. We also hypothesized that viewing an unpleasant picture would increase anticipation for the next picture, as evidenced by a larger SPN, especially in the low-trait group. In both groups, the SPN just before picture presentation was greater after participants viewed unpleasant images than after they viewed neutral images. However, there were no group differences in the size of the SPN. In contrast, the SPN in an earlier window (just after picture offset) showed group differences. Students in the low psychopathic trait group showed a greater SPN after viewing erotic images than those in the high group. Our results suggest that psychopathic traits in college students affect their anticipation to emotional images.

## D33

### COST OR BENEFIT? TRANSCRANIAL DIRECT CURRENT STIMULATION PRODUCES OPPOSITE BEHAVIOURAL AND PHYSIOLOGICAL EFFECTS IN THE CASE OF MATHEMATICS ANXIETY

Amar Sarkar[1], Ann Dowker[1], Roi Cohen Kadosh[1]; [1]University of Oxford — Transcranial direct current stimulation (tDCS) has been used to induce benefits across the psychological spectrum. However, there is little research on how individual differences might influence stimulation outcomes. We investigated the role of trait differences in stimulation effects using the case of mathematics anxiety, the negative emotional response elicited by numerical tasks. Participants with high and low mathematics anxiety were tested in a double-blind, placebo-controlled, crossover experiment. tDCS was applied to the dorsolateral prefrontal cortex while participants performed a simple arithmetic task. Stimulation produced opposite effects depending on the level of mathematics anxiety. For high mathematics anxiety participants, real tDCS significantly lowered both reaction times on the arithmetic task and salivary cortisol concentrations (a biomarker of stress) in real compared to placebo tDCS. For participants with low mathematics anxiety, real and placebo tDCS exerted precisely the opposite effects in reaction times and salivary cortisol. Both groups exhibited a tDCS-induced cost, impaired executive control on the attentional networks tasks. These behavioural and physiological double-dissociations reveal tDCS can produce completely different outcomes based on individual trait levels. These findings are particularly important given the increasing excitement over non-invasive brain stimulation techniques such as tDCS, and highlight the necessity of investigating traits and situations where stimulation may not be beneficial. Indeed, to our best knowledge, these are the first findings indicating tDCS may produce impairments without any appreciable gains, as with the low mathematics anxiety individuals, rather than merely having little to no effect.

## D34

### THE MODULATION OF CLASSICALLY CONDITIONED FEAR GENERALIZATION WITH D-CYCLOSERINE: AN FMRI STUDY

Tori Espensen-Sturges[1], Alicia Kielbasa[1], Philip Burton[1], Kathryn Cullen[1], Shmuel Lissek[1]; [1]University of Minnesota — During conditioned fear generalization, learned fear responses extend to a range of safe stimuli that resemble the original conditioned danger-cue. Although some amount of generalization is adaptive, overgeneralizing fear to safe stimuli is a conditioning correlate of anxiety disorders. As such, fear generalization may be a potential target for treatments of these disorders. To attempt modulation of fear generalization in healthy participants, we used D-cycloserine (DCS), a partial agonist of the NMDA receptor glycine site that has been shown to reduce conditioned generalization in animals. Our generalization paradigm included 5 rings of increasing size, with extreme sizes serving as conditioned danger-cues (CS+: paired with electric shock) and conditioned safety-cues (CS-).The rings of intermediary size served as generalization stimuli, creating a continuum of similarity between CS+ and CS- with which to assess response slopes, referred to as generalization gradients. Participants received either 250mg of DCS, 500mg of DCS, or placebo before acquisition of conditioned fear to the CS+ versus CS-. Twenty-four hours later, generalization was assessed via presentation of the CS+, CS-, and the 3 intermediately sized rings. Due to higher activations to the CS+, generalization gradients were

steeper in the 500mg drug group versus placebo in bilateral anterior insula, medial frontal and supplementary motor areas, and caudate, indicative of reduced generalization. These findings suggest that enhanced memory consolidation of conditioned-fear by DCS, strengthens the retention of CS+/US association, and renders the memory of the CS+ more readily retrievable in the presence of stimuli that only approximate the danger cue.

# EXECUTIVE PROCESSES: Goal maintenance & switching

## D35

### GENETIC CONTRIBUTIONS TO NON-NATIVE SPEECH LEARNING: A NEUROCOGNITIVE APPROACH

Sharon Noh[1], Han-Gyol Yi[1], W. Todd Maddox[1], Valerie Knopik[2,3], John McGeary[2,3,4], Bharath Chandrasekaran[1]; [1]The University of Texas at Austin, [2]Rhode Island Hospital, [3]Brown University, [4]Providence Veterans Affairs Medical Center — We examined non-native speech category learning using a neurocognitive-genetic approach. In vision, two competing dopaminergic category learning systems exist: a reflective system mediated by the prefrontal cortex, and a reflexive system mediated by the striatum. Previous studies have shown that individuals vary in speech learning performance as well as in strategy use, but optimal speech learning is characterized by an initial reliance on reflective strategies and an eventual transition to a reflexive strategy. We tested the hypothesis that genetic predispositions may contribute to the individual variability in speech learning. We focused on the well-studied COMT (SNP rs4680) polymorphism, which has been found to disproportionally modulate dopaminergic activity in the prefrontal cortex relative to the striatum and thereby affects reflective processing. Young adults learned to categorize non-native Mandarin tones in an MR scanner using trial-by-trial feedback. Initially, the carriers of the dopamine-promoting Met-Met genotype showed enhanced learning relative to the carriers of the dopamine-catabolizing Val-Val genotype. Functional magnetic resonance imaging results showed increased prefrontal involvement during feedback processing in Met-Met carriers, suggesting that the early Met-Met advantage was due to enhanced reflective processing. Val-Val carriers eventually showed enhanced learning relative to Met-Met carriers. Computational modeling revealed increased reflexive strategy use in Val-Val carriers towards the end of training, suggesting that the diminished prefrontal activity provided an advantage for the competing striatally-based reflexive system. These results suggest that the individual variability observed in speech learning may partly be due to genetic factors that modulate the underlying neurocognitive mechanisms.

## D36

### BILINGUAL PROFICIENCY AND LEFT PARIETAL ACTIVITY DURING NON-VERBAL TASK SWITCHING

Kelly A. Vaughn[1], Maya R. Greene[1], Aurora I. Ramos-Nuñez[1], Arturo E. Hernandez[1]; [1]University of Houston — Previous research has examined the relationship between language and cognition in bilinguals. This study focuses on the unique contributions of first and second language proficiency on cognitive control. The researchers measured behavioral responses and fMRI activity in a group of 45 Spanish-English young adult bilinguals during the shape-color task, which involves non-verbal task switching. Non-verbal cues presented after every 8-19 trials indicated whether participants should switch rules or continue following the same rule for sorting stimuli by shape or color. Bilinguals showed increased activity in the left parietal lobe (LIPL) to a greater extent for switch trials than non-switch trials, and more for non-switch cues than switch cues. Activity in this region during the trials was also positively correlated with Spanish, but not English proficiency. During the presentation of the cues, activity in the LIPL was correlated with English, but not Spanish proficiency. These findings fit with the notion that the first language, Spanish, is rooted in motor and perceptual abilities, skills that are necessary to respond to the trials. Conversely, the second language, English, is more academic and cognitive, which is helpful for processing the symbolic, non-verbal cues. Behavioral results indicate that English and Spanish proficiency are both negatively correlated with switch costs, which suggests that better overall language skills are correlated with better cognitive control. Taken together these findings show that both language specific and language general skills may be differentially related to separate aspects of cognitive control.

## D37

### THE NEURAL CORRELATES OF MULTITASKING PERFORMANCE FOLLOWING TRAUMATIC BRAIN INJURY: BIGGER IS NOT ALWAYS BETTER.

Starla M. Weaver[1,2], Jordan Grafman[3,4], Glenn R. Wylie[1,2]; [1]Kessler Foundation, [2]Rutgers University, [3]Rehabilitation Institute of Chicago, [4]Northwestern University — A common disabling impairment following traumatic brain injury (TBI) is a deficit in executive functions, including multitasking ability. The current study examined the neural correlates associated with multitasking in persons with TBI using the task switching paradigm. Participants with moderate-to-severe TBI and healthy controls performed task switching while undergoing fMRI. Participants were instructed on the performance of two simple tasks (Uppercase/Lowercase task and Consonant/Vowel task). Following instruction, participants were presented with a series of letter stimuli, which afforded both tasks, and performed one specific task on each stimulus. The experiment included pure task blocks, in which participants performed the same task on each trial, and mixed blocks in which participants switched between tasks in a predictable order. Task performance resulted in more distributed areas of activation in persons with TBI than in healthy participants performing the same task. This difference was particularly large in mixed blocks, in which participants were required to switch tasks. Specifically, mixed block performance led to increased activation in the right superior and middle frontal gyri, the right superior parietal lobe, and bilaterally in the precuneus in persons with TBI. Further, activation in these distributed brain regions was greater for TBI participants who had poor accuracy than for those who performed well. The results suggest that following brain injury multitasking becomes reliant on a more distributed group of brain areas, including greater reliance on right hemisphere regions. However, use of these "compensatory" brain regions does not result in superior performance.

## D38

### LANGUAGE SWITCHING FREQUENCY IN BILINGUALS IS INCONSISTENTLY LINKED TO EXECUTIVE FUNCTIONING

Hunter Johnson[1], Oliver Sawi[1,2], Kenneth R. Paap[1]; [1]San Francisco State University, [2]University of Connecticut — Bilingual advantages in executive functioning (EF) compared to monolinguals are generally believed to be constrained to certain types of bilinguals and/or bilingual experiences (Bialystok, Craik, & Luk, 2012; Kroll & Bialystok, 2014). Recently, Verreyt, Woumans, Vandelanotte, Szmalec, & Duyck (2014) reported advantages of high-switch over low-switch bilinguals in the magnitude of both Simon and flanker effects and concluded that the frequency of language switching is a determining component in reaping bilingual advantages in EF. Given their relatively small n's, 20 per group, confidence in the Verreyt et al. conclusion would be bolstered by a successful replication. We repartitioned our composite database of 168 bilinguals into two groups to re-test this hypothesis based on the bilinguals' responses to a five-point scale regarding how often they currently switch languages: high-switch bilinguals reported switching either several times a day or dozens of times a day whereas low-switch bilinguals reported switching either a couple of times a week or a couple of times a day. Eight separate one-way ANOVAs were conducted using eight different measures of EF obtained through a Simon task, flanker task, and color-shape switching task. There was no evidence supporting the hypotheses that switching frequency in bilinguals enhances the inhibitory control, monitoring, or switching components of EF. Our results are also consistent with the results of three large-n experiments reported by Hernandez, Martin, Barcelo, & Costa (2013) showing no language group differences in switching costs for Spanish-Catalan bilinguals who have very high rates of language switching.

## D39

### HIERARCHICAL ERROR REPRESENTATION GRADIENTS IN MEDIAL PREFRONTAL CORTEX

Noah Zarr[1], Joshua Brown[1]; [1]Indiana University — The medial prefrontal cortex (mPFC) is reliably activated by errors. However, it remains unknown whether error-related activity reflects a scalar error signal, or if instead there are multiple error signals for different

kinds of errors. Substantial evidence shows that lateral prefrontal cortex (lPFC) is arranged in a hierarchy of abstraction, such that more abstract concepts and rules are represented in more anterior cortical regions. Due to the close interaction between lateral and medial PFC, one might expect that mPFC would be organized along a similar rostro-caudal gradient of abstraction, such that more abstract errors are represented more anteriorly, and more concrete errors more posteriorly. Our aim was to investigate whether error-related activity in mPFC reflected a hierarchy of abstraction corresponding to a hierarchy of task rule switches. We predicted that when more abstract rules changed unexpectedly (i.e., when the task environment violated participants' predictions), the error-related activity in mPFC would occur more anterior to the activity observed when less abstract rules changed. Our findings matched our prediction, providing evidence of such a hierarchy of abstraction in mPFC. This result further suggests that regions of mPFC evaluate the rules maintained in correspondingly anterior regions of lPFC.

## D40

### TAI CHI AND MEDITATION-PLUS-EXERCISE EFFECTS ON NEURAL SUBSTRATES OF EXECUTIVE FUNCTION. A CROSS-SECTIONAL, CONTROLLED STUDY.

Teresa Hawkes[1], Wayne Manselle[2], Marjorie Woollacott[2]; [1]Air Force Research Laboratory, [2]University of Oregon — We report the first study of Tai Chi effects on the P300 event-related potential, a neuroelectric index of human executive function. Tai Chi combines exercise and meditation. Exercise and meditation have been associated with enhanced executive function. Importantly, meditation includes yoga or other moderate exercise. This cross-sectional study utilized the P300 event-related potential (ERP) to compare executive network neural function between long-term Tai Chi, meditation, aerobic fitness, and sedentary groups. We hypothesized because Tai Chi requires moderate aerobic and mental exertion, this group would show similar or better executive neural function compared to meditation, and aerobic exercise groups. We predicted all training groups would outperform sedentary controls. 54 volunteers (Tai Chi, n = 10; meditation, n = 16; aerobic exercise, n = 16; sedentary, n = 12) were tested with the Rockport 1-mile walk (estimated VO2 Max), a well-validated measure of aerobic capacity to document exercise effects, and an ecologically-valid visuo-spatial, randomized, alternating runs task switch test during dense-array (256 electrodes), electroencephalographic recording at 250 Hz. The P3b at electrode Pz was extracted using well-validated methods ( Electrical Geodesics, Incorporated). Only Tai Chi and meditation plus exercise groups demonstrated larger P3b ERP switch trial amplitudes compared to sedentary controls, though Tai Chi, meditation, and aerobic groups did not differ significantly. These results suggest long-term Tai Chi, meditation plus exercise, and aerobic fitness may similarly benefit the neural substrates of executive function, but exercise requiring mental exertion may provide superior benefits.

## D41

### WHAT'S THE DIFFERENCE BETWEEN REST VS. REST? DEFINING BASELINE BRAIN STATES IMPORTANT FOR GOAL-DIRECTED COGNITION

Erica Pool[1,2], Anthony J.-W. Chen[1,2,3], Courtney L. Gallen[1], Sahar M. Yousef[1,2,4], Michael A. Silver[1,4], Mark D'Esposito[1,2]; [1]Helen Wills Neuroscience Institute, UC Berkeley, [2]V.A. Northern California, [3]University of California, San Francisco, [4]Vision Science, UC Berkeley — The neurophysiology of baseline brain states at 'rest' have typically been studied during a task-free period allowing unconstrained mind-wandering. Aspects of a 'rest state' have explained variability in cognition within and across individuals. "Rest" likely involves differentiable states, but the nature of these states has remained poorly defined. Indeed, we previously found that functional brain network organization during a more defined form of rest (with an attentional focus) predicted changes in cognitive functioning with training. Here we turned to investigating differences in functional network organization for "focused" vs. "standard" rest. During two separate counterbalanced fMRI sessions, we asked 8 healthy young subjects to rest and gaze at a fixation cross, but either focus on the cycle of their breathing or allow the mind to wander. Subjects rated degree of focus vs. mind-wandering. Whole-brain correlation matrices were generated from the AAL anatomical atlas and used to calculate optimized global modularity, an index of connectivity within and between network modules. Given that prefrontal areas play a role in attention regulation, we calculated within-module degree and participation coefficient for prefrontal nodes (measures of connections within and across network modules, respectively). We found higher global modularity ($p=.05$) and higher within-module degree in prefrontal nodes ($p<.05$) during focused rest. These findings suggest that prefrontal nodes are more functionally connected within organized modules during focused rest than during standard rest, helping to define differentiable 'rest' states. This approach provides a basis for further investigations of the nature of baseline states from which goal-directed cognition is launched.

## D42

### NEURAL CORRELATES OF RECONFIGURATION FAILURE REVEAL THE TIME COURSE OF TASK-SET RECONFIGURATION

Marco Steinhauser[1], Martin E. Maier[1], Benjamin Ernst[1]; [1]Catholic University of Eichstätt-Ingolstadt — The ability to actively prepare for new tasks is crucial for achieving goal-directed behavior. The task-switching paradigm is a frequently used tool to investigate this task-set reconfiguration. In the present study, we adopted a novel approach to identify preparatory activity related to task-set reconfiguration in event-related potentials. Our method was to isolate neural correlates of reconfiguration failure and to use these correlates to identify the strength and time course of reconfiguration. To this end, we employed a task-switching paradigm in which two types of errors could be distinguished: task errors (in which the incorrect task was applied) and response errors (in which an incorrect response for the correct task was provided). Because differential activity between both error types distinguishes successful and failed reconfiguration, this activity was used as a marker of the reconfiguration process. We found that, while reconfiguration takes place on task repetitions and task switches, it occurred earlier in the former than in the latter. Moreover, single-trial analysis revealed that the same activity predicted response times as well as the magnitude of error-related brain activity. Our results suggest that reconfiguration is not switch-specific and that the time course of reconfiguration is an important determinant of behavioral performance.

## D43

### QUANTIFYING THE INTERPLAY OF COGNITIVE FLEXIBILITY AND STABILITY IN PREDICITION USING FMRI

Ima Trempler[1,3], Anne-Marike Schiffer[2], Gereon Fink[3], Ricarda Schubotz[1,3]; [1]University of Muenster, [2]University of Oxford, [3]University Hospital Cologne — In daily life, it is of crucial importance to adjust our expectations to environmental changes without losing track of our action goals. We have to stabilize our predictions in the face of potential distracters but also adapt them to altered circumstances. Recent studies suggest that we build such internal models to predict upcoming events and plan movements and actions in anticipation of those events. However, it is not evident when to revise or shield an internal model. This trade-off between cognitive flexibility and stability in prediction is supposed to depend on individual differences in response bias and the anticipated likelihood of updating demands. To assess the explicit and implicit stabilization and flexibilization of prediction, we used fMRI while twenty-one healthy subjects performed a modified serial prediction task. Here, switches between predictable sequences had to be indicated via button press while sequence omissions had to be ignored. This enabled us to simultaneously measure flexible switching and inhibition of irrelevant distractors whereby both type of trials occurred with a certain probability. We observed mesial Brodmann area 10 activation during switch detection while rejection of omissions was accompanied by lateral premotor cortex activation and deactivation of Brodmann area 9. Behavioral results further suggest that both functions depend on the volatility of environment as performance adapted to the probability of an event to occur. In line with recent studies, this anticipation was accompanied by striatal activity. Our study addressed for the first time the interplay of cognitive flexibility and stability in a predictive setting.

# EXECUTIVE PROCESSES: Working memory

## D44

### PRECISE PREDICTIONS: PERSONALITY PREDICTS THE RESOLUTION OF VWM REPRESENTATION

Kristin Wilson[1], Jason Rajsic[1], Justin Ruppel[1], Jenny Shen[1], Susanne Ferber[1,2]; [1]University of Toronto, Canada, [2]Rotman Research Institute, Baycrest, Toronto, Canada — Visual working memory (VWM) performance varies between individuals and across the lifespan. Evidence suggests that variance in the ability to control the selectivity of attention plays a critical role in VWM outcomes, however there aren't many well-established methods for predicting prowess in selective attention. There is reason to believe, however, that personality may be a critical predictor of attention, as these two psychological factors play a mutually important role in shaping and constraining our experience of the world and who we become. In the present experiment we explore the question of whether personality might predict VWM parameters. We used a colour-wheel change detection task with memory arrays composed of circles and squares and we manipulated Set-Size (2, 4 & 6) and Attention (Attend-All items or selectively attend to just the circles and Filter out the squares). Employed the Bays & Hussain (2009) 3-factor model of VWM, we calculated measures of precision/resolution, probability of target, non-target (swaps) and guess responses. We hypothesized that Conscientiousness (associated with rule-following, attention to detail, self-control, etc.,) would be related to the selectivity of attention and thus would predict VWM performance, particularly in the Filter condition when the selectivity of attention is taxed. Our results are consistent with our hypotheses, as we find Conscientiousness to be predictive of the precision/resolution of VWM in the Filter condition, however, this relationship does not exist in the Attend-All condition.

## D45

### VISUAL WORKING MEMORY IMPAIRMENTS FOLLOWING MEDIAL TEMPORAL LOBE DAMAGE: A STATE-STRENGTH APPROACH

Robin I. Goodrich[1], Andrew P. Yonelinas[1]; [1]University of California, Davis — It is well established that the medial temporal lobes (MTL), including the hippocampus, are essential for long-term memory. However, recent evidence indicates that the MTL also supports perception and working memory under certain conditions, such as when strength-based judgments are necessary for the successful detection of relational changes between scenes (Aly, Ranganath, & Yonelinas, 2013; Graham, Barense, & Lee, 2010). To examine the extent to which sub-processes underlying visual working memory (VWM) critically depend on the MTL we analyzed the receiver operating characteristics (ROC) of patients with MTL damage and healthy age-matched controls using a dual-process model in a standard change-detection paradigm (Luck & Vogel, 1997). Compared to controls, patients with MTL damage demonstrated significant VWM impairments. Interestingly, the difference in overall performance was primarily driven by significant reductions in patients' strength-based judgments of change. Patients also exhibited numerical reductions in state-based judgments, although this difference was nonsignificant. These findings indicate that VWM is impaired following MTL damage, and that such deficits arise mainly from the inability of patients to make quantitative strength-based judgments of change and less so from an inability to make qualitative state-based judgments. By taking a novel dual-process ROC analytic approach, we show that not all sub-processes underlying VWM are equally affected following MTL damage. These results provide strong support for the use of methodologies that allow the distinct sub-processes that contribute to VWM to be independently measured, rather than treating VWM as a unitary phenomenon.

## D46

### THE NEURAL BASIS OF IMPLEMENTING INSTRUCTED STIMULUS-RESPONSE RULES.

Jelle Demanet[1], Baptist Liefooghe[2], Egbert Hartstra[3], Dorit Wenke[4], Jan De Houwer[2], Marcel Brass[1]; [1]Department of Experimental Psychology at Ghent University, [2]Department of Experimental-Clinical and Health Psychology at Ghent University, [3]Donders Institute at Radboud University, Nijmeghen, [4]Institut für Psychologie at Humboldt-University, Berlin — The present study was designed to investigate the processes that allow us to learn on the basis of instructions. More specific, by using fMRI we were able to focus on the neural mechanism that translates instructed information about stimulus-response (S-R) mappings into ready-to-use procedural S-R associations. Already some fMRI studies have shown that a fronto-parietal network is involved when processing verbal instructions. By adapting a novel behavioral paradigm for fMRI we found strong evidence that one region in the right inferior frontal sulcus (IFS) plays a specific role in translating instructed S-R mapping into implemented S-R associations. First, we found that this region is only involved when subjects implement these rules and not when subjects simply maintain these same rules in working memory. Second, we were able to show that higher activation in this region during instruction presentation predicts better performance during the later execution phase. Third, we showed that our manipulations affected the behavioral index of the strength of this implementation process (which we adopted from the behavioral literature) in a similar way as it affected the activation cluster in the IFS.

## D47

### ARE ITEMS IN WORKING MEMORY STORED WITH LONG-TERM MEMORY MECHANISMS?

Nathan Rose[1], Emma Meyering[1], R. Shayna Rosenbaum[2], Steven Baker[2], Christa Dang[3], Bradley Buchsbaum[3], Bradley Postle[1]; [1]University of Wisconsin-Madison, [2]York University, [3]Rotman Research Institute — Are items held in working memory (WM) but outside of focal attention (FA) retained via long-term memory (LTM) mechanisms? To address this question we conducted an fMRI study in which we first scanned healthy young adults performing a one-item WM task (i.e., delayed recognition of a word, a face, or a direction of moving dots), and trained multivariate pattern classifiers to decode WM maintenance for the three categories of stimuli. In a second phase, we scanned the participants performing a two-item WM task (using the same categories of memoranda) with retrocues that manipulated how long items were held in FA. Outside the scanner, we administered surprise LTM tests of declarative and nondeclarative memory for items from the WM test. The multivariate pattern classifier successfully decoded items in WM that were actively being attended to, but failed to find evidence for an active neural trace for items held in WM but outside of FA. Subsequent word-stem completion priming was insensitive to the amount of time an item was held in FA. Subsequent cued recall and delayed recognition, however, was superior for items held longer in FA. These results are inconsistent with the idea that unattended memory items receive privileged encoding into LTM. To further test the LTM memory account, these results will be compared to a developmental amnesic with bilateral hippocampal lesions.

## D48

### HIGH-RESOLUTION WORKING MEMORY AND THE MEDIAL TEMPORAL LOBE

Alyssa Borders[1], Charan Ranganath[1], Andrew Yonelinas[1]; [1]University of California, Davis — The idea that working memory (WM) is independent of the medial temporal lobes has been challenged by fMRI and patient studies, but the findings have been mixed. Recent work has proposed that the hippocampus is involved in working memory tasks that require the binding of high-resolution information whereas it is not necessary for tasks that require only low-resolution binding. To test this theory, we used fMRI to compare hippocampal involvement in two similar WM tasks which have different demands on the quality of information necessary to successfully complete the task and have yielded conflicting findings in neuropsychological studies. In the current study, participants study an array of colored squares and are asked to maintain the information over a 1-second delay. At test, one location of the study array is cued. In the low-resolution condition, participants report whether the color in the cued square changed or remained the same. In the high-resolution condition, participants report the exact color of the cued location using a continuous color wheel. Changes in the low-resolution condition switch from one distinct color to another (e.g., purple to green) and do not require precise color information to successfully detect. In contrast, the high-resolution condition required participants retain the precise color information across the delay to discriminate and report the correct color. Preliminary results suggest that hippocampal activity predicts successful WM performance in the high-resolution task but not the low-resolution task. This finding supports the prediction that the hippocampus plays a role in high-resolution binding in WM.

### D49

### BENEFICIAL EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION ON WORKING MEMORY IN HIGH-FUNCTIONING ADULTS WITH AUTISM

Joseph Jason van Steenburgh[1], Mark Varvaris[1], Tracy Vannorsdall[1], David Schretlen[1], Barry Gordon[1]; [1]Johns Hopkins School of Medicine — Specific Goals: To measure transcranial direct current stimulation effects on working memory and identify responder characteristics in high-functioning adults with autism (HFA). Participants and Methods: Twelve adults with HFA (10 men; age=32 years; education=14 years; ADOS score=11, KBIT-IQ=101) received separate counterbalanced sessions of anodal, cathodal, and sham tDCS over the left and right dorsolateral prefrontal cortices (DLPFC) while performing WMS-III digit and spatial span backward (SSB) tests, letter and spatial n-back, and the Brief Test of Attention (BTA). Cohen's D effect sizes and reliable change indices (Hageman et al., 1993) were used to assess response to stimulation. Results: Anodal (T-score=43, Cohen's D=0.4, t=2.2, p= .05) and cathodal stimulation both enhanced (T=48, D=0.6, t=4.9, p<.01) performance on the BTA compared to sham (T=39), and improvement was correlated with age (anodal: r=.66, p=.02; cathodal: r=.65, p=.02). Anodal (raw=9.6, D=1.3, t=3.3, p<.01) and cathodal stimulation (raw=9.2, D=1.1, t=4.2, p<.01) both improved SSB performance vs. sham (raw=6.8). K-BIT Nonverbal IQ predicted anodal facilitation of SSB (r=.695, p=.012), while high ADOS scores predicted weaker effects of cathodal stimulation on SSB (r=-.587, p<.05). Effects of anodal (letter n-back average D=0.18; spatial n-back average D=0.25) and cathodal stimulation on n-back performance were small (letter n-back average D=0.27; spatial n-back average D=0.19). N-back responding increased without improving d-prime, accuracy or speed. Conclusions: TDCS strengthened attentional control, which may have increased ability to manipulate a greater informational load. As responders become better characterized, tDCS may become a useful method for treating deficits related to prefrontal hypoactivation in HFA.

### D50

### EFFECTS OF CONCUSSION ON WORKING MEMORY, SELECTIVE ATTENTION, AND HEMODYNAMIC RESPONSE

Nicholas J. A. Wan[1], Allison S. Hancock[1], Sandra L. Gillam[1], Ronald B. Gillam[1]; [1]Utah State University — Investigations into concussions using neuroimaging techniques have indicated an increased activation in the dorsolateral prefrontal cortex (DLPFC) for working memory or selective attention tasks during the days after a concussion-inducing incident. Previous findings also indicate a greater consumption of oxygen in DLPFC during these tasks but have not spoken to the increase in oxygen being received by the DLPFC. Two participants who participated in a neuroimaging study of neural activation while completing memory (n-back) and attention (Stroop effect) tasks subsequently suffered concussions and volunteered to repeat the testing while presenting post-concussion symptoms. Functional near-infrared spectroscopy (fNIRS) was used to examine both the consumption of oxygen and the increase in oxygen concentration within DLPFC. Behavioral results indicated no difference in accuracy or speed of responding for either n-back or Stroop tasks between pre-concussion (2-back item accuracy: M = 30.6; Stroop: M = 32) and post-concussion (2-back: M = 31; Stroop: M = 32) recordings. However, fNIRS hemodynamic results revealed a greater consumption of oxygen and also a greater increase in oxygen concentration while performing n-back and Stroop tasks soon after concussion. Implications of these results can factor into both the microstructural injury compensation hypothesis and the neural efficiency hypothesis, in which task performance requires greater resource consumption in order to reach typical behavioral accuracy.

### D51

### ON THE FATE OF IRRELEVANT MENTAL REPRESENTATIONS IN VISUO-SPATIAL WORKING MEMORY: EVIDENCE BY A RETRO-CUING PARADIGM

Daniel Schneider[1], Edmund Wascher[1]; [1]Leibniz Research Centre for Working Environment and Human Factors — Directing attention toward representations in working memory serves for adapting the stored information to behavioral goals. According to current theories, this adaptation is associated with an active maintenance of relevant information and a rapid decay of representations declared as irrelevant. By means of a visual retro-cuing paradigm, we investigated the influence of such irrelevant working memory representations on further information processing. A retro-cue indicated if the items on the left or right side of a previous memory array remained relevant. After a 700–1000ms delay interval, a central probe item was presented and participants had to state whether this stimulus was previously shown on the relevant side of the memory array. The probe was either a relevant memory item ("relevant probe"), irrelevant memory item ("irrelevant probe") or was not shown in the previous memory array ("new probe"). While the same response was required, the "irrelevant probe" condition featured delayed response times referred to the "new probe" condition. Thus although irrelevant working memory representations should decay rapidly, they still interfered with the processing of the probe material. We further compared the different probe conditions on ERP level and revealed a late left-frontal activation that was increased for irrelevant compared to new probe items. This effect was accompanied by an increased posterior positivity for irrelevant probes compared to new probes subsequent to response. These results suggest that additional top-down control is required to actively suppress the residual representations of irrelevant information in working memory and support the selection of the required response.

### D52

### WORKING MEMORY AND VISUAL ATTENTION COMPETE FOR NEURAL RESOURCES

Anastasia Kiyonaga[1], Emma Wu Dowd[1], Tobias Egner[1]; [1]Duke University — We constantly employ working memory (WM) to keep information in mind over short periods of time. This internal maintenance—which may be described as inwardly-oriented attention—often co-occurs with immediate demands for attention in the environment. Such external distraction can impede WM performance, yet we know relatively little about how the brain manages simultaneous demands on internal maintenance and external attentional processes. Here we acquired fMRI data during a task that independently manipulates internal (WM) and external (visual) attentional load. Participants remembered one or two images (i.e., low vs. high internal load) for a delayed match-to-sample task. During the delay, they performed a series of visual searches for target items that were either highly distinct from or similar to visual distractors (i.e., low vs. high external load). Slower reaction times and lower task accuracy during high load conditions confirmed that these manipulations were effective. Likewise, high external load robustly activated the prototypical fronto-parietal control network. A narrower set of brain regions—including parts of the superior parietal lobule, lateral prefrontal cortex, and temporo-parietal junction—also displayed an interaction between internal and external attention factors, demonstrating that the neural response to visual attention demands depended on the level of concurrent WM load. Moreover, the degree to which WM and visual attention demands interacted in these brain regions was predicted by individual visual search efficiency and WM capacity scores. Thus, we have identified brain regions that may underlie prioritization between internally- vs. externally-oriented attention and whose activation varies with individual cognitive capacities.

## LANGUAGE: Development & aging

### D53

### NEUROPHYSIOLOGICAL CORRELATES OF PERCEPTUAL LEARNING FOR MANDARIN CHINESE LEXICAL TONE CATEGORIES: AN ERP STUDY

Guannan Shen[1], Karen Froud[1]; [1]Teachers College, Columbia University — Whether native speakers of non-tonal languages can acquire categorical representations of lexical tones and recruit native-like neural mechanisms for lexical tone perception remains controversial. This study investigates the nature of lexical tone categorization for three groups of adult listeners: 1) native English speakers who had no exposure to Mandarin Chinese before age 17, but who took advanced Mandarin courses as adults; 2) native English speakers with no experience of Chinese; and 3) native Mandarin speakers. Two tonal continua were derived from natural speech through interpolation within two tonal contrasts (Tone 1/Tone 4; Tone 2/Tone 3). Firstly, the category boundaries were examined through classic identification and discrimination tasks. Secondly, high-density EEG was used to record brain responses while participants listened to tones in two oddball paradigms: across-category and within-category. If perception of lexical tones is categorical, cross-category deviants are expected to elicit larger mismatch negativity (MMN) and P300 than within-category devi-

ants. Both behavioral and ERP results indicate that lexical tones are perceived categorically by native Chinese speakers but not by inexperienced English speakers. Although English learners of Chinese demonstrated categorical perception in behavioral tasks, their MMN and P300 amplitudes were significantly attenuated compared to native Chinese speakers, and did not differ between within- and across-category conditions. The results suggest that experience of learning Chinese did not change the ability of these adult English speakers to process category boundaries for lexical tones at early stages of auditory processing. Instead, such exposure may modify perceptual boundaries in a top-down manner.

## D54

### WHITE MATTER CORRELATES OF POOR READING IN YOUNG ADULTS: EVIDENCE FOR A COMPENSATORY RESPONSE

Stephen Bailey[1], Laurie Cutting[1], Sheryl Rimrodt[1]; [1]Vanderbilt University — Reading is important in academic settings but young adults in post-secondary education demonstrate widely variable basic reading skills. Previous diffusion tensor imaging (DTI) studies have correlated FA to reading skill, but have not typically included a broad range of reading abilities. We hypothesized that DTI in a sample of academically-focused young adults could reveal information about neurobiological correlates of compensatory strategies. Forty-six young adults (18-24 years old; 16 female) entering or attending post-secondary education completed the Sight Word Efficiency subscale of the Test of Word Reading Efficiency (TOWRE); standard scores ranged from impaired to high average (SS=46 to 117; median = 100.0). Participants underwent high-angular resolution diffusion-weighted imaging with 60 gradient directions in a 3T Phillips scanner. In FSL, image processing included head motion and eddy current corrections, construction of fractional anisotropy (FA) maps using Camino RESTORE, and construction of white matter skeletons using tract-based spatial statistics (TBSS). Using FSL Randomize, non-parametric statistical analysis with threshold-free cluster enhancement (5000 permutations) identified regions with significant FA correlations to TOWRE raw scores. Results showed significant negative correlations in bilateral anterior corpus callosum (cluster size = 710; $p < 0.05$) and left anterior forceps minor (cluster size = 2187; $p < 0.05$) overlapping the uncinate fasciculus. Thus, our less skilled readers show greater coherence of white matter tracts connecting left frontal lobe (near Broca's area) to right frontal lobe. Consistent with functional neuroimaging-based theories about dyslexia, our findings may represent structural refinement of pathways that facilitate compensatory recruitment of right inferior frontal gyrus.

## D55

### AGE-RELATED DIFFERENCES IN GRAMMAR UNDERSTANDING IN PRESCHOOL CHILDREN

Sergey Kiselev[1]; [1]Ural Federal University — The goal of the research was to reveal the age-related differences in understanding different type of grammatical constructions in Russian-speaking preschool children. The sample consisted of 45 4-year-olds, 48 5-year-olds, 56 6-year-olds typically developing children from Russia. The children were assessed with the task "Comprehension of grammatical structures" from Luria's child neuropsychological assessment battery. The first part of this task was designed to assess comprehension of reversible passive sentences. The second part of the task was designed to assess comprehension of sentences with prepositions that indicate the spatial relations between objects. One-way ANOVAs by group revealed significant differences between the groups for scores in the comprehension of reversible passive sentences. However we did not reveal significant differences between the groups for scores in the comprehension of sentences with prepositions that indicate the spatial relations between objects. The obtained result shows the heterochronicity in the development of different aspects of grammar understanding in preschool children.

## D56

### THE DEVELOPMENT OF WHITE MATTER REGIONS INVOLVED IN FOREIGN SPEECH SOUND PRODUCTION

Mary Elizabeth Sutherland[1,2,3,4], Pierre-Yves Herve[5], Tomas Paus[6], Robert J. Zatorre[1,2,3]; [1]Montreal Neurological Institute, McGill University, Montreal, QC, CANADA, [2]BRAMS International Laboratory for Brain, Music and Sound Research, Montreal, QC, CANADA, [3]CRBLM Centre for Research on Brain, Language and Music, Montreal, QC, CANADA, [4]Centro Interdisciplinario de Neurociencias, Pontificia Universidad Catolica de Chile, Santiago, CHILE, [5]Groupe d'Imagerie Neurofonctionnelle, Université Bordeaux Ségalen, Bordeaux, FRANCE, [6]Rotman Research Institute, University of Toronto, Toronto, ON, CANADA — Previous research has shown that adults who are more accurately able to produce a foreign consonant, the voiced uvular stop found in the Persian language, have higher white matter (WM) density in the left insular/prefrontal cortex and in bilateral inferior parietal cortices. It is unclear, however, whether these anatomical differences evolve during development or whether they reflect more stable underlying structural traits. The current study addressed this question using a longitudinal design with 43 healthy, right-handed, native English-speaking adolescents. Anatomical MRI scans were obtained from these participants at the age of 10, 11.5, and 13 years; at the age of 14.5, their ability to produce the voiced uvular stop was tested. Two independent judges scored the accuracy of the utterances. Using these scores as regressors in a voxel-based morphometry analysis revealed that the regions of WM density correlating with these scores varied at each time point. At the age of 10, the network that predicted the ability to pronounce foreign speech sounds at age 14.5 encompassed WM in the left inferior temporal gyrus, left middle frontal gyrus, bilateral heschl's gyrus, and finally the left insular cortex. By the age of 13, this network had become more specific and adult-like, with WM in bilateral insular cortex being the main predictor of speech scores, although the correlation was only significant in the right hemisphere. Taken together, these results suggest that the structural correlates found in adults are not the same as those in pre-pubertal children, but instead that they emerge with maturity.

## D57

### STRUCTURAL BASES OF LANGUAGE-IMPAIRMENT IN CHILDREN WITH AND WITHOUT AUTISM

Michelle Han[1], Zhenghan Qi[1], Kelly Halverson[1], Lisa Wisman Weil[2], Helen Tager-Flusberg[2], Kenneth Wexler[1], John Gabrieli[1]; [1]Massachusetts Institute of Technology, [2]Boston University — Language impairment is a behavioral phenotype for autism spectrum disorder (ASD). However, it is unclear whether language-impairment in children with and without autism share a structural basis. In this study, we explored whether measures of white matter integrity would provide insight into the distinction between groups of children with language impairment (LI) and ASD by contrasting them with a group of typically developing (TD) children. Group designations were defined by in-study results from the Clinical Evaluation of Language Fundamentals (CELF) and Autism Diagnostic Observation Schedule (ADOS). 42 children (mean age=12.27; mean IQ=110.2; 14 per group; matched for age and IQ) were scanned in an MRI scanner. During the scan, diffusion-weighted images (DWI) with 30 directions were acquired from which individual subjects' white matter tracts were reconstructed. The average mean diffusivity (MD) of the left anterior thalamic radiation (ATR) was significantly different between the TD and LI groups (two-tail p=0.0058) and the TD and ASD groups (two-tail p=0.0021) but not between the LI and ASD groups (two-tail p=0.67), which suggest the left ATR is common to language-impairment with and without autism. In contrast, average MD in the right inferior longitudinal fasciculus (ILF) was significantly different between the TD and LI groups (two tail p=0.011) but not between the TD and ASD groups or the LI and ASD groups, which suggest the right ILF is unique to language-impairment without autism. Together, these results point to both overlapping and distinct structural bases for language-impairment in children with and without autism.

## D58

### REDUCED FUNCTIONAL CONNECTIVITY IN NEURAL LANGUAGE SYSTEMS IN PERSONS WITH AGE-RELATED MACULAR DEGENERATION

Jie Zhuang[1], David Madden[1,2], Xuan Duong-Fernandez[1], Ying-hui Chou[1], Micah Johnson[3], Michele Diaz[4], Scott Cousins[5,6], Guy Potter[1,2], Nan-kuei Chen[1], Heather Whitson[5,7,8]; [1]Brain Imaging and Analysis Center, Duke University Medical Center, [2]Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, [3]Department of Psychology, University of California, Los Angeles, [4]Department of Psychology, Pennsylvania State University, State College, [5]Department of Ophthalmology, Duke University Medical Center, [6]Duke Eye Center, Duke University Medical Center, [7]Department of Medicine, Duke

University Medical Center, [8]Durham VA Medical Center — Recent research has found that visual loss in age-related macular degeneration (AMD), the most common cause of blindness in Americans, is associated with lower performance on verbal fluency tasks. However, the neural underpinning of a connection between AMD and impaired language processing remains unclear. Here we investigated intrinsic functional connectivity strength among regions within the fronto-temporo-parietal language networks in AMD patients and how these connectivity patterns differ from those in healthy controls. We performed seed-based whole brain connectivity analysis on resting state scans of 11 AMD patients (mean age 74.4 ± 6.6) and 11 controls (mean age 72.5 ± 1.6). We observed significantly reduced connectivity among low-level visual processing regions (V1 and lateral occipital complex) in patients compared to controls, indicating expected damage of visual function pathways associated with AMD. Similarly, AMD patients exhibited weaker connections in typical language networks (between left inferior frontal gyrus (BA 45/47) and angular gyrus/posterior middle temporal gyrus) than controls. In contrast, patients and controls generated similar connectivity patterns in low-level acoustic processing regions (bilateral Heschl's gyri and surrounding superior temporal gyri), indicating that observed group differences in connectivity were region-specific rather than global. Our finding that AMD is associated with weaker functional connectivity among low-level visual processing regions and major connections within language networks suggests that AMD may be a disease with specific consequences for both eye and brain. Longitudinal research is needed to understand whether AMD-related brain changes are causally mediated or reflect shared risk factors for neurodegeneration in retina and brain.

### D59

### READING THE FUTURE: CONTEXT MAINTENANCE AND TASK DEMAND AFFECT PREDICTION IN ELDERLY READERS

Shruti Dave[1], Trevor Brothers[1], Matthew Traxler[1], Tamara Swaab[1]; [1]University of California, Davis — Language in elderly adults concurrently benefits from lifetime vocabulary exposure and is challenged by requiring active online processing. Changes in crystallized and fluid intelligence can influence language-related electrophysiological components, which in elderly subjects are typically reduced in amplitude and delayed in time (reviewed in Federmeier, 2007). The source of this age-related difference may be linked to deficits in anticipation for upcoming words, or alternatively, by an overall delay in lexical processing. In a previous study with young adult readers, the effects of specific lexical predictions were assessed by separately averaging ERP trials with accurate and inaccurate predictions (Brothers, Swaab, & Traxler, in press). In this study, prediction accuracy had a large independent effect on N400 amplitudes that preceded the effects of contextual support by approximately 100ms. In the current study, this task was replicated in elderly adults. Behaviorally, older adults reported equal levels of prediction accuracy as younger adults. Older adults also showed a similar latency delay between the effects of prediction accuracy and contextual facilitation, but the onset of these effects was approximately 60ms later compared to young adults. These results suggest that deficits in lexical prediction cannot explain the overall delay and reduction of contextual facilitation in elderly adults. Additionally, in comparison to a high-low cloze comprehension task, young adults' cloze effect latency was identical with or without the addition of the prediction task. However, older adults' effect latency was significantly delayed between comprehension-only and prediction-added tasks, indicating a likely detrimental role of increased load and task demand.

## LANGUAGE: Lexicon

### D60

### INCREASED FUNCTIONAL CONNECTIVITY IN THE CINGULO-OPERCULAR NETWORK DURING REST IN CHILDREN WITH DYSLEXIA FOLLOWING INTERVENTION

Tzipi Horowitz-Kraus[1], Mark DiFrancesco[1], Claudio Toro-Serey[1], Scott Holland[1]; [1]Cincinnati Children's Hospital Medical Center — The goal of the current study is to define the effects of executive-function-based reading training on functional connectivity of the cingulo-opercular-network and reading performance in children with dyslexia and in typical readers. Method Fifteen children with dyslexia and 17 typical readers (8-12 years old) were included in the study. Reading and executive function neurocognitive tests as well as 5.5 minutes of resting state fMRI data were collected before and after training. Training on the Reading Acceleration Program (RAP) was done in English 5 times per week for 4 weeks. Imaging data were analyzed using the CONN toolbox: a graphical network modeling tool. Results Both groups showed greater reading and executive-function scores post training, with greater gains among the dyslexia group. Both groups showed an increasing functional connectivity in the cingulo-opercular-network with training time: [$F(1,30)=9.024, P<.01$]. Paired t-test analysis revealed that children with dyslexia showed significantly increased functional connectivity in the cingulo-opercular-network [$t(14)=-3.59, P<.01$]. Conclusions 1) Increased functional connectivity in the cingulo-opercular-network after training in children with dyslexia demonstrates the importance of cognitive control during reading in this population; 2) These results are in line with previous findings of greater error monitoring activation after training in children with dyslexia and confirm greater gains with RAP training in this group.; 3) Training may have less effect on cognitive control in typical readers and more direct effect on the visual area, as previously reported; and 4) A future study should also examine the effects of training on the fronto-parietal cognitive-control-network.

### D61

### NEURAL MEASURES OF INFORMATION RETRIEVAL IN NON-NATIVE LEXICAL ACCESS

Kailen Shantz[1], Darren Tanner[1]; [1]University of Illinois at Urbana-Champaign — Second language (L2) learners experience persistent difficulty using grammatical gender in an L2, even at high levels of proficiency. Recent research has further suggested that these difficulties stem from processing problems, not basic learnability problems (Grüter et al., 2012). We used ERPs to investigate processing-based loci for these difficulties using a covert picture naming task. We specifically focused on the time course and cognitive load associated with gender and phonological information retrieval in native English speakers who were proficient in L2 German using the dual-task go/no-go paradigm. Previous research using this paradigm with native speaker populations has found that grammatical gender information is retrieved before phonological information (Van Turennout et al., 1998). Our preliminary results show no clear latency advantage on the no-go N200 response for grammatical gender over phonology, in contrast to the previous findings with native speaking populations. Moreover, results show a larger amplitude P300 "go" effect for the go/no-go decisions based on phonological information compared to those based on grammatical gender information. Overall these findings suggest that possible loci for second language difficulties with online use of grammatical gender may stem from: 1) delays in the time course of gender feature retrieval, relative to phonology, as indicated by the N200 results and 2) the possibility that the use of grammatical gender information is more cognitively taxing compared to the use of phonological information, as suggested by the P300 results.

### D62

### GRAY MATTER CHANGES IN CHINESE VOCABULARY LEARNING

Jennifer Legault[1], Shin-Yi Fang[1], Indy Majere[2], Yu-Ju Lan[2], Ping Li[1]; [1]The Pennsylvania State University, [2]National Taiwan Normal University — Learning of various cognitive tasks has been associated with changes in both neural activity and gray matter volume (see Li, Legault, &Litcofsky, 2014 and Lövdén et al., 2013 for reviews). Our study used a longitudinal design with structural neuroimaging to examine how learning of a second language (L2) may lead to corresponding changes in the brain. We used whole brain and a priori designated region of interest (ROI-based voxel based morphometry (VBM) analyses to parse out regions that showed increased gray matter (GM) volume as a function of L2 learning, and whether these changes are mediated by individual differences in cognitive tasks. To examine possible effects of learning environment, we randomly assigned participants to either picture-word (PW) association learning context or to a virtual environment (VE; www.secondlife.com) learning context. After each learning session, participants performed a forced choice recognition task. Participants in the PW reached high accuracy in fewer sessions than the VE group; however both groups performed near ceiling at the end of training. VBM analyses show that GM volume in the left inferior frontal gyrus was associated with L2 vocabulary performance. The VE group showed greater volume in the left inferior parietal lobe as compared to the PW group at the end of training. Further, GM volume in the right middle frontal gyrus

and inferior parietal lobule were associated with performance on cognitive tasks. In conclusion, our study shows that learning Chinese vocabulary is associated with GM volume in regions implicated with cognitive control.

### D63

### DIFFERENCES IN P1 AND N170 ERP COMPONENTS FOR DEAF VS. HEARING READERS

Casey Kohen[1], Katherine J. Midgley[1], Phillip J. Holcomb[1], Jonathan Grainger[2], Karen Emmorey[1]; [1]San Diego State University, [2]CNRS & University of Provence — Visual word recognition generally exhibits a left-lateralized asymmetry for the N170 ERP component, which is interpreted as reflecting expertise in processing visual word forms in highly automatized adult readers and is suggested to reflect activity in the visual word form area (VWFA). We report a different pattern of early ERP components in deaf individuals reading in their less fluent L2 (English). EEG from 32 channels was collected in 15 congenitally deaf and 15 hearing adults presented with 60 words (e.g., TABLE) and 60 symbol strings (e.g., %$#@+) in a familiarity judgment task (is this item familiar?). We measured the amplitude of the P1 and following N170 over left and right hemisphere posterior electrode sites (O1 vs. O2 and T5 vs. T6). Hearing readers showed the classic left more negative than right ERP pattern for words starting as early as 100 ms (i.e., P1) and continuing through the N170 epoch (250 ms). Symbol strings produced a similar pattern but the asymmetry was less notable. In contrast, deaf readers showed a different pattern. For symbol strings the N170 was slightly more negative over the right hemisphere. For words the P1 and N170 were both larger over the left hemisphere (i.e., the P1 was more positive and the N170 more negative), although the N170 asymmetry was not nearly as large as for hearing readers. This pattern likely reflects the overall lower reading competence in the deaf readers (smaller N170 asymmetry) as well an earlier perhaps attentionally mediated enhancement (P1) due to deafness.

### D64

### THE AUDITORY KILOWORD STUDY: ERP EVIDENCE FOR TASK SPECIFIC EFFECTS OF PHONOLOGICAL NEIGHBORHOOD DENSITY DURING SPOKEN WORD RECOGNITION

Kurt Winsler[1], Katherine J. Midgley[1], Phillip J. Holcomb[1], Jonathan Grainger[2]; [1]San Diego State University, [2]CNRS & Université de Provence — A number of previous studies have indicated that certain characteristics of visually presented words produce systematic differences in the timing and amplitude of various ERP components. The present study extended this work to auditory word recognition. Specifically, we investigated electrophysiological effects of phonological neighborhood density, orthographic neighborhood density, and word frequency on auditory word recognition. Two different go/no-go tasks were used; lexical decision (LD) and semantic categorization (SC). Thirty-two channels of EEG were collected from 27 monolingual English-speaking adults while they listened to a list of 960 words (480 each in LD and SC). Overall, and consistent with previous visual word studies, the results indicated that words with many phonological or orthographic neighbors as well as words that were low in word frequency elicited larger N400s than words from small phonological or orthographic neighborhoods and words that were high in word frequency. Importantly, the frequency and orthographic neighborhood effects remained unchanged across the two tasks. However, the N400 effect for phonological neighborhood density was significantly greater during the LD than in the SC task. This finding is consistent with the hypothesis that making auditory lexical decisions leads listeners to focus on the phonological level of processing which in turn enhances the effect of the number of phonological competitors. Making semantic decisions, on the other hand, does not require this kind of focus. This pattern provides further evidence of the influence of top-down task effects on the neuro-cognitive underpinnings of word recognition.

### D65

### BILINGUALS' ANTERIOR CINGULATE REFLECTS BOTH NATIVE AND SECOND LANGUAGE NORMS DURING NATIVE LANGUAGE PRODUCTION

Tianyang Zhang[1], Benjamin Zinszer[2], Ruiming Wang[3], Ping Li[1]; [1]Pennsylvania State University, [2]Pennsylvania State University & University of Rochester, [3]South China Normal University — Recent research has demonstrated that variation between native speakers and cross-language transfer are both important influences on bilinguals' lexical semantics (e.g., Ameel et al., 2009; Zinszer et al., 2014). In the present study, we examined how native speakers' lexical semantic variability modulates the neural processes underlying bilingual language production. Two groups of native Chinese speakers (11 monolinguals and 11 Chinese-English bilinguals) named 183 objects from approximately thirty lexical categories (e.g., cup) while undergoing fMRI scanning. For each object, we normed two lexical variables based on responses from monolingual norming samples in English and Chinese: Name Agreement and the number of Alternate Names describe unique variations in each language's categories for individual object exemplars (e.g., various shirts or trucks). We selected three left-hemisphere anatomical ROIs based on dominant models of word production (e.g., Rodriguez-Fornells et al., 2009; Price, 2012) to examine their correlation with Agreement and Names norms: anterior cingulate cortex (ACC), pars triangularis (PTri), and middle temporal gyrus (MTG). The fMRI results indicate that Chinese monolinguals' activity in ACC and PTri was significantly correlated with Names for each object ($p<0.001$, uncorrected). Variation in MTG was marginally related to Agreement ($p=0.005$). Chinese-English bilinguals' ACC activity was correlated with both Chinese ($p=0.003$) and English Names ($p<0.001$). Our findings point to the functional involvement of both languages' lexical semantics in bilinguals' native language production. The results also suggest that these ROIs are involved in bilinguals' cross-language conflict monitoring and selection, consistent with the extant bilingual imaging literature (e.g., Abutalebi et al., 2012).

## LANGUAGE: Other

### D66

### BILINGUALS DEMONSTRATE INCREASED CORPUS CALLOSUM VOLUME

Christine Chiarello[1], Aurora I. Ramos[2], David Vazquez[1], Maya R. Greene[2], Adam Felton[1], Alessandra McDowell[1], Arturo E. Hernandez[2]; [1]University of California, Riverside, [2]University of Houston — Are there neuroanatomical correlates of bilingualism? A recent review noted mono/bilingual differences in regional cortical volume/density, primarily in left hemisphere language areas, but there has been little direct examination of left/right asymmetries (P. Li et al., 2014). We found similar cortical thickness asymmetries for these groups in language relevant cortex, but reversed rightward cortical thickness asymmetry in the anterior cingulate for bilinguals (Chiarello et al., 2014). Here we describe companion analyses that examined corpus callosum volume to determine structural correlates of interhemispheric transmission. Two MRI scans were obtained for 78 right-handed young adults [39 monolingual English, 39 bilingual Spanish-English (mean L2 age of acquisition 6.8 years), age- and gender-matched]. The FreeSurfer pipeline was used to segment the corpus callosum into 5 subregions (anterior, midanterior, central, midposterior, posterior). Callosum volume was regressed against total intracranial volume and the residuals were used to obtain callosum volume estimates unbiased by overall brain size. Total callosum volume did not differ between groups ($p = .12$), but bilinguals had greater volume in midanterior $t(38) = 3.32$, $p < .002$, and central $t(38) = 2.65$, $p < .01$, subregions. DTI data indicate that these callosum subregions maximally interconnect cingulate and superior frontal cortex (Park et al., 2008), and that anteromedial superior frontal cortex is strongly interconnected to anterior and mid-cingulate areas (critical nodes of the cognitive control and default mode networks) (W. Li et al., 2013). The current data suggest that bilingualism may be associated with altered interhemispheric dynamics in regions associated with cognitive control.

### D67

### THE NEURAL TRAJECTORY OF ADULT SECOND LANGUAGE ACQUISITION: AN FMRI STUDY OF LEARNING A REDUCED NATURAL LANGUAGE

Kaitlyn M. Tagarelli[1], Xiong Jiang[1], Kyle F. Shattuck[1], Itziar Laka[2], Aron K. Barbey[3], John W. VanMeter[1], Kara Morgan-Short[4], Alison Mackey[1], Aron J. Newman[5], Peter E. Turkeltaub[1], Elissa L. Newport[1], Michael T. Ullman[1]; [1]Georgetown University, [2]University of the Basque Country, [3]University of Illinois at Urbana-Champaign, [4]University of Illinois at Chicago, [5]Dalhousie University — What are the neurobiological substrates of adult second language (L2) acquisition, and how do they change with increasing exposure and proficiency? Though understanding the learning of a full natural language is the goal of language acquisition research, it is logistically impractical to

longitudinally investigate the entire course of L2 learning from initial exposure to advanced proficiency, since this process takes many years. The current study aims to address this problem and resulting gaps by examining the learning of a reduced natural language, using continuously acquired behavioral and fMRI measures. Nineteen English native speakers (8 female; mean age = 20.6 years) were trained on a subset of real Basque words and sentences. Learners achieved very high proficiency in vocabulary (98% accuracy) and reasonably high proficiency in grammar (82%) after only a few hours of training in the MRI scanner. Within grammar, syntactic word order was learned quite well, whereas morphosyntactic agreement was more difficult. Preliminary fMRI analyses indicate involvement of the hippocampus and other medial temporal lobe (MTL) structures in early word and grammar learning, followed by increased activation in areas of the inferior frontal gyrus involved in lexical retrieval (e.g., BA45/47) and the processing of automatized procedural skills (e.g., BA44). Additionally, basal ganglia activation increased for syntactic word order over the course of learning. The results have implications for neurobiological models of language learning, most clearly supporting the Declarative/Procedural Model, as well as more generally informing the neurobiology of the language learning process.

## D68

### NAMING IN SPANISH, ENGLISH, OR MIXED CONDITIONS DIFFERENTIALLY MODULATES CONNECTIVITY STRENGTHS AMONG COGNITIVE CONTROL REGIONS IN BILINGUALS

Aurora I. Ramos-Nuñez[1], Maya R. Greene[1], Kelly A. Vaughn[1], Arturo E. Hernandez[1]; [1]University of Houston — Previous imaging and language impairment research has shown evidence of a cognitive control mechanism needed for bilinguals' management of two languages, which involves areas in the prefrontal, inferior parietal and anterior cingulate cortices, and basal ganglia, and has been implicated in executive function processes. However, previous research has not discussed how these areas interact during language switching and how they are connected in the healthy bilingual brain. The purpose of this study was to examine modulatory effects of picture-naming language conditions on cognitive control network interactions using Dynamic Causal Modeling (DCM). Spanish-English young adult bilinguals (n=47) participated in this experiment. Participants named objects in three conditions: Spanish only, English only and mixed (alternating between Spanish and English) in a picture-naming task while inside the scanner. Effective connectivity was examined among prefrontal, parietal, and caudate and an object recognition region (fusiform gyrus) during the three conditions. Bayesian Model Selection (BMS) analyses revealed that the model representing the Spanish and English conditions showed greater influence on connectivity among the four regions examined. The mixed condition had no modulatory influence on any of the connections. These results suggest that this group of bilinguals may not be accustomed to switching between their two languages, leading to weak brain connections. Conversely, speaking in Spanish and English requires brain processes that may be more practiced than those used in language switching, suggesting that the more practiced task leads to stronger brain connections.

## D69

### REFERENTIAL CONTEXT PROCESSING DEFICITS IN SCHIZOPHRENIA: EVIDENCE FROM ELECTROPHYSIOLOGY

Megan Boudewyn[1], Debra Long[1], Matthew Traxler[1], Tyler Lesh[1], George R. Mangun[1], Cameron Carter[1], Tamara Swaab[1]; [1]University of California, Davis — In order to establish reference during comprehension, a referential expression must be connected to its antecedent in discourse. In recent work with healthy adults, we have shown that referential processing is significantly influenced by individual differences in verbal skill and by attentional engagement to the context in which the antecedent to a referential expression was introduced. In the current study, we investigated whether context-maintenance deficits in schizophrenia would lead to impaired recognition of referential ambiguity. We tested 20 individuals with schizophrenia and 19 demographically-matched controls. EEG was recorded while participants listened to stories, which introduced antecedents that were either more or less difficult to represent as separate entities (two oaks, vs. one oak and one elm). This rendered a referential expression in the final sentence (oak) ambiguous or unambiguous. ERPs to this expression revealed that controls, but not patients, were sensitive to referential ambiguity. Further, alpha oscillations in the third sentence (which contained the antecedents) predicted the size of the ERP effect in controls, but not in patients: control participants who had higher alpha oscillations when they heard the antecedents in the ambiguous condition (e.g., two oaks) relative to the unambiguous condition (e.g., an oak and an elm) showed decreased sensitivity to referential ambiguity in sentence four. These results indicate that, although context-maintenance in control participants may be sensitive to fluctuations in attentional engagement, individuals with schizophrenia may have a more pervasive deficit in the ability to represent and maintain language context over time.

## D70

### CORTICAL ENCODING AND NEUROPHYSIOLOGICAL TRACKING OF ENGLISH STRESS PATTERNS IN NATIVE AND NONNATIVE SPEAKERS

Gavin Bidelman[1], Weilun Chung[1]; [1]University of Memphis — Acoustically, English stress can be represented by variations in intensity and frequency between a stressed and an unstressed syllable. Previous behavioral and neuroimaging work has revealed that adult Mandarin-speaking English learners exploit frequency as a primary acoustic cue when perceiving English stress, consistent with the importance of tone in their native language. Here, we examined cross-language differences in the ability to encode and track English stress patterns based on intensity variations. Auditory event-related brain potentials (ERPs) were recorded in English and Mandarin listeners in response to English pseudoword stimuli with primary stress on the second syllable (i.e., "nocTICity"). Across syllables, we found stronger encoding of English stress in English relative to Mandarin speakers in the latency of the N1-P2 complex (100-200ms). We further evaluated correlations between the amplitude of ERPs and continuous changes in the intensity and frequency of speech stimuli to assess how well each group's brain responses tracked these salient acoustic features of English stress. We found that English speakers' neural activity tracked intensity changes in speech better than Mandarin speakers; no differences were found in the tracking of frequency cues. Our findings suggest more robust and faithful processing of English stress patterns based on changes in stimulus intensity in the early auditory cortical processing of native relative to nonnative English speakers. Coupled with previous studies, our data demonstrate that linguistic experiences produce unique changes in brain function to enhance the most relevant cues necessary for a listener's native language.

## D71

### OSCILLATORY DYNAMICS OF INTRA-SENTENTIAL CODESWITCHING

Kaitlyn A. Litcofsky[1], Janet G. van Hell[1,2]; [1]Pennsylvania State University, [2]Radboud University Nijmegen — Codeswitching is a natural phenomenon of bilingual speech in which bilinguals switch between their two languages, such as "I ate huevos para el desayuno [eggs for breakfast]". Previous ERP research on intra-sentential codeswitching has found that codeswitches incur a processing cost in terms of an N400 and a late positive component (LPC), but these studies have not systematically studied the effect of language switching direction (switching from the first to the second language, or vice versa), even though studies on isolated word switching have shown modulatory effects of switching direction. Moreover, this research has only focused on traditional evoked response (component) analyses. The present study examined both components and event-related changes in EEG power during intra-sentential codeswitching. Oscillatory dynamics, which reflect local and long-range network synchrony, have begun to be studied in language processing, but not in codeswitching in bilinguals. In our study, highly proficient Spanish-English bilinguals read sentences that contained intra-sentential codeswitches in both language switching directions while ERPs were recorded. Component analysis showed that switches elicited only an increased LPC, and only when switching into the weaker language but not when switching into the dominant language, suggesting that codeswitches require sentence-level restructuring related to activation of the weaker language. Time-frequency analyses focused on theta and gamma band frequency ranges, which tend to indicate lexico-semantic and sentence level unification processing, respectively, to find convergent evidence between the ERP analysis methods. Results will be discussed in terms of the neurocognitive understanding of codeswitching and interaction of languages in bilinguals.

### D72

### ASYMMETRICAL MISMATCH NEGATIVITY EFFECTS IN MANDARIN TONES 2 AND 3

Stephen Politzer-Ahles[1]; [1]New York University Abu Dhabi — Phonological asymmetries are reflected in electrophysiological responses: for example, in English, /n/ is pronounced [m] in certain contexts (e.g., "rai[m]bow"), and a passive oddball paradigm elicits greater mismatch negativity (MMN) for rare [n] tokens mixed with frequent [m] tokens than for rare [m] tokens mixed with frequent [n] tokens. In other words, asymmetrical alternations may correlate with neurophysiological components. Such asymmetries have not been studied in non-Indo-European languages or in suprasegmental contrasts, which might not be represented in the same way as segments. The present study investigated the neural representation of a phonological asymmetry in Mandarin contour tones. Two tones, T2 and T3, are involved in a phonological alternation: in certain contexts, T3 is pronounced as T2. EEG was recorded during a passive oddball paradigm while participants heard blocks in which T3 (on a carrier syllable) was a frequent standard (85% of trials) and T2 an infrequent deviant (15% of trials), or vice versa. ERPs for standard tokens were subtracted from ERPs for the same token as a deviant, controlling for low-level acoustic differences and yielding MMN waves. T2 deviants in T3 contexts elicited smaller MMNs than T3 deviants in T2 contexts. The results suggest that T2 and T3 have different featural representations in the mental lexicon. Abstract phonological knowledge that T2 is a possible realization of T3 mitigates the clash of features between T2 deviants and T3 standards, whereas the reverse is not the case (as T3 is not a possible realization of T2).

### D73

### AN EVENT-RELATED BRAIN POTENTIAL INVESTIGATION OF MULTI-LEVEL PROBABILISTIC EXPECTATIONS IN SENTENCE COMPREHENSION

Edward W. Wlotko[1], Margarita Zeitlin[1], Gina R. Kuperberg[1,2]; [1]Tufts University, [2]Massachusetts General Hospital — Prediction during language comprehension occurs in a probabilistic manner at multiple levels of representation. Here we used event-related brain potentials (ERPs) to investigate how these multi-level predictions influence neural processing of incoming words in context. Sentence contexts conveying events or states were strongly or weakly lexically constraining, and were completed with either the most expected word, an unexpected but plausible word, or a word that violated the coarse semantic constraints of the context, creating an impossible meaning representation. ERPs were recorded while participants read sentences word-by-word in a delayed acceptability judgment task. The N400 was larger to impossible words (that mismatched course-grained semantic constraints) than to plausible but unexpected words (that mismatched finer-grained semantic constraints). The N400 to both types of semantically unexpected words was, however, insensitive to lexical predictability, underlining the fact that it is primarily a reflection of semantic — as opposed to lexical — constraints. Plausible but unexpected words that violated strong lexical constraint also elicited a late frontal positivity effect. This is consistent with the idea that the late frontal positivity reflects a violation of a high-certainty specific semantic-wordform prediction (lexical prediction) within a coherent meaning representation. In contrast, when these same words created impossible meanings in their contexts, we did not observe any late positivity effect in either strongly or weakly constraining contexts, perhaps because, unlike in previous studies, the contexts did not constrain strongly for a single, specific semantic-syntactic structure.

## LONG-TERM MEMORY: Development & aging

### D74

### AGE ESTIMATION BASED ON FACIAL IMAGES OF OTHERS: THE EFFECT OF THE ACCUMULATED MEMORY OF A KNOWN FACE ON THE OVERESTIMATION OF OTHERS

Yuki Kitaoka[1], Kenji Katahira[1], Noriko Nagata[1]; [1]Graduate School of Science and Technology / Research Center for Kansei Value Creation, Kwansei Gakuin University — This study aimed to investigate an age estimation of others based on facial images. In our previous study, we conducted experiments in which participants estimated the ages of those in facial images presented to them that were younger or older than the participants and found that people tend to overestimate others' ages. We hypothesized that accumulated memory of one's own face is a possible cause of this tendency. This time, we examined whether the memory of others also influences age estimation. In four experiments, the participants estimated the ages of unknown others presented in facial images (comparison stimuli) as younger or older than standard stimuli. In Experiments 1 and 2, two types of standard stimuli were presented: facial images of well-known others (brothers or sisters) and unknown others, respectively, with age information. Participants had different amounts of accumulated memory regarding these two stimuli. In Experiment 3, only age information was presented to examine the influence of age instruction, and only the facial images of unknown others were presented in Experiment 4 (control). The participants overestimated the comparison stimuli by 3.62, 2.01, 3.46, and -0.41 years, respectively, in Experiments 1–4. The results revealed that age information influenced the tendency to overestimate (Experiment 3 versus 4), and that accumulated memory of others' faces also influenced this tendency (Experiment 1 versus 2). We concluded that two factors influence this overestimation: accumulated memory of individual others' faces and an average face related to a certain age constructed based on experience or memory.

### D75

### AGE RELATED DECREASE IN WHITE MATTER AND GRAY MATTER VOLUMES RELATED TO FAMILY HISTORY OF ALZHEIMER'S DISEASE

Prabhjyot Singh[1], Ariana Stickel[1], Kevin Kawa[1], Adrienne Buller[2], Lee Ryan[1]; [1]University of Arizona, [2]McGill University, Montreal, Canada — Family history of Alzheimer's disease (AD) and Apolipoprotein E □4 status are risk factors for developing AD. Although the relationships between ApoE □4 and brain volume have been well studied, there are fewer studies on the role of family history of AD on the brain. The present study examines this relationship in 81 cognitively normal late middle age and older adults (49-89 years). Participants included 40 individuals with a first degree relative with AD (+FH) and 41 age, gender, education, and ApoE e4 matched controls without a family history of AD (-FH). Voxel based morphometry was used to analyze structural MRIs. Segmented gray and white matter images were analyzed to determine regions in which +FH volumes were significantly smaller than in -FH individuals, controlling for intracranial volume and age. Significant gray matter regions included bilateral frontal, temporal, occipital, cerebellar, and thalamic regions while significant white matter regions included bilateral frontal, parietal, and cerebellar regions. These results suggest that FH of AD does affect brain structure in older adults with no signs of dementia.

### D76

### AUTOPHAGY ACTIVATORS RESCUE AND ALLEVIATE THE PATHOGENESIS OF A FTLD-TDP MODEL WITH TDP-43 PROTEINOPATHIES

IFang Wang[1,2], Kuen-Jer Tsai[3], Che-Kun James Shen[1,2]; [1]Academia Sinica, [2]National Defense Medical Center, [3]National Cheng Kung University — Amyotrophic lateral sclerosis (ALS) and Frontotemporal lobar degeneration (FTLD) have been reported to share the same pathological linkage to TDP-43 proteinopathies, which is the mis-metabolism of TDP-43 and the formation of ubiquitin (+), TDP-43 (+) inclusions in the diseased neurons of 90% of ALS cases and 50% of frontotemporal lobar dementia cases (FTLD-TDP). We have studied the neuronal functions and dysfunction of TDP-43 with the use of conditional transgenic mouse model of FTLD-TDP generated in our lab. The data showed that overexpression of TDP-43 caused FTLD-TDP in mice with cognition defect and learning/memory impairment. This mouse model now has been used for the identification, validation and screening of drugs/ chemicals for the treatment of TDP-43 proteinopathies. Autophagy activation is an effective route for therapy of TDP-43 Tg mice with FTLD phenotypes. In particular, the elevation learning and memory capability and cognition upon rapamycin treatment indicates that the cells in the forebrain of the mice, still maintain an autophagy system, albeit impaired, that is responsive to and reusable by pharmacological stimuli to restore neuronal activity underlie memory storage and processing. The therapeutic effects of other autophagy activators indeed support this conclusion. This study has set the basis for therapy of neurodegenerative diseases with TDP-43 proteinopathies by pharmacologically targeting autophagy.

## D77

### AGE EFFECTS ON ASSOCIATIVE MEMORY FOR NOVEL OBJECT PAIRINGS

Anna-Lena Scheuplein[1], Emma K. Bridger[1], Roni Tibon[2], Nurit Gronau[3], Daniel A. Levy[2], Axel Mecklinger[1]; [1]Saarland University, Saarbrücken, Germany, [2]The Interdisciplinary Center, Herzliya, Israel, [3]The Open University of Israel, Raanana, Israel — Normal aging is characterized by a greater memory decline for recollection than for familiarity. Though associative memory is generally supported by recollection, it has been suggested that familiarity can also contribute to associative memory when different components of an association can be unitized to one single configuration. In the current event-related potential (ERP) study we explored whether older adults' associative memory deficit can be reduced under conditions that facilitate unitization at encoding. We used pairs of semantically unrelated objects that were positioned, relative to each other, in either spatially implausible or plausible locations (e.g. a drill oriented away from or towards a donut), the latter of which was assumed to foster unitization at encoding. Consistent with our predictions, age-related memory impairments were attenuated for pairings which were subjectively experienced as spatially plausible as compared to pairings experienced as spatially implausible. An early and broadly distributed old/new effect (presumably reflecting unit familiarity) was present for spatially plausible pairings in both age groups. Supporting the view that recollection is attenuated in old age, a late parietal old/new effect (the ERP correlate of recollection) was present for young but not for old adults. These findings suggest that even though recollection is attenuated in older adults, they can still use knowledge about relative object spatial relations to form memory representations that ameliorate associative retrieval.

## D78

### DIFFERENCES IN ENCODING NETWORKS RELATED TO RETRIEVAL ACCURACY ACROSS THE LIFESPAN FOR SPATIAL AND TEMPORAL CONTEXT INFORMATION

Elizabeth Ankudowich[1], David Maillet[2], Diana Kwon[1], Stamatoula Pasvanis[1], Maria Natasha Rajah[1]; [1]McGill University, [2]Harvard University — Age-related change in episodic memory is characterized by larger deficits in context or source memory relative to item memory, which are thought to be due, in part, to age-related differences in the ability to successfully encode contextual details of events. Previous functional magnetic resonance imaging (fMRI) studies investigating age differences for encoding events subsequently remembered vs. forgotten at retrieval (subsequent memory effects) have shown activation in frontal and parietal cortex in older vs. young adults associated with decreased performance. However, little is know about how successful encoding networks relate to context memory performance at mid-life. The present study aimed to investigate successful encoding activation related to context memory performance across the lifespan. Using fMRI, we compared how encoding activity for correct trials in young (20-35; n=36), middle-aged (40-58; n=30), and older (60-76; n=31) adults related to retrieval accuracy in a subsequent memory paradigm that tested for the spatial and temporal details of faces. Behaviorally, a significant Task x Group interaction on retrieval accuracy ($p<.05$) revealed that young adults outperformed middle-aged and older adults on both tasks, whereas middle-aged adults performed no differently from older adults on either task. We used multivariate behavioral partial least squares (B-PLS) analysis to identify whole-brain patterns of successful encoding activity that correlated with subsequent behavior across age groups. We found medial temporal areas in addition to frontal and parietal areas where encoding activity differentially correlated with task accuracy across groups, suggesting that age-related functional change in encoding networks related to retrieval accuracy begins at midlife.

## D79

### EFFECTS OF DISTRACTION AND AGE ON SPACING BENEFIT

Ashleigh MacLean[1], Patricia Simone[1], Matthew Bell[1]; [1]Santa Clara University, [2]Santa Clara University, [3]Santa Clara University — We evaluated the effect of events that occurred in that time between study and retrieval, with the goal of examining what factors are necessary or relevant to the spacing benefit. Additionally, we were interested in potential age-related differences in the effects of these factors. In the learning session, participants were presented with English word pairs. There were 5 within-subject conditions, with 10 word pairs in each: no cued retrieval, cued retrieval immediately after presentation, cued retrieval after 20 seconds of a blank screen following presentation, cued retrieval after 20 seconds of a comic following presentation, or cued retrieval after approximately 20 seconds of interleaving presentations and retrievals following initial presentation. The learning session was followed by the Reliable Digit Span task and finally a testing session with cued retrievals for all word pairs. Younger adults experienced spacing benefit in all spaced conditions, performing best in the condition with interleaving presentations and retrievals (mean proportion correct was .720 compared to .539 and .502 for the comic and blank screen conditions respectively). Older adults also experienced a spacing benefit in all three spaced conditions, but with no significant difference between these experimental conditions: means were .440, .447 and .427 for interleaving presentations/retrievals, comic, and blank respectively. Differences in performance between age groups may be explained by previously established differences in contextual encoding: compared to younger adults, older adults are less able to incorporate new contextual cues, and the distraction created by interleaving events could create additional contextual cues for the retrieval.

## D80

### STRUCTURAL AND FUNCTIONAL NETWORK CHANGES IN DEMENTIA: A COMBINED STUDY OF VBM AND RESTING-STATE FMRI

Hongjie Yan[1], Keiichi Onoda[1], Shuhei Yamaguchi[1]; [1]Shimane University Faculty of Medicine — Alzheimer's disease (AD) is characterized by progressive cognitive impairment with metabolic decline and neuron loss in the brain, and mild cognitive impairment (MCI) has been considered to be a prodromal stage of AD. In this study, we explored structural and functional changes during different stages of cognitive impairment by using AD Neuroimaging Initiative database. We collected 73 subjects from the database, which included 21 with early MCI, 16 with late MCI, and 15 with AD. Voxel-based morphometry (VBM) and functional network analysis by graph theory were performed to elucidate anatomical and functional alterations along dementia progression. The VBM analysis showed significant differences in gray matter volumes of the inferior frontal gyrus, precuneus, cingulate gyrus, angular gyrus, lingual gyrus, supramarginal gyrus, precentral gyrus, basal ganglia and thalamus among the groups. The progression of cognitive impairment was associated with reduction or increment of gray matter volume in each region. The graph theory analysis revealed that the AD group had increased clustering coefficients (network segregation), flow coefficients (centrality), and decreased characteristic path (network integration) of functional networks compared with other groups. Most regions with morphometric changes showed decreased local path length or betweenness in association with cognitive impairment, but some regions had only functional network changes without volume changes. Our results suggest that the changes of gray matter volume and graph properties of functional brain network could be dissociable along with development of cognitive impairment.

## D81

### PATTERN SEPARATION AND RELATIONAL BINDING ACROSS THE LIFESPAN

Kelsey M. Hassevoort[1], Patrick D. Watson[1], Sarah E. Zola[1], Charles H. Hillman[1], Neal J. Cohen[1]; [1]University of Illinois at Urbana-Champaign — Behavioral pattern separation and relational binding are both sensitive measures of hippocampal function (Bakker et al., 2008, Watson et al., 2013) and are sensitive to changes in memory that occur both in healthy aging and mild cognitive impairment (Stark et al., 2014, Monti et al., 2013). However, less is known about these examples of hippocampal-dependent memory in the developing brain. The current study assessed memory in preadolescent children (N = 59; mean age = 8.7 years) who underwent a structural MRI scan and completed behavioral testing as part of a larger randomized controlled trial. The current analyses represent baseline data. Participants completed both the Behavioral Pattern Separation Task - Object Version (BPS-O, Stark et al., 2014) and a memory reconstruction task. Whereas previous studies using the BPS-O have shown a decline in behavioral pattern separation performance but no decline in recognition memory performance with age, we found that children exhibited poorer recognition memory but were not impaired on behavioral pattern separation performance compared to young adults. For memory reconstruction, memory errors for spatial relations and memory errors for feature relations between highly similar objects were differentially related to behavioral pattern separation

and recognition memory performance on BPS-O. These results suggest that both tasks may provide measures that are sensitive to changes in memory during development and that are likely distinct from the BPS-O pattern separation measure that is sensitive to changes in memory in healthy aging.

# LONG-TERM MEMORY: Episodic

## D82

### ELECTROPHYSIOLOGICAL EVIDENCE FOR STRATEGICALLY ORIENTING RETRIEVAL PROCESSES TOWARD THE AGE OF A MEMORY

Jeffrey Johnson[1], Anna McGhee[1]; [1]University of Missouri — For over a century, memory researchers have extensively studied the differences between retrieving memories that were encoded in the remote past as opposed to recently. This body of research has largely focused on the changes that memory traces are subjected to over time, such as decay, retroactive interference, and consolidation. A relatively unexplored issue, however, is that retrieval attempts and processes might be differentially oriented in order to effectively retrieve remote versus recent memories. The current study addressed this issue by having subjects (n = 22) retrieve words that were encoded one week (remote) or 30 minutes earlier (recent). To encourage the adoption of distinct retrieval orientations, the memory test employed exclusion procedures in which the words from only one of the encoding periods were targeted at a given time (in separate blocks). Event-related potentials (ERPs) elicited by correctly-rejected new items during the test blocks revealed differences according to the targeted week, such that ERPs over posterior scalp were more positive-going for the recent compared to remote condition. Furthermore, using multiple methods, these ERP effects were dissociated from differences in retrieval difficulty across the two conditions. The findings thus provide novel evidence that knowledge about the age of a memory leads to the adoption of different orienting strategies in support of episodic retrieval.

## D83

### PROSPECTIVE REPRESENTATION OF NAVIGATIONAL GOALS IN THE HUMAN MTL

Thackery I. Brown[1], Karen F. LaRocque[1], Serra E. Favila[1,2], Valerie A. Carr[1], Alan M. Gordon[1], Ben Bowles[1,3], Anthony D. Wagner[1]; [1]Stanford University, [2]New York University, [3]University of California, Berkeley — The mental representation of future states is a critical component of goal-directed behavior. The hippocampus and neighboring medial temporal lobe (MTL) cortices are believed to play a critical role in spatial navigation through representation of goal locations (McKenzie et al., 2013) and prospective location coding (Johnson and Redish, 2007) in rodents, and supporting goal-directed route planning in humans (Brown et al., 2014; Hartley et al., 2003). Using high-resolution functional magnetic resonance imaging (hr-fMRI), we examined whether the human MTL supports goal-directed navigation by representing future goal states during initial navigational planning. On day 1, participants learned to navigate to hidden goal locations in a virtual open-field environment. Each location was uniquely associated with a distinct pair of fractal images. On day 2, participants repeatedly navigated to the goals during hr-fMRI scanning. Participants began each trial at a familiar location, after which the environment was hidden from view and participants were cued by of one of the fractals to plan navigation to its location. Participants subsequently navigated to this goal. Using multivoxel pattern analyses (MVPA), initial results from eight healthy, right-handed young adults demonstrated that hippocampal and parahippocampal cortical patterns contain information during initial planning that predicts the goal location to which participants will subsequently navigate. Moreover, when the classifier was more confident, classifier evidence for the goal was correlated between these MTL regions. Collectively, these results suggest that the human MTL prospectively represents future goals, contributing to flexible planning of future navigation behavior.

## D84

### WHEN THE WHAT DETERMINES THE WHERE: A META-ANALYSIS OF HIPPOCAMPAL DIFFERENTIATION OF STIMULUS CONTENT DURING EPISODIC ENCODING AND RETRIEVAL

Jonas Persson[1], Hedvig Söderlund[1]; [1]Uppsala University, Uppsala, Sweden — From lesion studies in rodents and imaging studies in humans it has become increasingly clear that the hippocampus is functionally heterogeneous along its longitudinal axis, with spatial tasks frequently engaging the posterior hippocampus. The areas that are engaged during episodic memory are more distributed along the hippocampal axis and may depend on the specific nature of the stimuli. Here, we investigate the effect of stimulus content on the location of hippocampal recruitment during episodic memory encoding and retrieval of verbal and pictorial material with a meta-analysis approach, using activation likelihood estimation (ALE) and restricting the analysis to the hippocampus. Verbal material was associated with left-lateralized and anterior activation, compared to pictorial material that recruited a more posterior aspect of the hippocampus, primarily within the right hemisphere. This effect held for encoding of both single items and item-item associations but was less clear during retrieval. Furthermore, within pictorial stimuli, there was a tendency for objects to activate the left anterior hippocampus with faces and scenes being located more posteriorly and bilaterally. The findings lend further support to a functional subdivision of the hippocampus along its longitudinal axis and indicate that the content of episodic memories is one factor that determines the location of hippocampal recruitment.

## D85

### LOCAL AND DISTRIBUTED EFFECTS OF TARGETED NONINVASIVE STIMULATION OF THE HIPPOCAMPAL SYSTEM ON RESTING-STATE FUNCTIONAL NETWORKS

Jane Wang[1], Joel Voss[1]; [1]Northwestern University Feinberg School of Medicine — The hippocampus has a vital role in declarative/relational memory due to its ability to bind together elements of experience that are individually processed by distributed brain regions. However, the causal nature of hippocampal dynamics within whole-brain functional networks is largely unknown. We therefore modulated hippocampal network dynamics using multiple-day noninvasive repetitive transcranial magnetic stimulation (rTMS) targeted to the posterior-medial hippocampal system, as defined via resting-state fMRI connectivity with left hippocampal body (N=16). Using a sham-controlled within-subjects design, we found that stimulation increased connectivity within hippocampal-cortical networks and was associated with selective improvements in relational memory performance that far outlasted the treatment period. We describe for the first time the effects of stimulation on whole-brain network dynamics in relation to effects on hippocampus and on memory. Using a novel whole-brain connectivity analysis to identify regions that responded to stimulation with global increase in functional connectivity, we identified the specific areas of the hippocampus that were targeted in each subject, as well as other distributed cortical regions. Further analysis revealed that some of these regions, including the hippocampal target location, exhibited high functional connectivity to the cortical stimulation site at baseline, the majority of which were highly connected to the hippocampal target itself. Noninvasive stimulation can thus have both local effects on targeted networks as well as more distributed influences. We postulate that multiple-day stimulation can create direct and second-order connectivity changes in resting-state dynamics, possibly mediated by the hippocampal network.

## D86

### USING TDCS/CTBS TO INVESTIGATE THE INVOLVEMENT OF LEFT POSTERIOR PARIETAL COETEX IN EPISODIC MEMORY RETRIEVAL

Nai-Feng Chen[1], Chien-Ming Lo[1], Chi-Hung Juan[1], Neil Muggleton[1], Shih-kuen Cheng[1]; [1]Institute of Cognitive Neuroscience, National Central University, Taiwan — Functional neuroimaging studies of episodic memory retrieval have demonstrated the prominent contribution of the left posterior parietal cortex (LPPC), particularly the left angular gyrus (LAnG) to the conscious recollection process. The present study aimed to investigate whether the LPPC/LAnG is responsible for episodic retrieval by using transcranial direct current stimulation (tDCS) and continuous theta burst stimulation (cTBS). In the tDCS experiment, participants were divided into two groups: Anode and Cathode group. During the three sessions, Anode group received anodal tDCS over the left posterior parietal cortex (LPPC), anodal tDCS over the right motor cortex (M1), and sham; Cathode group received cathodal tDCS over LPPC, cathodal tDCS over M1, and sham. In each session, participants performed a study-test source memory task and on-line tDCS was delivered during the test phase. The results showed that source accuracy was diminished following cathdal tDCS. In the cTBS experiment, we further examined the LAnG involvement in episodic retrieval.

All participants encountered three stimulation sessions in separate days: cTBS over LAnG, Sham, and control. A modified multi-contextual source memory task was applied in each session, and an off-line cTBS was delivered five minutes before the test stage. No cTBS modulatory effect on source accuracy was found. These findings provide some supportive evidence for the causal involvement of LPPC in episodic retrieval process. However, the null results of the cTBS experiment might due to the delicate nature of the recollection network. More converging evidence is needed to establish the functional role of LAnG in episodic retrieval.

### D87

### LOOKING AT NOTHING: HOW EYE MOVEMENTS RELATE TO EPISODIC RICHNESS DURING EVENT RECONSTRUCTION

Michael Armson[1,2], Douglas A. McQuiggan[2], Brian Levine[1,2], Jennifer D. Ryan[1,2]; [1]University of Toronto, Toronto, ON, Canada, [2]Rotman Research Institute, Baycrest, Toronto, ON, Canada — Previous research has shown that eye movements may serve to rehearse information during encoding and maintenance stages of memory. The current study addressed the role of eye movements during memory retrieval. Twenty healthy participants verbally recalled autobiographical memories while their eye movements were monitored as they viewed a blank screen. There were two viewing conditions: (1) free viewing: participants were able to look anywhere on the screen, and (2) fixed viewing: participants had to maintain fixation on a central cross throughout recall. There were also two memory conditions: (1) specific events: unique episodes specific in time and place, and (2) repeated events: frequent experiences remembered in a more generic manner. Participants' recollections were scored for details according to Levine et al.'s (2002) Autobiographical Interview protocol. More fixations were generated during free than fixed viewing ($F(1, 19) = 22.210$, $p = .000$) with longer saccade length ($F(1, 19) = 49.044$, $p = .000$). Participants made more fixations and provided more internal (episodic) details while recalling specific than repeated events (fixations: $F(1, 19) = 55.612$, $p = .000$; internal details: $F(1, 19) = 34.124$, $p = .000$). There was a positive correlation between number of fixations and number of internal details during free viewing ($r(19) = .578$, $p = .008$). These findings suggest that specific events involve richer re-experiencing than repeated events and that the degree of episodic richness is related to the number of eye movements. Eye movements may facilitate event reconstruction or may be a by-product of such detail generation.

### D88

### ELECTROPHYSIOLOGICAL CORRELATES OF RECOLLECTION AND CORTICAL REINSTATEMENT

Rachael L. Elward[1], Leslie J. Lewis[1], Preston P. Thakral[1], Michael D. Rugg[1]; [1]Center for Vital Longevity, University of Texas at Dallas — Previous research has shown that the neural processes engaged during encoding are reinstated during retrieval. In contrast, generic recollection effects are associated with successful recollection regardless of the encoding context. The relationship between the generic recollection-related cortical activity and cortical reinstatement is not well understood. According to one proposal, however, pattern completion processes in the hippocampus provide access to the content of the stored memory representation, and further recollection-related processes act on this information post-retrieval. We contrasted the time-courses of content-sensitive ERP recollection effects with that of modality-independent effects (i.e. the parietal recollection effect, and the late right frontal effect). Participants studied pictures of objects along with the objects' visual or auditory names. At test, they first discriminated between studied and unstudied pictures and, for each picture judged studied, then judged whether it had been paired with a visual or auditory name, using a two-point confidence scale. The electrophysiological data at test contrasting source correct and source incorrect judgments showed the typical pattern of generic ERP recollection effects. In addition, the results indicated that modality-specific recollection effects demonstrated a similar time-course to the generic effects, onsetting around 400ms post-stimulus and lasting for the remainder of the recording epoch. These findings suggest that, as indexed by scalp electrophysiological activity, the neural correlates of content-dependent reinstatement and generic recollection occur in parallel.

### D89

### RECALL-TO-REJECT: THE NEURAL CORRELATES OF FALSE MEMORY SUPPRESSION USING TRUE RECOLLECTION

Caitlin Bowman[1], Nancy A. Dennis[1]; [1]The Pennsylvania State University — Memories based on recollection involve the vivid reinstatement of a previous episode, including retrieval of specific contextual details of an item's previous occurrence. While recollection during recognition tasks has typically been associated with hits, previous evidence also suggests that recollection may help correction rejections by providing details of target items that are inconsistent with lures, a strategy known as recall-to-reject. The present study sought to evaluate both the common and distinct neural mechanisms supporting true recollection and recall-to-reject. Using a novel adaption of the Remember-Know-New paradigm, we asked participants to discriminate not only between recollection and familiarity for items they perceived as old, but also between recollection rejection and lack of familiarity for items they perceived as new. Despite the theoretical overlap between these memory responses, cortical overlap was limited to late visual and parietal cortices. Direct comparisons between recall-to-reject and true recollection revealed increased activity in left-lateralized prefrontal regions, consistent with the notion that using recollected details to reject as opposed to accept an item requires increased retrieval monitoring. In contrast, true recollection compared to recall-to-reject revealed activity in the typical recollection network, including left posterior MTL, medial prefrontal cortex, precuneus, and early visual cortex. Taken together, evidence suggests that recall to reject does not recruit the recollection network to the same extent as true recollection, but is instead associated primarily with monitoring processes.

### D90

### STRESS REACTIVITY ENHANCES MEMORY FOR EMOTIONAL CONTENT AT THE COST OF NEUTRAL INFORMATION

Tony Cunningham[1], Stephen Mattingly[1], Jessica Payne[1]; [1]University of Notre Dame — Emotional experiences create durable memory traces in the brain and tend to be exceptionally well remembered during times of stress. Stress, which leads to the release of the stress hormone cortisol, has been linked to enhanced memory consolidation for emotional content, but impaired consolidation for neutral content. Here, participants encoded scenes consisting of negative or neutral objects on neutral backgrounds, followed by a psychosocial stress task or a control condition. The following day, recognition memory was tested for objects and backgrounds separately. This allowed us to explore how stress exposure would affect the selective consolidation of emotional content. Mixed ANOVA analysis revealed a three-way interaction among Condition (stress/control), Scene Component (object/background), and Valence (negative/neutral) [$F(1, 41)=4.6$, $p=0.037$], which was driven by an increase in memory for negative objects but also a suppression of memory for associated neutral backgrounds after stress. Thus, there was a significantly larger emotional memory tradeoff effect in the stress group than in the control group [$t(41)=2.0$, $p=0.05$]. Based on cortisol reactivity to the stressor, we next divided participants into responders vs. nonresponders. While the aforementioned three-way interaction was retained in the stress responder group [$F(1,32)=6.9$, $p=0.01$], nonresponders performed identically to the control group, suggesting that a stress response is necessary to produce these memory effects. We suggest that HPA axis activation may help "tag" emotional objects as important to remember, enabling processes active during consolidation to selectively enhance emotional memory while concurrently suppressing neutral information.

## LONG-TERM MEMORY: Other

### D91

### FORGETTING IN THE HEALTHY BRAIN: FALSE RECOGNITION IS PRESENT BUT LIMITED IN YOUNG ADULTS UNDER HIGH VISUAL INTERFERENCE

Lok-Kin Yeung[1], Hannah Bild-Enkin[1], Anna Keshabyan[1], Morgan Barense[1,2]; [1]University of Toronto, [2]Rotman Research Institute, Toronto ON — In our previous work (Yeung et al., 2013), we found that older adults at-risk for mild cognitive impairment (MCI) exhibited false recognition under high feature-level interference conditions. In the current study, we investigated whether cognitively-intact younger adults would also exhibit the same impairment as feature-level interference was increased beyond

those of our original study. In a continuous viewing paradigm, participants viewed high- and low-interference novel stimuli, as well as familiar stimuli. Critically, we evaluated how implicit (eyetracking-based) and explicit measures of novelty changed as the number of stimuli (and thus the level of interference) increased. On both sets of measures, participants were initially able to identify high-interference stimuli as novel, but exhibited increased false recognition as interference increased. Regardless of the level of interference however, younger adults were still able to recognize some of the high-interference stimuli as novel, unlike the catastrophic interference experienced by memory-impaired older adults in our previous study. In contrast, novelty detection was unimpaired for familiar or low-interference novel items, regardless of how many stimuli were shown. These results demonstrate that while younger adults are still vulnerable to feature-level interference, they benefit from a protective mechanism that shields them from catastrophic interference, which is lost in older adults at-risk for MCI.

## D92

### ELECTROPHYSIOLOGICAL AND BEHAVIOURAL CHARACTERISTICS OF VIRTUAL NAVIGATION TASK PERFORMANCE

Erin L Zelinski[1], Mashal Fida[1], Bailee Stasiuk[1], Scott Oberg[1], Robert J Sutherland[1]; [1]Canadian Centre for Behavioural Neuroscience, University of Lethbridge — Examination of the neurological underpinnings of spatial abilities often requires human subjects to be stationary. Thus, virtual reality is a commonly used tool for elucidating how we process information about the world around us. We hypothesized that differences in navigational skill would impact the strategy implemented by subjects, whether they would notice changes to the environment, and the electrophysiological responses to the presentation of manipulated vs. non-manipulated and remembered, non-remembered, and novel scenes during performance of a virtual navigation task. Object-location memory was assessed within a large-scale, virtual environment whilst recording dense array EEG. Subjects were restricted to a central circular area by a fence, but the world beyond (e.g., mountains, seascape, forest) remained visible. In addition to these distal cues, various naturalistic objects (e.g., boulders, trees) were present within the navigable portion of the environment to provide proximal cues. During the exploration phase of the task, subjects moved through the environment until all object-location pairs were encountered. The second phase of the task was a targeted search wherein subjects were shown pictures of objects with background images that were either congruent with the original object-location pair or incongruent. Subjects began each trial at a central start location and rotated until their perceived optimal direction to travel straight to their current target. The final phase of the task required subjects to place objects in their original locations over a topographical representation of the environment. Several factors influenced performance including sex, experience playing video games, and attended stimuli during task performance.

## D94

### SEX DIFFERENCES IN MUSIC: A FEMALE ADVANTAGE AT RECOGNIZING MELODIES

Scott A. Miles[1], Robbin A. Miranda[1], Natasha C. Janfaza[1], Michael T. Ullman[1]; [1]Georgetown University — Sex differences have been reported in various aspects of cognition. For example, females may have an advantage at verbal abilities, and males at spatial processing. There has been little research, however, on sex differences in music cognition. One aspect of music in which such differences might be expected is in the storage and retrieval of melodies. A growing body of evidence suggests that aspects of music and language cognition depend on overlapping neural substrates. Thus the apparent female verbal advantage may translate to a female advantage at aspects of music. Some evidence suggests, moreover, that the verbal advantage may hold particularly for words, in part because words are stored in the declarative memory brain system, which has shown female advantages (Ullman, Miranda and Travers, 2008). Additional evidence suggests that melodies may also be stored in this system (Miranda and Ullman, 2007), perhaps because it is specialized for learning arbitrary bits of information and binding them together—which may be necessary not only for words (phonemes bound together) but also for melodies (notes bound together). Thus we hypothesized that females might show an advantage in the storage and retrieval of melodies. We administered a melody recognition task to test this hypothesis. We found that females were both more accurate and faster than males at recognizing familiar melodies, and that this held for both musicians and non-musicians. No sex differences were found in a tone-recognition control task. The results suggest the existence of sex differences in music that parallel those in language.

## D95

### EFFECT OF 2-[(6-NITRO-2-BENZOTHIAZOLYL)AMINO]-2-OXOETHYL 4-[2-(N,N-DIMETHYLAMINO)ETHYL]PIPERAZINE-1-CARBODITHIOATE ON LEARNING AND MEMORY PARAMETERS OF RATS IN EXPERIMENTAL ALZHEIMER'S DISEASE MODEL

Nazlı Turan[1], Taliha Harika Aydın[1], Ümide Demir Özkay[1], Özgür Devrim Can[1], Yusuf Özkay[2]; [1]Anadolu University, Faculty of Pharmacy, [2]Anadolu University, Faculty of Pharmacy — 2-[(6-Nitro-2-benzothiazolyl)amino]-2-oxoethyl4-[2-(N,N-dimethylamino)ethyl]piperazine-1-carbodithioate (2PCT) is a compound having remarkable anticholinesterase inhibitory enzyme activity. In this study, based on this in vitro activity, we planned to investigate potential therapeutic effect of this drug on cognitive parameters of rats in streptozotocin-induced Alzheimer's disease model (SADM). Morris water maze test (MWMt) and active avoidance tests (AAt) were performed in order to examine the effect of 2PCT (10,20 mg/kg) on learning and memory parameters of rats. Effects of test compound on spontaneous locomotor activities of rats were examined with the activity cage tests. In MWMt there was a significant difference between the initial acquisition latency and first retention latency values of i.c.v. citrate buffer-injected control group, displaying the ability of learning and memory behaviors of the control animals. However, difference between these parameters was not significant in the i.c.v. STZ-injected groups indicating the occurrence of Alzheimer's disease model in these groups, as expected. Similar results were observed for latency times and numbers of avoidances parameters in AAt. 2PCT was significantly declined the 2nd retention latency times of animals in the MWMt. Further, latency times of animals were significantly decreased and avoidance numbers of animals were significantly increased with the administration of this compound in the AAt. Donepezil (3 mg/kg), reference drug, improved the measured learning parameters in both of the tests. The test compound was not significantly changed the spontaneous locomotor activities of rats. Results of this study revealed that, 2PCT repaired the parameters related to the learning and memory deficits in SADM.

## D96

### THE EFFECT OF MIANSERIN TREATMENT ON MORRIS WATER MAZE PERFORMANCE OF STREPTOZOTOCIN INDUCED DIABETIC RATS

Feyza Alyu[1], Umut İrfan ÜÇEL[1], Özgür Devrim Can[1], Ümide Demir Özkay[1]; [1]Anadolu University Faculty of Pharmacy — Recent studies have indicated that Diabetes mellitus (DM) induces notable detrimental effect on central nervous system. As well as psychiatric disorders, diabetic patients have been reported to suffer from impaired cognitive performance. However, there are only limited number of nootropic drugs and none of them is favorable for diabetes-induced cognitive disorders. Therefore, new therapeutic approaches are needed and psychotropic drugs with treating potential of not only hyperglycemia but also emotional and cognitive disorders may provide additional advantage by avoiding polypharmacy. Mianserin, an atypical antidepressant drug, has been shown to reduce hyperglycemia in STZ-diabetic rats. Further, this drug has been restored depression and anxiety levels of diabetic animals. Therefore, in this study, we planned to examine potential therapeutic effect of mianserin (30, 45 mg/kg) on diabetes-related cognitive impairments. Diabetes was induced by a single intravenous injection of streptozotocin (45mg/kg). Cognitive performance of the animals were evaluated in Morris water-maze test. In water-maze, day 4 escape latency times was taken as an index of acquisition, whereas mean time spent in target quadrant on day 5 was taken as an index of retrieval (memory). Diabetic rats showed an impairment of acquisition as well as retention on water maze task in comparison to the healthy animals. On the other hand, mianserin-treated animals located the hidden platform faster and stayed longer in the target quadrant time than the controls. These results suggest that, in diabetic animal impaired spatial learning and memory capacity was significantly improved following mianserin treatment.

### D97

**SENSE OF AGENCY IN SELF-DIRECTED LEARNING RECRUITS HIPPOCAMPUS FOR ENHANCED MEMORY.** SukHee Yun[1], Yeon Soon Shin[2], Na-Young Shin[3], Seung-Koo Lee[3], Sanghoon Han[1]; [1]Yonsei University, Seoul, Korea, [2]Princeton University, Princeton, USA, [3]Yonsei University College of Medicine, Seoul, Korea — Although recent studies have shown benefits of self-directed learning on subsequent long-term memory, exploration of the benefits based only on Sense of Agency (SOA) among various factors is inadequate since the paradigms lack considering of the participants' spontaneous on-line preference and conative learning methods. Our study used a card-flipping task in encoding phase to distinguish the volitional effects caused by SOA, allowing participants to select and carry out their preferred method of learning (Self-Directed Learning (SDL) or Passive Learning (PL)) in real-time. Cross-interaction of the magnitude and direction of the volitional effect depending on the presence of the motor response was identified. In fMRI analyses, levels of subsequent memory strengths parametrically modulated activities of right hippocampus and parahippocampal regions when SDL is compared to motor-associated PL. Additionally, the mentioned effect was more stronger for individuals preferring SDL over PL, and these participants showed better memory and shorter response times in SDL. Also, preference on SDL over PL was correlated with higher level of connectivities within important networks of resting state; hippocampus to right anterior cingulum, right mid frontal, bilateral superior frontal region, left Insula and bilateral mid temporal region. The current findings on volitional benefits with equivalent levels of access to target information across learning methods suggest that the benefits cannot be solely attributed to the fact SDL allows ease of encoding by reducing the need of cognitive control.

### D98

**HIPPOCAMPAL INVOLVEMENT IN THE PERCEPTUAL JUDGEMENT OF ESCHER-LIKE IMPOSSIBLE SCENES.** Danielle M Douglas[1], Sathesan Thavabalasingam[1], Zahraa Chorghay[1], Andy C H Lee[1,2]; [1]University of Toronto, [2]Rotman Research Institute — Although a large body of work has established that the hippocampus is critical for spatial cognition, it remains contentious whether this role can be extended beyond memory to perception. To date, studies directly implicating the hippocampus in scene perception are confounded by significant working memory demands, such as the comparison of multiple, simultaneously presented stimuli, or the comparison of stimuli over a short delay. Thus, the possibility remains that working memory requirements, rather than perceptual manipulations, drive hippocampal involvement in scene processing. In order to address this, hippocampal activity in sixteen young, neurologically healthy participants was investigated using functional magnetic resonance imaging during a scene perception task with minimal working memory demands. In this task, the subjects made coherency judgments of 56 trial-unique scenes presented in isolation, each containing no moveable objects. Crucially, half of these images were manipulated such that the structural coherency of the scene was violated, while the individual components of the scene remained intact. Moreover, a surprise recognition memory task was performed following scanning in order to investigate the contribution of long-term encoding to hippocampal activity. We found that activation in the hippocampus was greater for structurally incoherent compared to structurally coherent scenes, and importantly, this activity could not be explained by long-term memory encoding of the scenes. Our findings indicate that hippocampal involvement can be observed during a scene perception task with minimal working memory demands, irrespective of long-term memory processing, and provide further support for a role for the hippocampus in spatial perception.

### D99

**DIFFERENCES IN WHITE MATTER INTEGRITY OF LEARNERS AND NON-LEARNERS AFTER MODERATE AND SEVERE TRAUMATIC BRAIN INJURY** Kathy S. Chiou[1], Nancy D. Chiaravalloti[1,2], Helen M. Genova[1,2]; [1]Kessler Foundation, [2]Rutgers-New Jersey Medical School — Deficits in learning and memory are common after traumatic brain injury (TBI); however, the underlying mechanism of these impairments remains unclear. Previous research suggests that learning abilities after TBI may be moderated by executive processes. It is well-established that deficits in executive functioning are associated with compromised white matter integrity (WMI) of the frontal lobes after TBI. Thus, it is suspected that frontal WMI related to disordered executive processes could also affect the domain of learning. This study examined the impact of decreased WMI, as measured with diffusion tensor imaging (DTI), on learning abilities in persons with moderate and severe TBI. We hypothesized that there would be a significant difference in frontal WMI between TBI participants with intact versus impaired learning abilities. 16 adults with moderate/severe TBI were divided into 2 groups [learners (n=7) and non-learners (n=9)] based on achievement of 2 perfect repetitions of a 10-word list presented over a maximum of 15 trials. Participants completed a DTI scan and neuropsychological tests. Results indicate that learners had greater WMI in the right frontal cortex than the non-learner group. Fractional anisotropy (FA) values were extracted from this region. Higher FA values were correlated with better performance on a working memory task in the learner group, but not in the non-learner group. In contrast, lower FA values were associated with worse performance on visual processing speed tasks in the non-learner group, but not the learner group. These findings have implications for rehabilitative approaches to improve learning and memory after TBI.

## LONG-TERM MEMORY: Priming

### D101

**A CRITICAL ROLE OF THE HUMAN HIPPOCAMPUS IN IMPLICIT MEMORY PROCESSING** Rick James Addante[1]; [1]University of Texas at Dallas, School of Behavioral & Brain Sciences — The hippocampus has traditionally been thought to be critical for conscious explicit memory but not necessary for implicit memory processing that is unavailable to conscious recollection. In a recent study of a group of mild amnesia patients with evidence of MTL damage limited to the hippocampus, and two groups of healthy controls subjects, subjects were tested on a direct test of item recognition confidence, while indirect measures of memory were acquired with electroencephalogram (EEG). Intact physiological measures of explicit memory (mid-frontal old-new effect, FN400) were evident in both patients and controls from 400-600ms. The current investigation re-analyzed this data to study event-related potentials (ERPs) of implicit memory, using a procedure that eliminated declarative memory differences. Prior findings from this technique were first replicated in the two independent control groups, which exhibited reliable implicit memory effects in posterior scalp regions from 400-600 msec. However, patients were found to be dramatically impaired relative to control subjects, as quantified by a reliable condition x group interaction. Several control analysis were conducted to consider alternative factors that could account for the results, including outliers, sample size, age, or contamination by explicit memory, and each of these were systematically ruled out. Results suggest that the hippocampus plays a fundamental role in aspects of memory processing that is beyond conscious awareness. The current findings therefore indicate that both memory systems of implicit and explicit memory may rely upon the same neural structures – but function in different physiological ways.

### D102

**VALUE ASSOCIATIONS INHERENTLY TRANSFERRED TO NOVEL ITEMS** Hillary Wehe[1], Shelly Staley[1]; [1]Colorado State University, Fort Collins, Colorado — Wimmer and Shohamy (2012) demonstrated that reward is transferred through hippocampal memory systems. They first had subjects view pairs of objects, and then paired half the objects with a potential reward. On a subsequent two alternative forced choice test subjects showed a decision bias for objects that had been paired during the first part with later-to-be-rewarded objects, even though the object was never directly paired with reward itself. This transfer of value happens without recollection of the original reward conditioning. Other research has shown that inherent associations exist between stimuli that share individual features. Subjects report higher familiarity for novel test items with orthographic features that are similar to items previously studied (Cleary, 2004). We examined whether decision biases would be present for new items that share features with studied items paired with reward, but which were not directly paired with reward or studied items. Subjects (n = 240) studied words; half of which were paired with a reward outcome and the other were not. At test subjects completed a forced-choice decision task between pairs of novel non-word stimuli one of which was orthographically similar to a rewarded studied word. Subjects showed a significant bias to choose

the word that was similar to the rewarded study word (t =15.7, p < .001). The bias remained after decreasing immediate study and response time for the task (n= 25, t =2.9, p < .01).

# METHODS: Neuroimaging

## D103

### USING A MULTI-TASK BRAIN IMAGING BATTERY TO RELATE SPEECH PRODUCTION TO PHONOLOGICAL WORKING MEMORY, EMOTION AND PROSODY

Kevin Sitek[1,2], Gregory Ciccarelli[2,3], Carlo de los Angeles[2], Thomas Quatieri[3], Satrajit Ghosh[1,2]; [1]Harvard Medical School, [2]MIT, [3]MIT Lincoln Laboratory — Producing meaningful speech involves the coordination of numerous motor, perceptual, and cognitive processing systems. In this study, we investigated the relation between emotion processing, pitch modulation, and phonological working memory in the context of overt verbal output. Participants performed a variety of tasks including overt sentence reading, nonword repetition, and rate and pitch modulation during functional magnetic resonance imaging (fMRI). To maximize the number of trials and temporal and spatial SNR, while minimizing the effects of scanner noise, we used state-of-the-art simultaneous multislice sequences with rapid sparse sampling. We found that producing emotional sentences involved a combination of limbic network structure also activated our non-speech visual emotional face task, including amygdala, prefrontal cortex, and cingulate cortex. Additionally, auditory and motor areas activated during emotional sentence production are similar to emotionally neutral content spoken with specified pitches (high, low, and normal), suggesting engagement of a prosodic network that is also active during emotional speech. Orbitofrontal cortex was more active in emotional vs. neutral sentence production, with modulatory effects of emotion observed in auditory cortex. The rapid acquisition paradigm also enabled us to confirm that auditory processing regions increased activation when faced with heavier phonological loads in a nonword repetition task, while ventral somatosensory cortex and supramarginal gyrus were activated during rapid production of speech sounds. Using task-optimized rapid acquisition parameters, we can collect a large battery of tasks that elucidate the complex cortical and subcortical mechanisms involved in modulation of speech production.

## D104

### CD4 COUNTS PREDICT WHITE MATTER INTEGRITY IN PEOPLE LIVING WITH HIV: A META-ANALYSIS BY THE ENIGMA HIV WORKING GROUP

Talia M. Nir[1], Jean-Paul Fouche[2], Victor G. Valcour[3], Cecilia M. Shikuma[4], Kalpana Kallianpur[4], Jintanat Ananworanich[5], Jaroslaw Harezlak[6], Giovanni Schifitto[7], Neda Jahanshad[1], Bradford A. Navia[8], Dan J. Stein[2], Ronald A. Cohen[9,10]; [1]Imaging Genetics Center, Keck USC School of Medicine, [2]Department of Psychiatry and Mental Health, University of Cape Town, South Africa, [3]UCSF, Neurology, [4]Office of Public Health Studies, University of Hawaii at Manoa, John A. Burns School of Medicine, [5]SEARCH, The Thai Red Cross AIDS Research Center, Bangkok, Thailand, [6]Indiana University Fairbanks School of Public Health, Indianapolis, [7]Department of Neurology, University of Rochester, [8]Department of Public Health, Infection Unit, Tufts University School of Medicine, [9]Department of Psychiatry and Human Behavior, the Warren Alpert Medical School of Brown University, [10]Centers for Behavioral and Preventive Medicine, The Miriam Hospital — Antiretroviral therapy has greatly improved the quality of life for many people living with HIV, but chronic infection is associated with neurological deficits, brain atrophy, and progressive decline in the brain's white matter pathways. By pooling data from neuroimaging studies of HIV worldwide, we boosted our statistical power to detect associations between immunological markers of disease and brain injury. In a diffusion tensor imaging (DTI) study for the ENIGMA HIV consortium (http://enigma.ini.usc.edu/ongoing/enigma-HIV-working-group/), we related CD4+ cell count to fractional anisotropy (FA), a measure of brain white matter integrity, in 281 HIV+ patients scanned in Thailand, South Africa, and across the United States (6 sites). We used the ENIGMA DTI analysis protocols for robust multi-site analyses. For each site, we ran linear regressions, adjusting for age and sex, to test associations between CD4 counts and corpus callosum FA (genu, body and splenium). No single cohort yielded significant evidence of association, but an inverse variance-weighted meta-analysis found consistent positive associations between FA in the corpus callosum genu and CD4 counts (p=0.03). Pooling brain scans from HIV+ individuals worldwide may implicate factors that predict white matter integrity, revealing effects that no single cohort can identify.

## D105

### UNCOVERING SEX ESSENTIALISM IN NEUROIMAGING RESEARCH ON HUMAN SEX/GENDER DIFFERENCES

Vanessa Bentley[1]; [1]University of Cincinnati — Sex essentialism, sometimes termed biological essentialism, is the view that the two sexes are essentially distinct; males and females have different biological essences that are a result of their sex. Sex essentialism as an assumption imposes methodological and theoretical limitations. The assumption is socially and ethically problematic because it naturalizes sex/gender differences and can be used to justify the oppression of women. I investigate two case studies in the neuroimaging of sex/gender differences and find that sex essentialism is pervasive. The first case study is on structural differences in the corpus callosum, comprising 45 articles. The second is on functional activation differences in the mental rotation task, comprising 14 articles. I find that: 1) researchers fail to distinguish sex and gender, giving the impression that all differences are due to sex factors (biology, hormones, genetics, "nature"); 2) researchers fail to consider evidence that contradicts their sex/gender-based theory; 3) researchers continue to hunt for sex/gender differences even though there are no consistent findings of differences across studies; 4) researchers assume their results generalize across time and cultures; and 5) researchers assume that experience doesn't affect brain structure and function. Throughout, it is unclear if researchers explicitly avow sex essentialism or if they are ignorant of the assumption. I suggest a new framework for cognitive neuroscience that is better founded epistemically and is more socially and morally responsible. This framework connects feminist standpoint empiricism (Intemann 2010) to the practice of cognitive neuroimaging.

## D106

### LATERALIZATION OF EXECUTIVE FUNCTION IN THE ASYMMETRIC ALZHEIMER'S DISEASE CONNECTOME

Adam F Mezher[1], Madelaine Daianu[1], Neda Jahanshad[1], Talia M Nir[1], Clifford R Jack, Jr.[2], Michael W Weiner[3], Matthew Bernstein[2], Paul M Thompson[1]; [1]University of Southern California, [2]Mayo Clinic, [3]University of California, San Francisco — Diffusion-weighted imaging (DWI) can be used to estimate the integrity of white matter tracts connecting brain regions. The present study used 3-Tesla DWI scans (41 diffusion-weighted and 5 b0 images) of 42 Alzheimer's disease (AD) participants and 50 normal controls (CN) as part of the Alzheimer's Disease Neuroimaging Initiative (ADNI) to examine lateralization of executive function (EF) – a composite score from several implicated neurocognitive assessments. Although morphometric asymmetries are widely recognized, lateralization of brain networks in relation to EF is not well understood. Using whole-brain tractography, we reconstructed connectivity matrices describing normalized fiber density between cortical regions segmented by FreeSurfer. A laterality matrix was generated for each subject by subtracting the right from the left hemispheric connectivity matrices. We assessed the association between these laterality matrices and EF scores using linear regression with age and gender as covariates. We found a decrease in the proportion of fibers in the laterality matrix within the insula with decreasing EF scores, indicating a left asymmetry in AD participants. In addition, fiber density in left hemispheric connections between the insula and frontal cortex areas (superiorfrontal, precentral, caudal middle frontal) also declined with decreasing EF (FDR p-value=0.8x10-3). In a similar setup, we assessed the laterality matrix differences between AD and CN (CN=0; AD=1) and found further evidence of a decrease in the proportion of fibers in left insula, relative to CN (FDR p-value=0.7x10-3). Results suggest that the hemispheres in AD may degenerate at different rates with most impairment observed in the left hemisphere.

## D108

### BRAIN WHITE MATTER INTEGRITY IN BIPOLAR DISORDER SUBTYPES ASSESSED WITH DIFFUSION TENSOR IMAGING

Joshua Faskowitz[1], Jair Soares[2], Christopher Ching[1], Nicholus Warstadt[1], Paul M. Thompson[1], Benson Mwangi[2], Jennifer L. Kroll[2], Neda Jahanshad[1]; [1]University of South-

ern California, [2]University of Texas Medical School — Bipolar disorder (BP) is a mood disorder categorized broadly as type I (BP I), defined by intense manic episodes, type II (BP II), which includes hypomanic and depressive episodes, and not-otherwise specified (NOS) with similar, yet less severe, symptoms. Here we characterized white matter structural differences across different BP subtypes. We measured white matter integrity in adults (n: 133, mean age: 37.42, 62% women) with diffusion tensor imaging measures (fractional anisotropy [FA], mean diffusivity [MD], and radial diffusivity [RD]) in a voxel-wise analysis across the white matter. Frontal lobe white matter tracts may be altered in BP and schizophrenia perhaps reflecting myelin anomalies (Adler et al., 2004). Here we found measures of RD and MD were significantly higher in BP subjects in the left anterior corona radiata (ACR) and the right superior corona radiata after controlling the false positive rate (q=0.05) in multiple comparisons across all voxels. Measures of RD and MD were still significantly higher in the left ACR when limiting the analysis to a comparison of only BP I (n=35) subjects to healthy controls. No difference was detected for MD or RD in BP II (n=12) and BP NOS (n=11) when analyzed separately. White matter disruption in BP I, the clinically more severe condition, supports the observation of a relationship between symptom intensity and disruptions in white matter structure (Lagopoulos et al., 2013).

## D109

### THE UNCERTAIN RELATIONSHIP BETWEEN BOLD VARIABILITY AND AGE

Brian A. Lopez[1], Benjamin O. Turner[1], Tyler Santander[1,2], Misty Schubert[1], Michael B. Miller[1]; [1]University of California, Santa Barbara, [2]University of Virginia — Given the vast amount of complex data typically acquired in fMRI studies, researchers tend to focus their efforts on measures of central tendency of the time series. However, an increasing number of researchers have begun to systematically explore within-individual brain signal variability. Rather than being attributed to mere noise, their findings suggest that moment-to-moment variability is actually a functional property of the human brain and is related to task performance and changes in the brain associated with aging and disease. Given this rising interest in BOLD signal variability, it is important to address certain methodological issues and possible confounds that may obscure the relationship of interest. Toward that end, we demonstrate the impact of a variety of analysis choices on the relationship between age and BOLD variability with data acquired from participants ages 18-75 during a recognition memory test involving criterion shifting. We show that subtle changes in preprocessing or analysis strategy can have a profound effect on the qualitative story told by the data—for example, swinging from a map showing extensive positive correlation between age and BOLD variability to one showing mostly negative correlation when more stringent corrections (i.e., partialing out grand mean intensity normalization factor and mean relative motion) are applied. Given the considerable uncertainty regarding what the true pattern is for our dataset, we believe caution should be exercised when making claims about how within-individual brain variability is related to other variables including age. As we illustrate, the relationship depends critically on the exact analysis pipeline used.

## D110

### INTERACTION BETWEEN WHITE MATTER MICROSTRUCTURE AND BOLD COMPLEXITY ENHANCE BRAIN EFFICIENCY

Ian McDonough[1], Jonathan Siegel[1]; [1]University of Texas at Dallas — Brain structure has been proposed to facilitate as well as constrain functional interactions within brain networks. Simulation models suggest that white matter microstructure should be positively related to the complexity of BOLD signal—a measure of network interactions. Using 80 young adults from the Human Connectome Project, we empirically tested whether greater white matter microstructure via fractional anisotropy (FA) would be associated with greater complexity of the BOLD signal during rest via multiscale entropy. Multiscale entropy measures the randomness of a given time series across varying time scales and has the advantage of estimating fluctuating signal dynamics within brain networks. We also tested whether these measures were associated with processing speed and whether complexity of the BOLD signal moderated the effects of white matter microstructure on processing speed. Using multivariate analysis techniques (Partial Least Squares), we found that greater fractional anisotropy distributed across the brain was associated with greater BOLD complexity at slower time scales, but lower BOLD complexity at faster time scales. These relationships were found across Dorsal Attention, Ventral Attention, Fronto-Parietal, and Limbic Networks. In relation to cognition, BOLD complexity moderated the effects of FA on processing speed; people with high FA values showed a positive relationship between BOLD complexity and cognition, but no relationship was found with people with low FA values. These findings support simulation models of white matter microstructure and BOLD complexity and provide new insights into the brain mechanisms underlying efficient cognitive processing.

## D111

### A SEMI-AUTOMATED ALGORITHM FOR SEGMENTING THE HIPPOCAMPUS IN CONTROL AND PATIENT POPULATIONS

Nathan Muncy[1], Christopher Doxey[1], Naomi Goodrich-Hunsaker[2,3,4], Christopher Finuf[1], Mikle South[1,4], Brock Kirwan[1,4]; [1]Brigham Young University, Neuroscience, [2]University of California, Davis, MIND Institute, [3]University of California, Davis, Psychiatry and Behavioral Science, [4]Brigham Young University, Psychology — Calculating hippocampal volume from MR images is an essential task in many cognitive neuroscience studies. The standard hand-tracing method is accurate but laborious, requiring expertly trained researchers and significant amounts of time. As such, processing large datasets with the standard method is impractical. Automated processes, like FreeSurfer and FSL's First, have been developed to calculate cortical volumes in an automated fashion, but are insufficiently accurate at hippocampal denotation and volumetry. We developed a semi-automated hippocampal segmentation algorithm based on the Advanced Normalization Tools (ANTs) suite of programs. Under this protocol, the researcher places landmarks to denote the structure of interest and a template segmentation is warped to the individual participants' native space. This method was compared to traditional hand segmentation for a group of healthy controls (mean age = 22), a group of older healthy adults (mean age = 71) and a group of high-functioning Autistic young adults (mean age = 23). Dice similarity coefficients between hand segmentations and semi-automated algorithm output were high (>.7) for all groups, although semi-automated hippocampal volumes were reliably larger than hand segmentations. Volumes significantly correlated between hand and semi-automated segmentation methods for all groups. These results indicate that the semi-automated method is equivalent in performance to the standard method across a variety of populations. Additionally, the semi-automated method requires less time to process MRI data, less training to become proficient, and is sufficiently adaptable such that it accurately calculates hippocampal volumes in diverse groups.

## D112

### DISTINCT CONNECTION PROPERTIES BETWEEN MORPHOLOGICAL CORRELATION NETWORKS: CORTICAL THICKNESS, SURFACE AREA, AND GRAY MATTER VOLUME

Jin-Ju Yang[1], Jong-Min Lee[1]; [1]Hanyang University — Structural correlation networks are constructed by a set of nodes that correspond to brain regions and a set of connection edges that correspond to statistical correlations in morphometric values between regions across individuals. Although gray matter volume, thickness, and surface area have been frequently used as a measure of structural association between brain regions, their relationships are poorly investigated. In this study, we characterized the degree of convergence and divergence edges assessing for the first time the concept of Venn-diagram to compare three morphological networks as measured in the same subjects. We also compared the network properties such as clustering coefficient, characteristic path length, small-worldness, global efficiency and betweenness centrality in these three networks. Structural magnetic resonance imaging data from 78 young healthy adults were measured gray matter volume, cortical thickness, surface area. For each cortical measure, inter-regional correlation maps were computed. Common edges in three networks were showed consistent 12 % of convergence at all network sparsity range found in most brain areas such as inter-hemispheric connection. When increasing network sparsity, the common edges in two networks increased but divergence edges in each network decreased. The observed network parameters revealed similar pattern whereas the hub regions were discrepancy in three networks. These findings provide direct evidence for the distinction

between these morphological correlation networks. The differences probably reflect the different information supporting region-specific neuroanatomical mechanisms.

## D113

### BETA-ADRENERGIC ANTAGONISM MODULATES DEFAULT MODE NETWORK COHERENCE IN AUTISM SPECTRUM DISORDER

John P. Hegarty II[1], Bradley J. Ferguson[1], Rachel M. Zamzow[1], Landon J. Rohowetz[1], Jeffrey D. Johnson[1], Shawn E. Christ[1], David Q. Beversdorf[1]; [1]University of Missouri

— Altered functional connectivity (FC) is implicated in autism spectrum disorder (ASD) with the majority of studies suggesting local hyper-connectivity and long distance hypo-connectivity. Beta-adrenergic antagonism, such as the use of propranolol, benefits social and communication domains in ASD and performance benefits on language tasks following propranolol administration have been associated with increased FC. The cognitive and behavioral benefits from propranolol administration may be due to pharmacological effects on network coherence improving cognitive processing. Resting-state fMRI data was acquired to assess drug-related changes in network coherence. Utilizing a graph theoretical approach, we assessed the effects of beta-adrenergic antagonism on resting state network coherence in individuals with ASD compared to unaffected individuals, with particular emphasis on the default mode network (DMN). DMN regions were also segregated into subnetworks using the Louvain algorithm for community detection. Regardless of diagnosis, beta-adrenergic antagonism decreased FC and network efficiency in the dorsal medial prefrontal cortex subnetwork of the DMN and increased connectivity and network efficiency in the medial temporal lobe subnetwork. However, these alterations in network coherence appeared to be due to diagnostic group specific effects on functional organization. Network coherence and functional organization effects were primarily not seen with nadolol, a peripheral beta-adrenegic antagonist, suggesting these findings were not due to peripheral cardiovascular effects on the BOLD signal. Our findings suggest that beta-adrenergic antagonism may be able to up- or down- regulate specific subnetworks in the brain and differentially affect functional organization of the DMN in individuals with ASD as compared to controls.

## D114

### ITERATIVE LASSO: AN EVEN-HANDED APPROACH TO WHOLE BRAIN MVPA

Christopher Cox[1], Qihong LU[1], Timothy T ROGERS; [1]University of Wisconsin -- Madison

— A long-standing issue in cognitive neuroscience is whether mental representations are encoded by distributed activation widely dispersed in the brain or within dedicated cortical regions. The question has been difficult to adjudicate with brain imaging since standard statistical methods assume localized representations and so are insensitive to distributed signal. We introduce a new method for whole brain multivoxel pattern classification, the iterated LASSO, that makes no assumptions about the anatomical distribution of the underlying signal and so provides an unbiased way of assessing whether neural representations are localized or distributed. We show through analysis of synthetic data that the method's accuracy does not depend on the anatomical arrangement of signal-carrying voxels, and that the method ameliorates some of the problems with other whole-brain approaches. We then applied the method to fMRI data in a domain where representations are widely thought to be localized, specifically the visual representation of faces, places, and objects. Consistent with the canonical view from univariate methods, we found that voxels within the putative face recognition system were more likely than other randomly-sampled voxels to consistently discriminate face from non-face stimuli. Nevertheless the great majority of signal-carrying voxels were found to lie outside the canonical face-processing system. These voxels were widely distributed anatomically, and their locations varied dramatically across individuals, so they cannot be identified using standard univariate contrasts. The results raise the possibility that neuro-cognitive representations may be considerably less anatomically localized than has previously been thought.

## D115

### ALTERED RESTING STATE FUNCTIONAL NETWORK AND MODULAR TOPOLOGY IN AUTISM SPECTRUM DISORDER, PHENYLKETONURIA, AND TRAUMATIC BRAIN INJURY

Rachel M. Zamzow[1], Jeffrey D. Johnson[1], John P. Hegarty II[1], Gary Yao[1], David Q. Beversdorf[1], Shawn E. Christ[1]; [1]University of Missouri

— Previous studies have suggested alterations in functional connectivity (FC), as measured by functional magnetic resonance imaging (fMRI), in individuals with neurological conditions. In the present study, we used graph theoretical analysis to examine how functional network topology differs based on diagnosis. Resting state fMRI data was collected from individuals with autism spectrum disorder (ASD, N=61), phenylketonuira (PKU, N=12), traumatic brain injury (TBI, N=18), and 61 typically developing (TD) individuals. Partial correlation matrices for 90 regions were generated and topological properties were compared between groups. The ASD group demonstrated reduced local network organization (decreased local network efficiency and likelihood of short-range connections, $p < .05$) and a bias toward greater global network organization (increased global network efficiency and likelihood of long-range connections, $p < .05$), as compared to the TD group. The PKU and TBI groups demonstrated the opposite pattern, showing more local organization ($p < .001$). In subsequent analyses, 13 identified modules were compared between groups for topology. The ASD group demonstrated reduced density in a temporal module ($p < .01$). The PKU group showed reduced FC in frontoparietal and orbitofrontal modules ($p < .01$). Lastly, the TBI group displayed widespread reduced efficiency and FC in 10/13 modules ($p < .01$). The results of the present study indicate alterations in functional network and modular organization in multiple neurological conditions. Future studies are needed to explore how the present findings fit into the context of other FC literature, as well as characterize network alterations across development and symptom severity.

## D116

### FUNCTIONAL CHANGE OF POSTPARTUM DECLINE IN RESTING-STATE: ANALYZING DEGREE CENTRALITY, HOMOTOPIC CONNECTIVITY, AND MULTIVARIATE PATTERN OF FUNCTIONAL CONNECTIVITY

Sehjung Yi[1], Na-Young Shin[2], Yoonjin Nah[1], Sanghoon Han[1], Seung-Koo Lee[2]; [1]Yonsei University, [2]Yonsei University College of Medicine

— Postpartum decline has been reported on both subjective and clinical levels, but most of studies lack efforts to find pathology of the deficiency utilizing neurological measures. Even more, cognitive domain was overlooked while most of focuses was given on emotional aspects of the problem. For our study, we collected subjective reports on cognitive deficiencies and functional resting-state data from postpartum subjects and analyzed against control group. Significant statistical difference on subjectively reported cognitive deficiencies existed between two groups. To locate neural basis of the reported deficiency, voxel-level degree centrality (DC) and voxel-mirrored homotopic connectivity (VMHC) along with multi-variate pattern analysis on functional connectivities (fcMVPA) among important regions were calculated and applied. fcMVPA found outstanding discrimination accuracies within connectivities of frontal gyri, and among cognition-related regions including bilateral frontal gyri, hippocampi, and precunei. Significantly lowered DC on bilateral hippocampi, parahippocampal gyri, left orbitofrontal gyrus, and left anterior cingulate cortex was found in postpartum over control group while left superior frontal gyrus and right middle temporal gyrus showed the opposite. Analysis of homotopic connectivities revealed weaker homotopic functional connectivities of hippocampus, precuneus, and anterior and middle cingulate cortices of postpartum subjects. Our analyses yielded results that are lying in the same direction to the subjectively reported postpartum cognitive deficiencies of subjects and offers insight into neural correlates of postpartum cognitive deficiencies.

# METHODS: Other

## D117

### VALIDATION OF AN AUTOMATED COGNITIVE ASSESSMENT INSTRUMENT

Charlotte Housden[1,2], Linda Hermans[1], Jenny Barnett[1,2], Francesca Cormack[1], Andy Blackwell[1,2]; [1]Cambridge Cognition, Cambridge, UK, [2]Department of Psychiatry, University of Cambridge, UK — Technological advances enable measurement of neurocognitive function outside the laboratory, potentially allowing high-frequency, large-scale data collection. However, it is important to demonstrate that data collected via automated testing is equivalent to that from face-to-face testing. This study compared cognitive performance measured using Cantab Connect Research delivered on an iPad to the established Cantab Research Suite software delivered on a Motion touchscreen tablet. Compared to the Cantab Research Suite, the Cantab Connect Research tests were shorter (20-25 min versus 15 min). Importantly, test instructions in Cantab Connect Research were delivered using an automated voiceover, whereas in Cantab Research Suite a rater read a standardised script. Seventy-one healthy individuals aged 19 to 67 (M± SD: 40.4 ± 14.7) completed tests from Cantab Research Suite and Cantab Connect Research at 3 time points. Tests assessed psychomotor processing (Cantab Reaction Time: RTI), episodic memory (Cantab Paired Associates Learning: PAL), and executive function (Cantab Spatial Working Memory: SWM). There was a strong correspondence between performance on the two platforms for RTI ($r71= 0.82$, $p< 0.001$), PAL ($r71= 0.68$, $p< 0.001$) and SWM ($r71= 0.68$, $p< 0.001$). Cantab Connect Research had high test-retest reliabilities for RTI ($r71= 0.81$, $p< 0.001$), PAL ($r71= 0.85$, $p< 0.001$) and SWM ($r71= 0.74$, $p< 0.001$). Similar values were obtained using Cantab Research Suite (RTI ($r71= 0.81$, $p< 0.001$), PAL ($r71= 0.79$, $p< 0.001$) and SWM ($r71= 0.88$, $p< 0.001$)). Our results demonstrate that Cantab Connect Research has good test-retest properties and good correspondence with the established Cantab Research Suite technology.

# PERCEPTION & ACTION: Motor control

## D118

### A MODEL OF CEREBELLAR GATING OF BASAL GANGLIA SELECTION PROCESSES

Matthew Boggess[1], Matthew Crossley[1], Richard Ivry[1]; [1]University of California, Berkeley — Natural behavior must solve a credit assignment problem between action selection and execution. E.g., a tennis player faced with a shot hit directly at her must select between a forehand or a backhand return. If her return is unsuccessful, how does she know whether her mistake was in her choice of shot (selection error), or whether she simply executed the chosen shot poorly (execution error)? We explored the hypothesis that execution errors limit modification of selection policies, motivated by consideration of anatomical links between the cerebellum (CB) and basal ganglia (BG), as well as CB projections on dopamine (DA) neurons. We built a biologically detailed spiking network of the BG, assuming that 1) action selection policies are learned via DA-dependent synaptic plasticity at cortico-striatal synapses, 2) DA cell firing reflects reward prediction errors, and 3) learning rates at cortico-striatal synapses are scaled by execution errors (presumably reflecting CB output to BG input and DA neurons). This model successfully accounts for new data showing that classic risk averse decision making is switched to risk seeking when learning on risky trials is paired with large execution errors. We conclude by discussing the anatomy and physiology of how our algorithmic model of CB function may be reconciled with more biologically detailed network models of the CB.

## D119

### ELIMINATING MIRROR RESPONSES BY INSTRUCTIONS

Lara Bardi[1], Carsten Bundt[1], Wim Notebaert[1], Marcel Brass[1]; [1]University of Gent — The observation of an action leads to the activation of the corresponding motor plan in the observer. This phenomenon of motor resonance has an important role in social interaction, promoting imitation, learning and action understanding. However, mirror responses not always have a positive impact on our behavior. An automatic tendency to imitate others can introduce interference in action execution and non-imitative or opposite responses have an advantage in some contexts. Previous studies suggest that mirror tendencies can be suppressed after extensive practice or in complementary joint action situations revealing that mirror responses are more flexible than previously thought. The aim of the present study was to gain insight into the mechanisms that allow response flexibility of motor mirroring. With this end in mind, we measured motor-evoked potentials (induced by transcranial magnetic stimulation) during the observation of hand movements in the context of imitative and counter-imitative task instructions. We showed that the mere instructions of a counter-imitative mapping changes mirror responses at the physiological level. Importantly, mirror activation was measured while participants were passively watching movements, without having the opportunity to execute the task. This result suggests that the implementation of task instructions activates stimulus-response association that can overwrite the mirror system. Our outcome reveals one of the crucial mechanisms that might allow flexible adjustments of mirror responses in different contexts.

## D120

### VISUOMOTOR ADAPTATION IS SPECIFIC TO MOVEMENT DYNAMICS

Jiang Lan Fan[1], Matthew Crossley[1], Richard Ivry[1]; [1]University of California, Berkeley — Interference between motor skills, and how it might be circumvented, is a fundamental problem in motor learning. Humans cannot typically learn to compensate for conflicting sensorimotor perturbations, even when provided with explicit contextual cues (e.g., color indicating the direction of a visuomotor rotation). However, recent work has shown successful learning of opposing force fields when the field direction is signaled via dynamic cues (e.g., by unique starting positions), suggesting an important constraint underlying the formation of motor memories (Howard et al., J Neurophysiology 2012). We find that a similar result holds for visuomotor adaptation and extend this work to assess the independence of these memories by examining interference effects in memory retention and recall. We used a design in which two blocks of movements with a clockwise rotation were separated by a washout block in which the rotation was removed (ABA). We compared conditions in which the dynamic cues in the washout block were identical to or different from the initial cues in the adaptation blocks. A different set of dynamic cues in the washout block preserved learning: When the initial cues were reintroduced in the reacquisition block, adaptation immediately returned to a level approximately equal to that observed at the end of initial acquisition. This pattern was observed even when the rotation was introduced and washed out gradually, thereby eliminating potential contributions from non-motor processes such as strategic aiming. Our results support the notion that dynamic cues lead to the formation of independent motor memories.

## D121

### CONTRIBUTION OF AUDITORY FEEDBACK TO POSTURAL STABILITY

Jessica Marie Ross[1], Ramesh Balasubramaniam[1]; [1]University of California, Merced — Human balance control is a multisensory process that is known to rely on visual, vestibular and somatosensory feedback. Although auditory information influences balance, much less is known about the mechanisms underlying this process, especially the role of acoustic noise. We examined the effect of auditory noise on postural sway variability in 19 participants by tracking fluctuations in their center of pressure (CoP) using a force platform. We found reduced CoP variability in the presence of auditory noise, which is similar to the reduction in variability with vision. Nonlinear time series analysis revealed that auditory noise has an additive effect, independent of vision, on postural stability. We used filtering to distinguish low (<0.3 Hz) and high frequency (>0.3 Hz) components of sway. Variability analyses of the filtered data demonstrated that for low frequency sway, noise interacts with vision, whereas for high frequency sway, the effect is additive. Our results support the idea that noise in the auditory modality, like somatosensory noise, reduces postural sway variability and that it might be due to similar sensory stochastic resonance mechanisms. It would be important to explore the role of noise in reducing the postural sway variability in older adults and those with balance disorders due to central nervous system dysfunction.

### D122

### IT'S NOT THE GOAL, BUT THE JOURNEY: GRASPING ADVANTAGE FOR HAND-TO-MOUTH MOVEMENT REQUIRES SIMULTANEOUS MOUTH OPENING.

Jason Flindall[1], Claudia Gonzalez[1]; [1]University of Lethbridge — Previous research has shown that grasping movements use smaller maximum grip apertures (MGAs) when a participant intends to transport a food item to the mouth; grasps to place the same item in a receptacle near the mouth use significantly larger MGAs. As limb transport phases of both movements are mechanically identical, this suggests that these actions may be initiated and controlled by distinct neural networks. Results from primate studies support this theory, as direct electrical stimulation to the macaque motor cortex may cause either grasp-to-inspect or hand-to-mouth movements. However, elicited hand-to-mouth movements are always coupled with simultaneous mouth opening; we therefore hypothesized that simultaneous mouth opening may itself prompt smaller MGAs, irrespective of the movement's end-goal. Participants grasped food items to either bring them to the mouth (MOUTH), or place them in a container near the mouth (CONTAINER). Participants opened their mouths as if to eat the item during 50% of trials (OPEN), with the mouth remaining closed during all other trials (CLOSED). Kinematic analysis revealed that participants produced smaller MGAs in the MOUTH/OPEN condition than in both MOUTH/CLOSED and CONTAINER/OPEN conditions. In CLOSED conditions, end-goal did not affect a change in MGA. Furthermore, larger MGAs were produced in the CONTAINER/OPEN condition than in all other conditions. These results suggest first that, contrary to our hypothesis, concurrent mouth movement may interfere with normal hand pre-shaping during grasping actions not directed toward the mouth. Second, grasp-to-eat movements have an ecological, and perhaps evolutionary, relevance extending beyond the sum of their parts.

### D123

### TEMPORAL DYNAMICS OF EEG AND MOTION CAPTURE DURING A DART THROWING VISUOSPATIAL WORKING MEMORY TASK

Robert Gougelet[1], Scott Makeig[2]; [1]UCSD, [2]Swartz Center for Computational Neuroscience — With an embodied cognition perspective at the forefront of recent cognitive theory, the link between brain activity and full body motion will become increasingly important. Few studies combine full body motion and electroencephalography (EEG), especially in visuospatial working memory tasks. This study involves humans performing a novel visuospatial delayed response working memory task. For each trial, a ceiling mounted projector projects a target stimulus onto a large white cork board. After a randomly variable 3 to 9 s integer delay, the subjects throw a dart to the persistently displayed or remembered position of the target. Continuous EEG data were collected using 128 active electrodes. The continuous EEG data were decomposed into maximally independent components using independent component analysis (ICA). Full-body kinematic motion data were collected from 32 LED locations on the limbs, torsos, and heads of the subjects. The behavioral data reveal a decrease in precision and accuracy of dart throws when throwing from memory, which grows as the delay length increases. Time-frequency interactions among equivalent dipole projections of continuous and event-related EEG were investigated during the delay period and during the throw. Theta, alpha, and gamma dynamics were identified to correspond with throwing from memory versus throwing to a visible target. Examination of interactions between EEG features and throw execution and performance is forthcoming, particularly as these dynamics evolve over time, throughout the task.

## THINKING: Reasoning

### D124

### ANTERIOR PREFRONTAL CORTEX AND RELATIONAL REASONING DURING ADOLESCENCE: AN EVENT-RELATED POTENTIAL STUDY

Robert G Morrison[1], Valerie Flores[1], Elise Gagnon[2], Sarah Zaza[1], Amanda Sweis[1]; [1]Loyola University Chicago, [2]Northwestern University — Neuroimaging studies have suggested that rostrolateral prefrontal cortex (RLPFC) is associated with relational integration, a capacity critical for relational reasoning. Recently, we adapted a geometric analogy paradigm for use with EEG and identified a response-locked ERP using a task subtraction to isolate relational integration (Nikitin & Morrison, 2011). The mean amplitude of this ERP was strongly correlated with reasoning accuracy. A prior neuroimaging study using this same paradigm suggested that structural and functional RLPFC changes during adolescence support changes in relational reasoning (Dumentheil et al., 2010). The present study tested 13- to 25-year-old females (adolescent group: n=13, 13.8 - 18.9 years; emerging adult group: n=16, 19.3 - 25.1 years) using this visual analogy paradigm. We also indexed participants' fluid and crystallized intelligence using the NIH toolbox. The two age groups showed no reliable accuracy or response time differences in either the control or relational integration task. Consistent with our prior study of young adults, we found a reliable late positive response-locked ERP corresponding to relational integration. However, the adolescent group failed to show this subtraction ERP. Across all participants the subtraction was strongly correlated with fluid intelligence as measured via the NIH toolbox. These results suggest that RLPFC activity during relational integration is strongly associated with fluid intelligence and its development may be a critical factor in achieving mature relational reasoning ability.

### D125

### GAZE PATTERNS REVEAL STRATEGIES DURING ANALOGICAL REASONING

Michael Vendetti[1], Elizabeth Johnson[1], Silvia Bunge[1]; [1]University of California, Berkeley — Analogical reasoning is a cognitive process in which similarities are made between two domains based on shared relations, rather than on perceptual or semantic similarity. Proportional analogy tasks (e.g., HANDS:GLOVES::FEET:?) allow control over the types of items involved in mapping the A:B relation (i.e., hands wear gloves) to the appropriate C:D combination (e.g., feet wear shoes). One could first focus on the A:B pair, extract the relation, and use this to discover the solution. However, given that A:B terms have many potential relations (e.g., hands could also knit gloves), another view suggests response choices constrain the decision, and predicts that semantic and perceptual distractors should greatly influence participants' responses. To test these two views, we measured eye gaze patterns in 34 healthy young adults while they solved analogies. We observed a significant interaction between location (top: partial analogy versus bottom: response choices) and accuracy (correct vs. incorrect analogy trials) on fixation duration, $F(1,31) = 7.55$, $p < .01$, $\eta_{partial2} = .2$. On correct trials, participants spent a greater proportion of time looking at the top versus bottom location, $t(31)=4.28$, $p < .001$, whereas no such difference was observed on incorrect trials, $p > .64$. Additionally, we observed a significant positive correlation between the ratio of top versus bottom fixation duration and proportion accuracy ($r = .54$). These results suggest that extracting the relation between the A:B pair (as defined by more time spent in the top location) is much more critical to solving analogy problems.

### D126

### PREDICTING PRACTICE-RELATED GAINS IN STANDARDIZED TEST PERFORMANCE FROM CORTICAL THICKNESS

Belen Guerra-Carrillo[1], Allyson P. Mackey[2], Silvia A. Bunge[1]; [1]University of California, Berkeley, [2]Massachusetts Institute of Technology — We have previously reported experience-dependent changes in structural and functional connectivity within the lateral fronto-parietal network in young adults who participated in an intensive 3-month course to prepare for the Law School Admissions Test (LSAT), a test that places heavy demands on reasoning skills (Mackey et al., 2011; 2012; under review). Some individuals benefited more from the course than others, showing larger gains across 3-4 LSAT practice tests regardless of their initial scores. Here, we sought to test for structural predictors of individual differences in learning trajectories in this adult dataset. In a longitudinal study of reasoning development over childhood and adolescence, we previously showed that that thinner (i.e., more mature) left inferior parietal cortex is a strong predictor of future reasoning ability (Wendelken et al., under review). Here, we asked whether cortical thickness in left inferior parietal cortex prior to test preparation would be predictive of gains on the LSAT. Indeed, thickness of left supramarginal gyrus at time 1 was a robust negative predictor of change in LSAT scores ($b= -.55$, $t(18)= -2.66$, $p<.05$), even after controlling for age ($R2= .56$, $F(2,18)= 3.63$, $p<.05$). This result was not obtained for right supramarginal gyrus or for superior parietal lobule or angular gyrus, and could not be explained by variability in time 1 LSAT scores or intracranial volume. These results sug-

gest that structural maturation within a specific portion of the left inferior parietal lobule is a strong predictor of learning in adulthood on a test that places heavy demands on reasoning.

## D127

### SEE THAT NUMBER? THE ROLE OF VISUOSPATIAL ABILITIES AND BRAIN STIMULATION IN SYMBOLIC NUMERICAL LEARNING

Jacqueline Thompson[1], Hannah Rafferty[1], Arwel Pritchard[1], Roi Cohen Kadosh[1]; [1]University of Oxford — Visuospatial abilities (e.g., mental rotation) have been linked to strength of basic numerical representations. However, the causality of this link is still uncertain; to what extent does the ability to recognise and visuospatially manipulate number symbols help us to learn their semantic (ordinal or magnitude) values? Therefore, this experiment tested mental rotation ability and visual symbol recognition ability in a group of 79 adults before and after they undertook intensive multi-day training paradigms to learn novel numerical symbols. 40 of these participants received transcranial random noise stimulation (TRNS), a form of noninvasive electrical neuroenhancement, to either parietal or occipital cortices during learning. Stimulation did not affect mental rotation or visual symbol recognition. However, learning rate of the symbols correlated with a pre-test of 3D (but not 2D) mental rotation, as well as with symbol recognition ability measured after, but not before, training of the symbols' relative magnitudes. Similarly, a measure of numerical representation strength (numerical distance effect) in the symbols correlated with symbol recognition after, but not before, training. Because the numerical distance effect is a measure that cancels out the contribution of visual processing to performance, these results are interpreted as suggesting that greater visual recognition of symbols may play a role in forming stronger numerical representation when learning novel numerical symbols.

## D128

### TRACKING THE NEURAL DYNAMICS OF HYPOTHESIS EVALUATION WITH MODEL-BASED FMRI

Nicole Marinsek[1], Benjamin O. Turner[1], Chloe Steindam[1], Michael B. Miller[1]; [1]University of California, Santa Barbara — In this study, we aimed to 1) model the component processes of hypothesis evaluation during the receipt of new evidence and 2) identify brain regions that support these processes. We used fMRI data from a previous experiment in which participants attempted to generate appropriate category labels for a series of novel word sets that were designed to either elicit repeated cycles of hypothesis formation and evaluation ("ad hoc" word sets) or minimize these processes ("control" word sets). We used a Bayesian model to estimate the strength of subjects' category hypotheses as the words in each set were presented, after first collecting behavioral data on a different group of participants to estimate latent variables in the model. We then conducted a model-based fMRI analysis of the fMRI data to identify brain regions that are sensitive to the various predictions of our Bayesian model, such as hypothesis strength, belief updating, or hypothesis acceptance. The results of this study provide insight into the psychological and neural processes of hypothesis evaluation, as well as the validity of Bayes' theorem as a model of belief updating in humans. This research was supported by the Institute for Collaborative Biotechnologies under grant W911NF-09-D-0001.

## D129

### EVIDENCE OF INTACT SOCIAL ANALOGICAL REASONING IN ASD

Natalie Gallagher[1], Ligia Antezana[2], Maya Mosner[2], Katerina Dudley[3], Lauren Kenworthy[3], Benjamin Yerys[2], Adam Green[1]; [1]Georgetown University, [2]The Children's Hospital of Philadelphia, [3]Children's National Medical Center — Social cognition is a weakness for children with autism spectrum disorder (ASD), but reasoning is often a strength.So what if an aspect of social cognition is approached as a reasoning problem? Analogical reasoning is a form of reasoning that supports our understanding of social interactions because novel interactions may be analogous to previously experienced interactions. Analogical reasoning with non-social stimuli appears to be well-preserved in ASD, but has not been tested in ASD with social interaction stimuli. We tested the hypothesis that when explicitly cued, children with ASD can employ analogical reasoning to understand similarities between social interactions, using photographs of real-world interactions. Age- and IQ-matched ASD and control groups performed social and nonsocial analogies. In older children with ASD (over age 10), social analogy performance rose to the level of controls, and to the level of nonsocial analogy performance. Effects of age and socialness (social analogies vs. nonsocial analogies) indicate that general analogical reasoning ability develops at a lag in ASD relative to typical development but that, once developed, this ability can be applied to counteract impairing effects of social content in ASD cognition.

## D130

### INFERRING REASONING STRATEGIES BASED ON THE PUPILLARY RESPONSE

Maria K. Eckstein[12], Silvia A. Bunge[1]; [1]UC Berkeley, [2]Graduate School of Systemic Neurosciences, Munich, Germany — When faced with a cognitively demanding task, the choice of strategy can make all the difference. Here, we sought to gain insight into strategies that participants adopt spontaneously when solving a task that requires integrating multiple rules. We hypothesized that strategies could be assessed using real-time measures of cognitive effort, such as the task-evoked pupillary response. To test this hypothesis, we collected eyetracking data while 37 healthy adults completed a rule integration task that could be solved in several ways. We first modeled the cognitive demands of two strategies, and made specific predictions about performance (response time, accuracy). We then compared the cognitive demand models to the pupillary responses obtained from each participant during task performance to infer which strategy the participant had used. Performance differences were successfully predicted by the pupil-based strategies. Specifically, when using a feature encoding strategy (participants encode all item features before identifying relevant rules) participants were significantly slower than when using a rule induction strategy (participants induce relevant rules while encoding the items and categorize subsequent items accordingly), $t(15.9) = -1.97$, $p = .033$, $r = .44$. In addition, error rates in detecting rule-based oddballs were reduced from 8.6% to 3.6% when using the rule induction strategy, $t(18.5) = -1.61$, $p = .063$, $r = .35$. Participants' self-reported strategies were consistent with predictions based on the pupillometry data, suggesting that our approach could also be used to study strategies in individuals with poor metacognitive skills, such as children or patient populations.

## D131

### CONCEPT COMBINATION WITH LOGICAL CONNECTIVES

Paolo Cherubini[1,3], Giosué Baggio[2,3], Doris Pischedda[1,3,4], Kai Görgen[4], Anna Blumenthal[2,4], John-Dylan Haynes[4], Carlo Reverberi[1,3]; [1]University of Milano-Bicocca, Milan, Italy, [2]SISSA International School for Advanced Studies, Trieste, Italy, [3]NeuroMi- Milan Center for Neuroscience, Milan, Italy, [4]Bernstein Center for Computational Neuroscience Berlin, Charité-Universitätsmedizin, Berlin, Germany — A defining trait of cognition is the capacity to combine information into compound concepts. This ability relies, among others, on the logical connectives 'and', 'or' and 'if-then'. Simple sentences, such as "there is a fork on the table" (A) or "there is a knife" (B), can be combined in different ways using different connectives. No evidence is available to date on how and where the brain represents different concept combinations produced by different connectives, and how these are evaluated against new facts. Here, participants learned associations between graphic cues and conjunctive (A and B), disjunctive (A or B) or conditional (If A then B) sentences. During fMRI scanning, a cue was presented, followed by a delay, during which participants had to represent the sentence associated to the cue; finally, a visual scene had to be evaluated for compatibility with the sentence. Two participant groups were recruited so that conditionals (If A then B) were interpreted in either of two alternative ways (thus, same form, different semantics). Multivariate decoding applied to the delay period revealed that the active sentence was encoded in left inferior frontal gyrus (BA44). During the delay, no difference was found between participant groups. During the target phase, we found higher activations in rostral regions of left inferior frontal cortex (BA47), for disjunctions and conditionals relative to conjunctions. Activation of the inferior parietal lobe only was modulated by the interpretation of conditionals.

## D132

### THE IMPACT OF STIMULUS-INDUCED PROCESSING STRATEGIES ON SYMBOLIC FRACTION REPRESENTATIONS

Elizabeth Y. Toomarian[1], Edward M. Hubbard[1]; [1]University of Wisconsin-Madison — Understanding fractions is key to establishing a solid foundation in mathematics, yet children and adults struggle to comprehend them. Previous studies have suggested that these struggles emerge because people fail to process fraction magnitude holistically on the mental number line (MNL), a process reliant on parietofrontal brain networks (Hubbard et al., 2005). Bonato et al. (2007) found that fraction processing was characterized by componential processing, as demonstrated by componential distance effects and a reverse SNARC effect. Subsequent studies of the distance effect for fractions have demonstrated holistic processing, and have suggested that componential processing was due to the limited stimulus set used (Meert et al., 2009; 2010). However, no studies have returned to investigate the spatial representation of fractions using stimuli that minimize componential strategies. We therefore conducted three behavioral studies: Experiment 1 replicated Bonato et al. (2007); 24 college undergraduate participants compared unit fractions (1/1-1/9) to 1/5, resulting in a reverse SNARC effect for reaction times. Experiments 2 and 3 had participants compare fractions to 1/2 and 3/5, respectively, and reduced potential strategic biases by expanding the stimulus set to include all irreducible, proper fractions. We observed a classic, categorical SNARC effect for overall fraction magnitude, demonstrating that participants can indeed represent holistic fraction magnitudes on a spatial MNL. The categorical rather than continuous SNARC effect reflects the magnitude dependent nature of the tasks. Taken together, these data suggest that adults can process fraction magnitudes holistically, and that stimulus-induced processing strategies can dramatically influence how adults represent fractions.

## D133

### DUAL PROCESS THEORY AND THE POLITICAL BELIEF BIAS EFFECT

Makiah R. Nuutinen[1], Dane Wendell[1], Richard Matland[1], Robert G. Morrison[1]; [1]Loyola University Chicago — Cognitive neuroscience methods have contributed greatly to our understanding of distinct fast and slow processing systems useful for higher-level cognition. We believe these dual-processes help explain why political beliefs can make it difficult for politicians to agree on significant policy decisions. While recent research suggests that people have an immediate and intuitive reaction of skepticism to opposing political views, recent neurocognitive research (Amodio et al. 2007) suggests that liberals appear to have a more flexible cognitive style. We designed a novel political belief bias paradigm to test how logical reasoning interacts with strongly held political heuristics. We predicted that liberals would be well suited to suppressing their political beliefs in order to engage in formal logical reasoning compared to political conservatives. Our findings confirm our hypotheses. We found that conservatives show a much greater belief bias effect than liberals when the content of the problem is political. This effect persists even when controlling for level of political knowledge and fluid intelligence, and is not explained by belief strength. Our results suggest that conservatives may have more difficulty inhibiting their fast political knowledge system in order to employ the slow logical reasoning system in the context of political information. In contrast, liberals may have a more flexible cognitive style, allowing them to engage in analytic reasoning more readily. Future studies will use neuroimaging to examine the time course of processing in liberals and conservatives to determine the mechanism responsible for the observed differences.

# Poster Session E

## ATTENTION: Auditory

### E1

**THE TEST OF ATTENTION IN LISTENING: AN EVENT-RELATED POTENTIAL STUDY** Hannah Jamieson Stewart[1,2], Sygal Amitay[1], Claude Alain[2]; [1]MRC Institute of Hearing Research, Nottingham, UK, [2]Rotman Research Institute, Baycrest, Toronto, Canada — The Test of Attention in Listening (TAiL) is a behavioural test designed to assess auditory selective attention in clinical populations using non-verbal stimuli. In a block of trials, participants indicate whether two tones, presented sequentially, have the same frequency or location depending on the task's instruction. A key part of TAiL's methodology is that the stimuli do not change throughout the task; just the instructions to the individual do – to pay attention to either the frequency or the location of the tones. Through different combinations of task-relevant and -irrelevant stimulus features, the test provides sensitive measures of distraction and conflict resolution. This study aimed to explore the underlying neurological networks involved in TAiL's different measures, using electroencephalography (EEG). Data was collected from 16 individuals aged 18-30. For the distraction measure, a positive component peaking at ~250ms post the onset of the second tone was found – a distraction positivity. Source analysis of this component suggest different sources for the two TAiL tasks (attending to frequency and location), with distraction by location more posterior than distraction by frequency, providing support for the dual-pathway theory. For the conflict resolution measure, a negative frontocentral component (300-450ms) was found reflecting auditory and visual conflict resolution tasks (e.g. the Stroop task). These results reveal distinct neural correlates for distraction and conflict resolution measures. The timing and distribution suggest a progression from sensory encoding to stimulus-response mapping providing further support for the use of TAiL as a selective auditory attention task for clinical populations.

### E2

**NEURAL MECHANISMS FOR PROCESSING SPEECH IN NOISE IN OLDER ADULTS** Samuel Evans[1], Dana Boebinger[1], Cesar Lima[1,3], Stuart Rosen[2], Markus Ostarek[1], Angela Gelic[1], Carolyn McGettigan[4], Zarinah Agnew[5], Sophie Scott[1]; [1]Institute of Cognitive Neuroscience, UCL, [2]Dept of Speech, Hearing and Phonetic Sciences, UCL, [3]Dept of Psychology, University of Porto, [4]Dept of Psychology, Royal Holloway, [5]Dept of Otolaryngology, University of California, San Francisco — Adults often report that they find listening to speech in the presence of background noise more effortful as they get older. Whilst a small number of studies have examined the neural basis of perception in noise in older adults, these studies have tended to examine neural responses to a single type of noise background. However, in our everyday life we encounter many kinds of background noise, for example noise from machinery and the speech of others, and these differing masking sounds draw upon different neural mechanisms. Here we compared neural responses between younger (n=19, mean age= 25, sd=5.26, range=19-36) and older adults (n=19, mean age=68, sd=3.07, range=63-75) using functional Magnetic Resonance Imaging. In the scanner, participants listened passively to short spoken narratives presented either without noise or in the presence of masking sounds that differed "parametrically" in their similarity to speech. Whilst behavioural performance on masking tasks was equivalent between the younger and older participants, neural activation patterns differed between the groups. Older participants showed reduced activity in sensory cortices, and increased activity in cognitive control regions, consistent with the decline-compensation hypothesis. In addition, older participants showed reduced activity at the onset of masking, suggesting a deficit in stream segregation. Taken together, our results demonstrate that well-performing older adults achieve their high levels of accuracy in perception in noise tasks via different neural mechanisms to those used by younger adults.

### E3

**CONFLICT-RELATED NEGATIVITY IS MEDIATED BY GLUTAMATERGIC NEUROTRANSMISSION IN THE RIGHT ANTERIOR CINGULATE CORTEX** Susanne Passow[1,2], Alexander R. Craven[1,2], Kristiina Kompus[1,2], Karsten Specht[1,3], René Westerhausen[1,3], Kenneth Hugdahl[1,2,3]; [1]University of Bergen, Norway, [2]University of Oslo, Norway, [3]Haukeland University Hospital, Bergen, Norway — Challenging listening situations with competing auditory inputs require cognitive control to focus on relevant and ignore irrelevant information. Recent dichotic listening (DL) studies have shown that the strength of blood oxygen level-dependent (BOLD) signal changes in response to cognitive control demands is predicted by glutamate concentration in the anterior cingulate cortex (ACC; Falkenberg et al., 2012, 2014). Further, an event-related potential (ERP) study revealed that a fronto-central negativity, approximately 450ms after stimulus onset, is more negative in high compared to low task demands in the DL task (i.e. N450 modulation effect; Passow et al., 2014). So far, the underlying neuromodulatory mechanisms of the N450 modulation effect are still not clear. Thus, in the present study we combined proton magnetic resonance spectroscopy (1H-MRS) and electroencephalography (EEG) to examine the relationship between inter-individual differences in the concentration of glutamatergic metabolites in the ACC and the N450 modulation effect. We collected data from twenty-two (11 female) healthy young adults. In line with previous findings, the N450 amplitude was modulated by cognitive control demand ($F(1,21)=30.83$, $p<.001$, $\eta 2=.09$). More crucially, we found a significant positive correlation ($r=.433$; $p<.05$) between glutamate+glutamine (Glx) concentration in the right ACC and the magnitude of the N450 modulation effect. This result lends further support for a critical role of glutamatergic neurotransmission in cognitive control in the DL task. Future studies should investigate how neuromodulatory, electrophysiological and hemodynamic correlates are related to each other and whether these associations are distorted in populations with cognitive control impairments.

### E4

**ELECTROPHYSIOLOGICAL CORRELATES OF ATTENTION SWITCHING IN A DYNAMIC "COCKTAIL-PARTY" SCENARIO: EVIDENCE OF OLDER AND YOUNGER ADULTS** Stephan Getzmann[1], Edmund Wascher[1], Michael Falkenstein[1]; [1]Leibniz Research Centre for Working Environment and Human Factors, Ardeystr. 67, D-44139 Dortmund, Germany — Speech understanding in complex listening environments requires (a) auditory scene analysis, comprising auditory object formation and segregation, and (b) allocation of the attentional focus to the speaker of interest. Changes in the auditory scenario, e.g., in speaker settings in a multi-talker environment, require re-focusing of attention. Here, the cortical activity related to attention switching was studied in a dynamic "cocktail-party" scenario in 22 older and 22 younger adults. A naturalistic "stock-price monitoring" task was employed (Getzmann & Falkenstein, Brain Res 1415:8-22, 2011), in which prices of listed companies were simultaneously recited by four speakers at different locations in space. The participants had to respond to the price of a target company, while ignoring all other companies. Target speaker voice and position were kept constant for a number of trials and then the speaker voice or position or both were occasionally changed. The analysis of event-related potentials indicated a larger N1 and a delayed P2 in the older, than younger, group, and a larger N2 in the younger, than older, group. In both age groups, changes in speaker setting resulted in a decline in performance, and triggered a phasic negative response over posterior parietal brain areas, peaking at about 440 ms after speech onset. These results suggest age-related differences in allocation of attentional resources and in inhibitory control, while neural correlates of attention switching appeared to be equally effective in both age groups.

### E5

### RESTING-STATE ALPHA-BAND FUNCTIONAL CONNECTIVITY IN TINNITUS

Carly Demopoulos[1], Leighton Hinkley[1], Danielle Mizuiri[1], Coleman Garrett[1], Susanne Honma[1], Anne Findlay[1], Steven Cheung[1], Srikantan Nagarajan[1]; [1]University of California, San Francisco — Tinnitus is a common auditory perceptual disorder whose neural substrates are under intense debate. Previous studies of individuals with tinnitus have identified abnormal resting functional connectivity in brain regions associated with auditory processing, multisensory integration, attention, and emotional state. The goal of the present study was to examine differences in MEG resting state functional connectivity for participants with tinnitus compared to controls and to identify associations between regional connectivity and functional impairment. Participants were 37 individuals ages 37-70, including 20 chronic tinnitus subjects (Mean age=52.6, SD=10.83) and 17 control participants (Mean age=53.99, SD=7.38). MEG scans were acquired using a 275-channel whole head biomagnetometer during six minutes of rest (eyes closed) and were co-registered to 3T T1 weighted MRIs for source space reconstruction. Imaginary coherence analyses were performed on a 60 second artifact free segment of the data to examine group differences in functional connectivity. Group contrasts in imaginary coherence identified increased connectivity ($p<0.05$, 10% adjusted FDR correction) for participants with tinnitus bilaterally in the middle frontal gyrus, left inferior parietal lobule, and left postcentral gyrus. Decreased connectivity was not identified for any region in the tinnitus group. In sum, consistent with previous research, increased connectivity in participants with tinnitus was detected in brain regions associated with networks regulating attention and distress.

### E6

### QEEG OF PASSIVE MUSICAL PARADIGMS ASSAYS INTEGRATIVE CEREBRAL FUNCTION IN THE MINIMALLY CONSCIOUS STATE

Brian C Fidali[1], Mary M Conte[1], Daniel J Thengone[1], Tanya J Nauvel[1], Nicholas D Schiff[1]; [1]Weill Cornell Medical College — Patients with disorders of consciousness demonstrate reproducible but inconsistent responses to external stimuli, making it difficult to assess their residual capacity for cognition. Auditory paradigms such as command following or passive language listening can assess the presence of these patients' covert cognition or integrative cerebral function, respectively, but their sensitivity is limited by receptive language capacity. The use of musical stimuli overcomes this limitation as music processing is more bilateral and, therefore, resilient to structural brain injury in the language-dominant hemisphere. In pilot studies, minimally conscious state (MCS) patients have demonstrated differential qEEG changes between familiar versus unfamiliar music. Here, we expand on these findings and compare the diagnostic utility of passive music and language qEEG paradigms. 37-channel video EEG data were obtained from 16 MCS patients, who listened to familiar and unfamiliar music along with an array of personally meaningful, comedic, and emotionally neutral language stimuli. Thomson spectral estimates for each condition were calculated from artifact and movement-free 3 sec EEG epochs. Significance was determined by the Two Group Test with 2 Hz resolution (alpha = .05). Seven of 16 MCS patients demonstrated differential alpha frequency suppression to familiar versus unfamiliar music, consistent with a release of attentional inhibition (Foxe & Snyder, 2011). Comparison of the patients' qEEG responses among music and language conditions demonstrates the robustness and relative sensitivity of familiar musical paradigms. Our findings support the use of passive musical paradigms to identify integrative cerebral function and, perhaps, elements of covert cognition in disorders of consciousness.

## ATTENTION: Spatial

### E7

### THE WRITE BIAS: THE INFLUENCE OF NATIVE READING DIRECTION AND DYNAMIC STIMULI ON AESTHETIC PREFERENCE BIASES

Trista Friedrich[1], Victoria Harms[1], Lorin Elias[1]; [1]University of Saskatchewan — Leftward asymmetries and preference biases are evident in visual artwork. This leftward asymmetry is particularly prominent when examining populations whose native language reads from left-to-right (LtR). However, examination of non-Western populations whose native language is read from right-to-left (RtL) often demonstrates a weakening of the commonly observed leftward biases. Experiment 1 examined aesthetic preferences in native LtR and RtL readers. Experiment 2 examined Hindi (LtR) and Urdu (RtL) readers to reduce the potential influence of confounding cultural differences on aesthetic preference biases as these groups share linguistic, cultural, and geographic similarities. We also investigated the effects of dynamic movement on directionality preference. In both experiments participants viewed mirror-imaged pairs of mobile objects and landscapes in both static and dynamic form, and judged which stimulus was more aesthetically pleasing. RtL readers failed to show a preference bias, whereas LtR readers preferred stimuli with LtR directionality regardless of the location of the mass. Native Hindi readers also demonstrated a strong preference for stimuli with LtR directionality, whereas Urdu readers failed to demonstrate a preference bias. Furthermore, the directional biases observed by both sets of sample groups were accentuated by the dynamic stimuli. This pattern of results provides evidence that the strength of aesthetic bias is influenced by both behavioural biases, such as scanning habits developed from reading direction, and neural and anatomical asymmetries in spatial attention mechanisms.

### E8

### STRUCTURAL VARIABILITY WITHIN FRONTOPARIETAL NETWORKS AND INDIVIDUAL DIFFERENCES IN ATTENTIONAL FUNCTIONS CAPTURED BY BUNDESEN'S THEORY OF VISUAL ATTENTION

Magdalena Chechlacz[1], Celine Gillebert[1], Signe Vangkilde[2], Anders Petersen[2], Glyn Humphreys[1]; [1]University of Oxford, [2]University of Copenhagen — Visuospatial attention allows us to select and act upon a subset of behaviourally relevant visual stimuli while ignoring the rest. Bundesen's Theory of Visual Attention (TVA) offers a quantitative analysis of the different facets of attention within a unitary model and thus provides a powerful analytic framework for understanding individual differences in attentional functions. Visuospatial attention is contingent upon large neuronal networks, distributed across both hemispheres, consisting of several cortical areas interconnected by long association frontoparietal pathways including 3 separate branches of superior longitudinal fasciculus (SLF I-III) and inferior fronto-occipital fasciculus (IFOF). Here we examine whether structural differences within frontoparietal networks mediate variability in visual attention abilities as assessed by the TVA framework (processing speed, visual short term memory capacity/VSTM, attentional weighting between left and right visual field/spatial bias, minimum effective exposure duration, attentional weight of distractors). Structural measures were based on spherical deconvolution and tractography derived indices of tract volume and hindrance modulated orientation anisotropy (HMOA). We report that individual differences in VSTM and processing speed are linked to variability in the microstructure (HMOA index) of SLF II and SLF III within the right hemisphere as well as hemispheric lateralization within the IFOF. Moreover, we show that variability in spatial bias is mediated by both individual differences in microstructure and volume of SLF II within the right hemisphere. We conclude that individual differences in some (VSTM, processing speed, spatial bias) but not all attentional functions, as assessed by TVA, link to variability in structural organization within frontoparietal pathways.

### E9

### THE ROLE OF RIGHT MIDDLE FRONTAL GYRUS IN SWITCHING BETWEEN EXOGENOUS AND ENDOGENOUS ATTENTION

Kelsey A. Holiday[1], Shruti Japee[1], Maureen Satyshur[2], Ikuko Mukai[3], Leslie G. Ungerleider[1]; [1]National Institute of Mental Health/National Institutes of Health, Bethesda, MD, [2]Feinberg School of Medicine, Northwestern University, Chicago, IL, [3]Laureate Institute of Brain Research, Tulsa, OK — To probe the contribution of the right middle fontal gyrus (MFG) to endogenous (top-down, goal-directed) and exogenous (bottom-up, stimulus-driven) attention, we compared performance on an orientation discrimination task of a patient with a right MFG resection to healthy controls. On endogenously cued trials, a central cue predicted with 90% accuracy (i.e., valid vs. invalid) the location of a peri-threshold Gabor patch. On exogenously cued trials, a cue appeared briefly at one of two peripheral locations, followed, after a variable inter-stimulus interval (ISI; range 0 to 700 ms), by a Gabor patch in either the same (valid) or opposite (invalid) location. For both the patient

and controls, valid cues facilitated faster reaction times compared to invalid cues, on endogenous and short ISI exogenous trials. However, at longer ISI exogenous trials, the patient performed poorly and had difficulty reorienting attention to top-down control after the effect of the exogenous cue had dissipated, a conclusion supported by his improved performance on trials that explicitly cued him during long ISIs to attend to both locations. The results thus indicate a role of the right MFG in switching between exogenous and endogenous attention. Resting state fMRI data revealed that the right superior parietal lobule and right orbitofrontal cortex showed significantly greater correlations with a left MFG seed region (a region tightly coupled with the right MFG in controls) in the patient. This paradoxical increase in cortical coupling may represent a compensatory mechanism in the patient to offset the loss of function of the resected tissue.

### E10

### AUDITORY SPATIAL ATTENTION TO SPEECH AND COMPLEX NON-SPEECH SOUNDS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

Laura Soskey[1], Paul D. Allen[1], Loisa Bennetto[1]; [1]University of Rochester — One of the earliest observable social communication impairments in autism spectrum disorder (ASD) is a failure to orient to speech and other social stimuli. A key component of social orienting is the ability to focus auditory perception on the specific location of a sound source. Social orienting deficits could also be driven by the increased acoustic complexity of speech compared to nonsocial sounds. This study examined the effect of acoustic complexity on auditory spatial attention in children with ASD compared to matched neurotypical controls. Target and distractor sounds were played randomly in quick succession from speakers in a free-field array. Subjects attended to a central or peripheral location, and were instructed to respond to target sounds at the attended location while ignoring sounds from adjacent locations. Stimulus-specific blocks evaluated spatial attention for simple non-speech tones, speech sounds (vowels), and complex non-speech sounds matched to vowels on key acoustic properties. We found that children with ASD had significantly more diffuse auditory spatial attention gradients compared to neurotypical children, indicated by increased responding to sounds at adjacent non-target locations. Additionally, children with ASD had significantly more diffuse attention for speech and complex non-speech, but not for simple sounds, which suggests that acoustic complexity has a deleterious effect on their auditory spatial attention. Together, impairments in auditory spatial attention and processing complex auditory stimuli may contribute to social orienting deficits and other social communication impairments in individuals with ASD.

### E11

### SELECTIVE ATTENTION AND MEMORY: EVENT-RELATED POTENTIALS AND THE IOR EFFECT

Leigh Andrews[1], Jacob MacDonald[1], Julie Markant[2], Erika Nyhus[1]; [1]Bowdoin College, [2]Brown University — Visual learning is dependent on the focusing of the attentional system. Studies show that attentional enhancement and suppression modify the encoding of otherwise identically presented stimuli. fMRI shows that activation for the attended stimulus is stronger with simultaneous suppression at the distractor location utilizing inhibition of return (IOR), in which an elongated cue to target interval suppresses attention at the cued location and enhances attention at the non-cued location. EEG research links the N1 component to attentional enhancement that occurs early in IOR and the Nd250 component to excitatory processes that override IOR. The present study utilized IOR to study the impact of target enhancement and distractor suppression on memory encoding. In the task a cue appeared on the left or right 600 ms before participants responded to target images appearing in the cued or non-cued location. Participants were not informed that the images used would be the subject of a subsequent recognition memory test. EEG was used to look for component differences between target enhancement and distractor suppression during encoding. Subjects' reaction times were marginally faster and memory was better for non-cued than cued targets. There was an increased N1 and Nd250 for non-cued relative to cued targets and an increased N1 for cued relative to non-cued distractors, which is consistent with N1 increases being associated with enhancement. These results suggest that subjects' memory is affected by selective attention during encoding; attentional enhancement of targets and suppression of distractors improves memory encoding.

### E12

### LEFTWARD PERCEPTUAL BIAS SURPASSES THE SNARC EFFECT IN NON-SYMBOLIC NUMEROSITY COMPARISON PERFORMANCE

Dasom Lee[1], Joohyung Chun[1], Soohyun Cho[1]; [1]Chung-Ang University — It is commonly believed that numbers are spatially represented. One well-known example is the SNARC (Spatial-Numerical Association of Response Codes) effect, in which small numbers are processed faster in the left and large numbers in the right side of space. In the present study, we found that nonsymbolic numerosity comparison was better when subjects chose the more numerous dot array presented and responded to within the left side of space compared to the right (the opposite of SNARC effect). Moreover, this pattern persisted even when the analysis was restricted to the easily discriminable ratios (in which the SNARC effect is more likely). This result can be interpreted as the leftward perceptual bias being stronger than the SNARC effect in the side-by-side format of nonsymbolic numerosity comparison. In addition, in the difficult ratio trials, such a leftward facilitation effect was stronger for large compared to small set sizes. This result can be interpreted as leftward attentional bias causing pseudo-neglect in the right side of space leading to underestimation of the right-side array. Given that underestimation increases for large set sizes, performance would benefit more on those trials. Interestingly, symbolic numerosity comparison was better when subjects chose the larger Arabic numeral presented and responded to within the right compared to the left space. Overall, our findings suggest that mental representations of nonsymbolic and symbolic magnitude may differ in their spatial organization.

### E13

### LARGE-SCALE SYNCHRONY IN ALPHA AND GAMMA BANDS UNDERLIES ATTENTION TO MULTIPLE VISUAL OBJECTS

Santeri Rouhinen[1], J Matias Palva[1], Satu Palva[1]; [1]University of Helsinki — We investigated the systems-level neuronal mechanisms of visual multi-object attention by using magneto- and electroencephalography (M/EEG) and data-driven analysis of inter-areal phase synchronization. M/EEG was recorded from nineteen healthy subjects who performed two visual multi-object tracking tasks with semi-naturally moving objects; one with 1-4 target objects and another with the same targets together with distracters. The subjects tracked the target objects and responded whenever they observed a 100 ms lasting target event that was a change in object shape. MaxFilter and independent component analysis were used to suppress extra-cranial noise and to remove ocular and heart-beat-related components from data. Anatomical magnetic-resonance images were automatically segmented with Freesurfer for individual grey matter surface reconstruction and neuro-anatomical labeling used to create fixed-orientation, cortically constrained surface source models for minimum-norm-estimate based source reconstruction of Morlet-wavelet filtered M/EEG data. Source time series were collapsed into cortical parcels and large-scale phase synchronization was then quantified between the cortical parcels. In both tasks in a 0.5 s pre-target-event time window, synchronization in the high alpha (10-15 Hz) band was stronger for the subsequently detected than for the missed target events and observed in fronto-parietal (FP) and dorsal attention networks (DAN). Synchronization was also positively correlated with the number of attended objects in alpha, beta (14-30 Hz), and gamma (40-120 Hz) frequency band. Subjects with low and high attentional capacities had distinct spectral and anatomical patterns of load-dependent synchronization. Large-scale synchronization in FP and DAN is hence functionally significant for attention to multiple concurrent visual objects.

## EMOTION & SOCIAL: Emotion-cognition interactions

### E14

### TOUCHY FEELY: THE INFLUENCE OF AFFECT ON SOMATOSENSORY POTENTIALS

Michiel Spapé[1,3], Imtiaj Ahmed[1,2], Ville Harjunen[1,3], Giulio Jacucci[1,2], Niklas Ravaja[1,3]; [1]Helsinki Institute for Information Technology HIIT, [2]University of Helsinki, [3]Aalto University — People commonly communicate feelings using touch, and much research has been devoted to the question of how interpersonal haptics affect attention, memory, emotion and

decision making. Psychophysiological research has, for instance, shown that a simple touch can enhance processing of emotional stimuli. However, few studies have explicitly focused on tactile processing itself and investigated whether affect has an influence on how we perceive a touch. Since interpersonal touch generally occurs within an affective context, this gap in our understanding is particularly problematic. To address the problem, we investigated the degree to which motivational and emotional cues determine the perception and processing of simple tactile stimuli. Two ERP studies were conducted in which the effects of a systematically varied affective context on subsequent somatosensory evoked potentials were measured. In Experiment 1, this context involved a symbolic monetary stimulus presented by a (fictional) other person, who subsequently delivered a remote vibrotactile signal. In the second experiment, the context involved a natural expression emoted by a 3-D avatar, presented in virtual reality, who subsequently reached out and initiated a tactile signal via a haptic glove. Each experiment showed that affective information modulates tactile processing, particularly in the later components, at ca.250-500 ms post-stimulus. Additionally, we investigated the differences and similarities between the abstract, symbolic communication in the first experiment and the naturally occurring touch in the second.

## E15

### COGNITIVE- VERSUS EMOTION-BASED INVOLUNTARY COGNITIONS: FRONTAL CONTROL AND HABITUATION EFFECTS

Hyein Cho[1], Sabrina Bhangal[1], Allison K. Allen[1], Pareezad Zarolia[2], Ezequiel Morsella[1,3]; [1]San Francisco State University, [2]University of Denver, [3]University of California, San Francisco — Neural processes can engender voluntary and involuntary conscious contents (e.g., an unintended, spontaneous thought). Interestingly, some contents are more likely to arise involuntarily than others. To examine this, we used a paradigm that builds on the classic research by Wegner revealing that, when instructed to suppress a conscious content, one is then more likely to experience it involuntarily. We investigated the contrast between cognitive- and emotion-based involuntary contents. (The latter are usually 'encapsulated.') After being trained to perform a word-manipulation task similar to Pig Latin (e.g., "CAR" becomes "ARCAY"), participants (n = 19) were instructed to not transform stimulus words in this way. In a comparison condition, participants were presented with emotion words and instructed to not feel the corresponding emotion. Involuntary conscious contents arose more frequently (trial proportion) for the language task (M = .50, SE = .05) than the emotion task (M = .29, SE = .05), $t(18) = 3.49$, $p = .003$, even though the former involved complex symbol manipulations associated with frontal cortex. Neuroimaging technologies could elucidate these task-related neural processes. In a follow-up experiment, we examined whether these effects can be diminished, not through intentions, but through habituation. Participants (n = 14) were shown 40 images of well-known objects and were instructed to not think of the object names. Each object was presented (4 s) across ten consecutive trials, in order to induce habituation. These new, robust paradigms are amenable to neuroimaging technologies capable of identifying the contrasts between voluntary and involuntary brain processes.

## E16

### VOCAL DISGUST MODULATES SOCIO-EMOTIONAL JUDGMENTS: BEHAVIORAL AND ERP EVIDENCE

Kathrin Rothermich[1,2], Zachary Shulman[1], Marc D. Pell[1,2]; [1]McGill University, Faculty of Medicine, School of Communication Sciences and Disorders, Montreal, Canada, [2]McGill Centre for Research on Brain, Language and Music (CRBLM), Montreal, Canada — Disgust is defined as a basic and universal emotion, consistent in its role in defending individuals against infection and disease. Over time, however, disgust has evolved to include a social and moral domain, and it has been shown that i.e. disgusting odor is able to influence social behavior (McGlone et al., 2013). The current study examines whether auditory signals of disgust (i.e., speech-embedded emotions, vocalizations) can bias socio-emotional evaluations of visual traits involved in person perception, when compared to cognitive judgments. We therefore used event-related potentials (ERPs) to test whether speech induced feelings of disgust can cross-modally influence a person's judgment of another person's physical attractiveness. Furthermore, we investigated what type of information is driving the effect, namely prosodic intonation or vocalizations. Participants listened to disgusting, happy, and neutral vocalizations or pseudo-utterances and were subsequently presented with a face and forced to make either an emotional (i.e. attractiveness) or cognitive (i.e. age) judgment. The results show that emotional primes bias the evaluation of the faces when subjects make socio-emotional judgments, but not on socio-cognitive judgments. This effect is visible in the behavioral data as well as in both early (N1 and P2) and late (LPC) ERP components. Furthermore, depending on the emotion we find different effects for vocalizations versus pseudo-utterances. Our findings show that vocal emotions are indeed capable of altering social behavior, and we will discuss our results in the light of current approach and withdrawal theories of human emotions.

## E17

### THE POWER OF COMPETITION: EFFECTS OF SOCIAL MOTIVATION ON LEARNING

Brynne DiMenichi[1], Elizabeth Tricomi[1]; [1]Rutgers University, Newark — Social motivation has been defined as a drive for a particular goal based on a social influence (Hoggs & Abrams, 1990). Recently, social motivation's effect on learning has been examined in the form of competition (Wentzel, 1999). In our fMRI experiment, 20 participants completed a learning task in which they were rewarded for remembering an overall average in the Self condition, or "beating" another "participant"--a same-sex confederate—in the Competition condition. Behaviorally, we found that participants remembered significantly more shapes during the task and later recalled more shapes learned while not competing. We also found that during working memory maintenance, in the Self condition, there was greater activation in the medial orbital frontal cortex, bilaterally in the temporal cortex, and bilaterally in the dorsolateral prefrontal cortex (dlPFC) in comparison to the Competition condition. While competing, there was greater activation in the thalamus and cerebellum, as well as the motor cortex. Furthermore, during feedback while competing, there was greater activation in the dlPFC, posterior cingulate, occipital lobe, and medial prefrontal cortex. Our results suggest that receiving feedback regarding competition produces more activation in brain regions previously implicated in social interaction (Zaki et. al, 2009) and competition (LeBouc & Pessiglione, 2013). However, individuals performed more accurately on the memory task in absence of competition, while also showing performance-related activation (Hare et al., 2010; Chein & Schneider, 2005).

## E18

### EMOTIONAL TASK-RELEVANCE IN COGNITIVE AND EMOTIONAL CONFLICT PROCESSING

Artyom Zinchenko[1,2], Philipp Kanske[2], Christian Obermeier[2], Erich Schröger[3], Sonja Kotz[2,4]; [1]International Max Planck Research School on Neuroscience of Communication (IMPRS NeuroCom), [2]Max Planck Institute for Human Cognitive and Brain Sciences, [3]University of Leipzig, [4]University of Manchester — Successful communication often requires processing of conflicting emotional information conveyed by the face and the voice (irony, satire). Emotional stimuli have been shown to speed up cognitive conflict processing, when they are task-relevant. It is unclear, however, what role task-relevance plays for emotional stimuli in emotional conflict processing. In two EEG Experiments we compared the influence of task-relevance of emotional stimuli in cognitive and emotional conflict processing. In order to maximally approximate real-life processes and to elicit robust neural responses, we used multisensory stimuli. Participants either categorized spoken vowels ('A' and 'O', cognitive conflict) or their emotional valence (emotional conflict), irrespective of congruence with visual information. The results revealed that emotion facilitates both cognitive and emotional conflict processing, as reflected in a reduced RT conflict effect for emotional relative to neutral trials. In contrast, we observed a conflict-specific reversal of the N100 response in the event-related potentials: the conflict effect was enhanced for emotional compared to neutral trials in cognitive conflict and reduced in emotional conflict. Additionally, domain-general conflict effects were observed in the P200 and the N200 responses. Emotional stimuli attract attention and facilitate conflict processing. However, neuropsychological mechanisms underlying facilitation of cognitive and emotional conflict processing may differ.

## E19

### FACIAL FEATURES THAT SIGNAL TRANSIENT EMOTIONAL STATES, BUT NOT ENDURING PERSONALITY TRAITS, MODULATE AUTOMATIC IMITATION

Emily Butler[1], Robert Ward[1], Richard Ramsey[1]; [1]Bangor University — Facial signals and automatic imitation are key social cues that guide behaviour. Indeed, facial signals convey what someone thinks, feels and desires, whereas imitation increases rapport and affiliation between interacting individuals. However, it is currently unclear, how facial signals influence automatic imitation. The current project investigated the hypothesis that specific facial signals would enhance automatic imitation. To test this hypothesis, we paired different types of facial cue with an automatic imitation task. We manipulated facial expressions to signal different emotional states and invariant facial features to signal trait characteristics. Across four behavioural experiments, we show a dissociation between the influence of state and trait signals. In the first two experiments, participants viewed composite images of faces based on self-reported agreeableness. These stimuli portrayed invariant trait features, which signalled high agreeableness, low agreeableness or were neutral. Despite readily identifying trait-based facial signals, levels of agreeableness did not differentially modulate automatic imitation. In experiment three and four, participants viewed expressive faces (smiling, frowning and neutral). Emotional expressions modulated automatic imitation, such that imitation was greater following presentation of smiling and frowning faces compared to neutral. Overall, these data suggest that imitative tendencies are more sensitive to transient changes in others' emotional states than trait-based character judgments. Moreover, we provide initial links between cognitive systems that extract facial signals and those that regulate interactions between individuals. Future work may use this paradigm to understand the nature of difficulties in Autism Spectrum Disorder as they have reported difficulties in face perception and imitation tasks.

## E20

### FACTORS RELATED TO EMPATHY IN A DIALOGUE BETWEEN TWO PEOPLE

Kyohei Oomon[1], Shu Morioka[1]; [1]Department of Neurorehabilitation, Graduate School of Health Science, Kio University — It has been reported that the therapist's empathy during rehabilitation has a positive effect on patients. However, factors related to empathy in a dialogue between two people remains unclear. The purpose of this study was to examine factors related to empathy in a dialogue between two people. Participants were recruited from the general population, and 16 pairs of the same-sex participants engaged in a dialogue meeting. The topic of dialogue was "an important aim in life," and the dialogue lasted for 5 minutes. We conducted the evaluation with an empathy coping scale, the Inclusion of Other in the Self scale(IOS),individual factors measured after the dialogue, synchrony of body movements based on video animation analysis during the dialogue, impression of others, and self-mood before the dialogue. Spearman's rank correlation coefficients were calculated for the relationship between each variable and empathy coping scores, and multiple regression analysis was employed with empathy coping scale score as the criterion variable. Only synchrony of body movements had a significant effect on empathy coping ($p < .05$, $R2 = .41$). Thus, Synchrony of body movements with others is necessary for empathy in dialogues between two people.

## E21

### SELF AS SENSOR: IDENTIFYING NEUROPHYSIOLOGICAL SIGNALS OF OTHERS' TRUSTWORTHINESS

Adam Russell[1], Ruthanna Gordon[1]; [1]Intelligence Advanced Research Projects Activity — Judging the trustworthiness of new potential partners is a vital social cognition process. However, little is known about the neurophysiological basis of such judgments, particularly as it accurately reflects the actual benevolence, integrity, and competence of others. In a series of studies, the Tools for Recognizing Useful Signals of Trustworthiness (TRUST) Program explored whether and how one's own neural, physiological, and behavioral signals reflect another's trustworthiness. All studies used variations on a standard "trust game" design, in which one participant in a dyadic task must choose whether to trust the other with monetary stakes, and the second participant must choose whether to act in a manner worthy of that trust. Experimenters measured EEG, skin conductance, heart rate, and hormone levels, as well as collecting data on decisions made and reaction times. There were four protocols, three of which were replicated across two labs each. Preliminary analyses suggested that skin conductance, heart rate, and EEG might offer signals reflecting others' trustworthiness. However, results were inconsistent and many possible avenues of analysis remained open. A follow-up challenge contest made de-identified data from 2 protocols publicly available, offering prizes for the best analysis. The winning solution demonstrates that heart rate and reaction time signals strongly reflect a partner's decision to act in a trustworthy or untrustworthy fashion, but not their ability to do so. This poster discusses two of the TRUST protocols in depth, explores methodological issues with the hormonal assays, and presents results from the challenge's winning algorithm developers.

## E22

### ATTENTIONAL ORIENTING TO SOCIAL THREAT CUES UNDERMINES FEEDBACK-BASED LEARNING IN FEMALES WITH HIGH SENSITIVITY TO INTERPERSONAL REJECTION

Christopher Crew[1], Geraldine Downey[1], Olta Hoxha[2], Jennifer Mangels[2]; [1]Columbia University, [2]Baruch College - City University of New York — Building on previous work on academic achievement and Rejection Sensitivity (RS), we ask whether High RS (HRS) compromises the ability to use negative performance feedback as an effective learning opportunity. If so, is the liability of HRS greater when the feedback occurs in a social context and what is the underlying mechanism? To address these questions, event-related potentials were recorded while participants answered general knowledge questions followed by immediate performance feedback and the correct answer. Error correction was measured with a surprise retest 24-48 hours later. Accuracy feedback was either social (e.g., incorrect: disappointed male face) or nonsocial (e.g., incorrect: red asterisk). HRS predicted poorer error correction following social feedback, but only in females. To understand these behavioral effects, we examined the P3a (300-450ms), an orienting response elicited by the performance feedback, and a set of negative-going waveforms over inferior temporal regions (400-800ms) associated with encoding of the correct answer. Although the P3a was generally larger for correct than incorrect responses, consistent with positive feedback being rarer (~35% of responses) and more salient, HRS females showed a larger P3a to social feedback that was incorrect compared to correct. A path analysis suggested that HRS females' P3a response to social feedback was related to diminished retrieval success by reducing engagement with corrective feedback (not true for males following social feedback or anyone following non-social feedback). Results parallel research on (under)achievement in HRS females. Poor encoding of learning opportunities in performance-evaluative situations may result in diminished self-efficacy and may perpetuate RS.

## E23

### MORAL PRIMING IN VENTROMEDIAL PREFRONTAL LESION PATIENTS—A PROCESS DISSOCIATION APPROACH

Justin Reber[1], Daryl Cameron[1], Daniel Tranel[1]; [1]University of Iowa — Convergent research from neuroimaging and the lesion method has identified the ventromedial prefrontal cortex (vmPFC) as an area of the brain critical to moral judgment and behavior. It remains uncertain, however, which aspects of vmPFC damage—emotional blunting and lack of autonomic reactivity or impulsivity and lack of executive control—is driving the changes in moral judgment and behavior seen in vmPFC lesion patients. This study used a process-dissociation paradigm (Jacoby, 1991) to examine the relative contributions of both automatic and controlled processes to vmPFC lesion patients' response patterns on a moral priming task. Neurological patients with focal lesions involving the vmPFC showed both higher rates of automatic moral judgment and lower rates of controlled moral judgment than demographically-matched comparison participants across both congruent and incongruent prime types. The lesion patients also had a higher tendency than comparisons to moralize nonmoral words of both negative and neutral valences. These findings suggest that vmPFC lesion patients' relative impulsivity and lack of control, and not just their affective dysregulation and lowered autonomic reactivity, may contribute more to their abnormal patterns of moral judgments than previously thought.

### E24

### THE EFFECTS OF OXYTOCIN ON PREFERRED INTERPERSONAL SPACE: A PHARMACOLOGICAL NEUROIMAGING STUDY

Daniela Cohen[1], Anat Perry[1], Gadi Gilam[2,3], Naama Mayseless[1], Talma Hendler[2,3], Simone Shamay-Tsoory[1]; [1]University of Haifa, [2]Sagol School Neuroscience, Tel Aviv University, [3]Functional Brain Center, Wohl Institute for Advanced Imaging, Tel Aviv Sourasky MedicalCenter — Background: Interpersonal distance, a space two people share, creates and defines the dynamics of social interactions. Considering that oxytocin (OT) plays a key role in social behavior, it has been recently suggested that it mainly increases the salience of social agent. Based on this hypothesis, the current study examined if the administration of OT would have a differential effect on the preferred space between friends and strangers. We hypothesized that two systems mediate interpersonal distance preference, the social cognition system (prefrontal cortex) and the threat system (amygdala) and that these networks would be modulated by OT administration. Methods: In a double blind, within-subject crossover design, 19 subjects were scanned, while performing an interpersonal distance task following the administration of either placebo or OT. The task involved watching different protagonists (a friend or a stranger) approaching the participant, and stopping them when feeling uncomfortable (CID task). Results: Behavioral results demonstrated that the friend was stopped at the closest distance, and stranger at the furthest distance. The fMRI results show an interaction between the effects of OT upon the different protagonists. The right amygdala, parahippocampal gyrs, anterior and posterior cingulate, and the left medial prefrontal cortex (BA9), were found to be more active following the administration of OT. Conclusions: The findings suggest that OT affects the activity of brain networks related to social cognition and threat. It is concluded that OT, which enhances the salience of social agents, modulates interpersonal distance between individuals depending on the relationship with the protagonist.

## EMOTION & SOCIAL: Person perception

### E25

### DEVELOPMENTAL PROSOPAGNOSIA (DP) IS BEST EXPLAINED AS A DEFICIT IN DETECTING FACIAL DISTINCTIVENESS: THE DISTINCTIVENESS HYPOTHESIS OF DP.

Edwin Burns[1], Jeremy Tree[1], Christoph Weidemann[1]; [1]Swansea University — Developmental prosopagnosia (DP) is a face perception disorder characterized by an inability to recognize faces. Some investigators have suggested that DP is best explained as an impairment of holistic face processing, however, research evidence has yielded mixed results. In a recent paper (Burns, Tree & Weidemann, 2014) we hypothesized that DP might actually be better described as an impairment at detecting facial distinctiveness. We decided to run two ERP experiments testing this hypothesis. Previous research has identified the N250 ERP component as being modulated by differing levels of facial distinctiveness. In one study, we showed faces that had been morphed to different degrees of distinctiveness to control and DP participants while recording electrophysiological data. Individuals with intact face processing skills exhibited the expected differential N250 responses to the different levels of distinctive faces. In contrast, those with DP showed no such differences between the different face types. In a second experiment, we recorded electrophysiological data as control and DP participants learned a specific face across a recognition memory paradigm. While the control participants developed an N250 response to this face in comparison to novel distractors rapidly, those with DP required more exposures to a face before developing a similar response; this finding was consistent with previous research suggesting that distinctive faces elicit a larger N250 response more rapidly than faces lacking in distinctiveness. Taken together, these findings provide strong evidence that DP is best explained as a deficit in detecting facial distinctiveness.

### E26

### EEG CORRELATES OF IMPAIRED SELF-OTHER INTEGRATION DURING JOINT TASK PERFORMANCE IN SCHIZOPHRENIA

Javier de la Asuncion[1], Manuel Morrens[1], Bernard Sabbe[1], Ellen R. A. de Bruijn[1,2]; [1]University of Antwerp, Belgium, [2]Leiden University, The Netherlands — Deficits in a wide variety of social cognitive processes are well established in schizophrenia. However, research focusing on actual interacting individuals is surprisingly scarce. Problems in low-level processes such as self-other integration may importantly underlie often-reported higher-level deficits. The current study aimed at measuring possible disturbances in self-other integration in schizophrenia using both behavioral and ERP (event-related potential) measures. Sixteen healthy controls and fifteen schizophrenia patients performed a social Simon task in both a joint and an individual setting. Behaviorally, patients showed general slower reaction times, but comparable self-other integration as reflected in the social Simon effect. The ERP results for the healthy controls revealed increased no-go P3 amplitudes in the joint compared to the individual setting. Crucially, patients did not show this increase in no-go P3 amplitude. In line with previous research, the present ERP findings demonstrate that healthy volunteers needed more effort to inhibit their responses in the joint compared to the individual setting. Patients however, showed altered self-other integration when they had to withhold their responses while their co-actor had to act. These outcomes indicate that schizophrenia patients have deficits in low-level processes required for successful joint action.

### E27

### THE IMPACT OF EXPERIENCE ON IMPLICIT AND EXPLICIT AFFECTIVE RESPONSES DURING ACTION OBSERVATION

Louise Kirsch[1], Arielle Snagg[2], Erin Heerey[1], Emily Cross[1,3]; [1]Bangor University, Bangor, UK, [2]Pomona College, Claremont, California, USA, [3]Radboud University Nijmegen, Nijmegen, the Netherlands — Perceiving others in action elicits explicit and implicit affective responses in observers. In the present study, we examined how these responses relate to observers' familiarity with the observed movements. We recorded facial electromyographic (EMG) responses in experienced dancers and non-dancers as they watched short videos of movements performed by professional dancers. Responses were recorded from the corrugator supercilii and zygomaticus major muscles, both of which have been shown to be engaged during observation of affect-evoking stimuli. In the first part of the experiment, participants passively watched the videos. In the second part, they explicitly rated how much they liked watching each movement. We found different patterns of EMG responses among dancers and non–dancers, such that participants' explicit affective judgements of the movements were related to facial muscle activation (a measure of implicit affective judgement) only if they were generally familiar with the movement. These findings advance our understanding of how the expression of affective responses when watching others in action. The findings have implications for the role of emotional valence during action perception engagement, as well as the psychology of art perception.

### E28

### USING GAZE STRATEGIES TO OPTIMIZE INFORMATION IN SOCIAL DECISION-MAKING

Nida Latif[1], Mashal K. Haque[1], Monica S. Castelhano[1], K.G. Munhall[1]; [1]Queen's University, Kingston, Ontario, Canada — Our ability to make quick social decisions during everyday interactions is vital to effective communication. However, in social situations, we have access to an abundance of information and the cognitive challenge to rapidly select optimal strategies to gather information necessary for the social decision-making process. In the present study, we investigated how manipulating availability of information influences observers' decisions and the gaze strategies selected to make affiliation judgment (friends vs. strangers) for silent videos of two interacting individuals. We demonstrated that eliminating information (full-body vs. head-only cues) resulted in a reduced ability to distinguish friends from strangers and the use of different eye-movement strategies to perform the same social task. Observers made more fixations towards the talkers' eyes than other locations in both conditions. However, when information was restricted to a head-only view, participants switched their gaze between eyes and mouth more frequently than with full information. Further, availability of full-body cues resulted in observers switching gaze between talkers more frequently to discriminate friends from strangers. When examining how gaze strategy predicts overall accuracy of a social decision given full-body information, we demonstrated that individuals who spent more time fixating on the mouth were likely to be more accurate in affiliation discrimination. These results demonstrate that observers select gaze strategies to optimize all available information and

that greater optimization predicts increased accuracy of our decisions. We further conclude that human social abilities rely on versatile decision-making strategies to handle the complexity of our social world.

## E29

### TRANSCRANIAL RANDOM NOISE STIMULATION AND COGNITIVE TRAINING IMPROVES FACE PERCEPTION

Rachel Bennetts[1], Sarah Bate[1], Tegan Penton[2], Carmen Kohl[2], Michael Banissy[2]; [1]Bournemouth University, [2]Goldsmiths, University of London — Several studies have found that cognitive training can improve face recognition. However, the effects tend to be relatively small and short-lived. Recent research has found that non-invasive brain stimulation techniques such as transcranial random noise stimulation (tRNS) can enhance and extend the effects of cognitive training in other domains, but this has not been examined for face recognition. In this study, we examined whether tRNS modulated the effects of a face recognition training program in people with typical face recognition abilities. Participants completed a face discrimination training task for one hour per day over five days. Training was preceded by twenty minutes of active high frequency tRNS or sham stimulation to lateral occipitotemporal cortices. Participants completed a battery of face processing tasks assessing face memory (the Cambridge Face Memory Test, CFMT), face perception (the Cambridge Face Perception Test, CFPT), and patterns of eye-movements to faces (free-viewing of faces and social scenes); these took place before training, after training, and at a one-week follow-up session. Participants who received active stimulation showed significant improvement on the CFPT following training, whereas those who received sham stimulation did not show any training gains. There was no improvement for inverted faces, and neither the active or sham stimulation group showed an improvement on the CFMT, or any change in eye-movement patterns. These results suggest that tRNS can enhance the effectiveness of face recognition training programmes, but further work is needed to establish whether perceptual gains can be generalised to memory.

## E30

### AN FMRI STUDY ON THE INFLUENCE OF BEING IMITATED ON EMPATHY FOR PAIN

Lize De Coster[1], Charlotte Desmet[1], Jelle Demanet[1], Liesbet Goubert[1], Marcel Brass[1]; [1]Ghent University — Being imitated has been shown to have several positive social consequences. In a recent study, it was shown that being imitated does not only affect complex social behaviour, but that it influences a basic process such as empathy for pain as well. Empathy for pain refers to the idea that pain-related brain activation is found when observing someone else in pain. In a paradigm designed to investigate the influence of being imitated on empathy for pain, participants' finger movements are being imitated by a hand on screen or not. Subsequently, the hand on screen receives painful stimulation. In the current fMRI study, brain activation was measured to investigate which brain areas related to pain observation are modulated by being imitated. Furthemore, it was explored whether neural evidence was found for the idea that self-other overlap underlies this effect. Peak activity was found in the right dorsal anterior insula (AI), supporting the idea that being imitated enhances activation in pain-related brain areas. Interestingly, this region has been related to translation of affective states into action tendencies. Furthermore, activation was found in the right temporo-parietal junction (TPJ), a region associated with self-other distinction. This activity was positively correlated with activation in the AI, indicating that stronger affective responding was associated with a greater need for distinction between self and other. These results provided the first direct evidence for the idea that being imitated modulates empathy for pain, and support a shared representational account.

## E31

### LINKING PERSON PERCEPTION AND PERSON KNOWLEDGE IN THE HUMAN BRAIN

Inez Greven[1], Paul Downing[1], Richard Ramsey[1]; [1]Bangor University — To date, neuroscience research has examined separately how we detect human agents in the environment (person perception) and how we reason about their thoughts, traits or intentions (person knowledge). Occipitotemporal cortices and fusiform gyri have been associated with person perception, whereas medial prefrontal cortex, temporoparietal junction and temporal poles have been associated with person knowledge. However, it remains unknown how multiple features of a person (e.g., thin and kind) are linked to form a holistic understanding of identity. In this functional imaging experiment, we investigated the hypothesis that when encountering another person, specialised circuits for person perception would be functionally coupled with those involved in person knowledge. In a factorial design, we paired bodies or names with traits or neutral statements and independent localiser scans identified networks associated with body perception and mental state reasoning. When observing a body paired with a trait-implying statement, person perception and person knowledge networks were preferentially engaged. In addition, functional connectivity analyses demonstrated that a region of right fusiform gyrus was functionally coupled with bilateral TPJ and right temporal pole. These results demonstrate that brain circuits for representing another person's physical appearance, such as body shape and posture, are linked to brain circuits that are engaged when reasoning about another person's trait-based character, such as whether they are friendly, helpful or generous. These data support the view that a "who" system for social cognition spans perceptual and inferential mechanisms and that these mechanisms communicate to each other when forming a representation of another's identity.

## E32

### SOUND FREQUENCY AFFECTS SPEECH EMOTION PERCEPTION: RESULTS FROM CONGENITAL AMUSIA

Sydney L. Lolli[1], Ari Lewenstein[1], Sean Winnik[1], Julian Basurto[1], Psyche Loui[1]; [1]Wesleyan University — Congenital amusia is a neurodevelopmental disorder of pitch perception and production. While amusia has clear effects on musical perception, its impact is on speech perception is less clear. Our study investigates the effects of amusia on perceiving emotional prosody in speech. It has been suggested that amusics may rely more on alternative cues within speech to infer emotional content, such as stress and emphasis, to compensate for poor pitch perception. We constructed low-pass-filtered conditions of the Macquarie Battery for Evaluation of Prosody to disrupt intelligibility of emotional speech while preserving melodic contour. Thirty-seven subjects performed an emotional identification task of 84 MBEP speech samples under both low-pass and natural speech conditions, as well as a psychophysical pitch discrimination task. Results showed a significant correlation between pitch discrimination threshold and accuracy in emotional identification for low-pass-filtered speech ($r=-.389$, $p<0.05$). In contrast, emotional identification was not significantly correlated with pitch perception ability under natural speech conditions ($r=-.039$, $p>0.05$). Given the different results in low-pass-filtered and natural speech conditions, we inferred that amusics may be compensating for poorer pitch perception by using speech cues that are filtered out in the low-pass-filtered manipulation. To assess this potential compensation, a second experiment is being conducted using high-pass-filtered speech samples intended to isolate non-pitch cues. Results show no significant correlation between pitch discrimination and emotional identification accuracy for high-pass-filtered speech ($r=.346$, $p>0.05$). Results from these experiments suggest an influence of low frequency information in identifying emotional content of speech.

## E33

### HIGH FREQUENCY TRANSCRANIAL RANDOM NOISE STIMULATION TO VENTROLATERAL PREFRONTAL CORTICES ENHANCES EMOTION DISCRIMINATION ABILITIES

Tegan Penton[1], Lauren Evans[1], Michael Banissy[1,2]; [1]Goldsmiths, University of London, New Cross, London, SE14 6NW, [2]University College London, 17 Queen Square, London, WCIN 3AR, UK — Reductions in emotion perception abilities contribute to deficits in communication and social competence, reduced quality of life, and social isolation. Given this, techniques that enhance this ability could be valuable. Transcranial Random Noise Stimulation (tRNS) is a form of non-invasive electrical brain stimulation that increases cortical excitability and has been used to enhance performance on various cognitive tasks. As yet, the effect of tRNS on emotion perception has not been studied. Here, we conducted two experiments to examine the effects of tRNS to bilateral Ventrolateral Prefrontal Cortices (VLPFC) on emotion recognition and perception abilities, with the prediction that tRNS would improve these processes. Experiment 1 investigated the effects of tRNS to VLPFC relative to V5/MT on emotion and identity discrimination using a same/different judgement task at baseline and following stimulation. Participants showed a greater improvement in performance following tRNS to VLPFC relative to V5/MT. To examine this further, we conducted a second study to investigate the

effects of active tRNS relative to sham tRNS targeted at VLPFC on the Cambridge Face Perception Happiness (CFPT-Happy), Cambridge Face Perception Anger (CFPT-Angry), and Cambridge Face Perception Identity, Test (CFPT-Identity). Participants receiving tRNS to VLPFC significantly outperformed those receiving sham stimulation on CFPT-Happy, but showed no differences on either the CFPT-Angry or CFPT-Identity. Collectively, these findings demonstrate that tRNS to VLPFC results in site and task specific enhancements in emotion discrimination, and imply that tRNS may be a useful tool to facilitate emotion discrimination abilities.

### E34

### TO SEE OR NOT TO SEE – BRAIN ACTIVATION TO BRIEFLY PRESENTED FEARFUL FACES

Paula Neumeister[1], Carina Yvonne Heitmann[1], Katharina Feldker[1], Thomas Straube[1]; [1]Institute of Medical Psychology and Systems Neuroscience, University of Muenster — Fearful faces have repeatedly been shown to activate a distributed network of cortical regions. However, it is a matter of debate to what extent fearful faces can be processed without conscious awareness during backward masking. In the present study, we used event-related functional imaging (fMRI) to investigate brain activation to very briefly presented (17 ms) fearful vs. neutral faces during two backward masking conditions (with and without 200 ms gap between target and mask) with scrambled faces serving as masks. After each trial, participants indicated by button press whether they had seen a face or not. Faces were perceived in the supraliminal condition but not in the subliminal condition, as revealed by signal detection theory analysis. Imaging results showed a main effect of facial expression across awareness conditions in the right superior temporal sulcus due to increased activation to fearful as compared to neutral faces regardless of whether faces were detected or not. This result shows critical involvement of the dorsal visual face processing stream, particularly the posterior STS, during automatic processing of facial emotion. Furthermore, the present results provide evidence for cortical processing of unseen fearful faces which have not been consciously perceived.

### E35

### LEARNING GROUP MEMBERSHIP: AN ERP EXAMINATION OF EARLY VISUAL PROCESSING OF IN-GROUP AND OUT-GROUP MEMBERSHIP DURING TRAINING

Holly Earls[1], Tim Curran[1]; [1]University of Colorado Boulder — It is well known that people are better at recognizing faces of their own race relative to other-race faces (Meissner & Brigham, 2001). Although it was originally proposed that this recognition bias was purely due to greater experience with own-race faces, more recent evidence has shown an in-group recognition bias for arbitrary groups even when prior exposure is equated (e.g. Bernstein, Young & Hugenberg, 2007). In the current experiment, electroencephalography (EEG) was used to measure event-related potentials (ERPs) while participants view own- and other-race faces of arbitrarily assigned in-group and out-group members. ERPs were measured from initial exposure of the faces through each of five runs of learning group membership. Results suggest that very little exposure to in-group faces is needed before neural activation discrepancies between groups are detected. Additionally, results indicate that although learning team membership impacts face processing, early visual effects of race are still present.

## EXECUTIVE PROCESSES: Monitoring & inhibitory control

### E36

### FOOD-CUE INHIBITORY TRAINING REDUCES REWARD REACTIVITY AND EATING URGES

Pin-Hao A. Chen[1], Richard B. Lopez[1], William M. Kelley[1], Mary DiGeronimo[1], Todd F. Heatherton[1]; [1]Dartmouth College — The current study compares the effectiveness of two types of training designed to reduce food-cue reactivity in brain reward regions and eating urges during daily living. According to the strength model of self-regulation, successful self-regulation relies on a domain-general resource. Further, this model suggests that training in one domain may transfer to other domains, but most studies have failed to find any evidence for transfer effects. It is therefore possible that domain-specific training may be more effective for reducing food-cue reactivity as well as eating urges in daily life. Thus, in this study, two weeks of domain-general (mindfulness) or domain-specific (food-cue inhibitory) training were used. Forty-six chronic female dieters were randomly assigned to one of these programs. Before and after the training, functional magnetic resonance imaging was used to assess food-cue reactivity in brain reward regions. Participants also completed one week of experience sampling before and after the training to examine eating urges during daily life. Results indicated that the domain-specific inhibitory training reduced activity in the bilateral orbitofrontal cortices more than the domain-general mindfulness-training program. Moreover, participants in the inhibitory training program also reported significant reduction in desires to eat during post-training experience sampling period. These findings suggest that domain-specific training may be effective in helping people control their temptations.

### E37

### DOPAMINE PRECURSORS DEPLETION IMPAIRS IMPULSE CONTROL IN HEALTHY VOLUNTEERS

Celine Ramdani[1], Franck Vidal[2], Laurence Carbonnell[3], Alain Dagher[4], Thierry Hasbroucq[2]; [1]Institut de recherche biomedicale des armées, Brétigny sur Orge, France, [2]Laboratoire de Neurobiologie de la Cognition, Aix-Marseille Univ/CNRS, Marseille, France, [3]Laboratoire de Psychologie Cogntive, Aix-Marseille Univ/CNRS, Marseille, France, [4]Montreal Neurological Institute, McGill University, Montreal, Quebec, Canada — The symptoms of Parkinson's disease (PD) are attributed largely to the loss of dopamine-producing neurons in the substantia nigra of the basal ganglia. These patients notably become more impulsive and display more predisposition than healthy controls toward unplanned actions. However, in PD, the progressive degeneration of dopamine neurons is associated with the dysfunction of other neurotransmitter systems. The aim of the present study was to decipher the role of the dopamine system in impulse control. Impulsive actions entail (i) activation of the motor system by an impulse, which is an urge to act and (ii) a failure to suppress that impulse, when inappropriate, in order to prevent an error. These two aspects of action impulsivity can be experimentally disentangled in conflict reaction time tasks, which measures susceptibility to acting on spontaneous impulses (as well as the proficiency of suppressing these impulses). In 12 healthy volunteers performing a Simon task, dopamine availability was reduced with an amino acid drink deficient in the dopamine precursors, phenylalanine and tyrosine. Classic behavioral measures were augmented with an analysis of the electromyographic activity of the response effectors. Electromyography allows one to detect covert activations undetectable with behavioral measures and reveals the participants' ability to quickly suppress covert activations before they result in an overt movement. Following dopamine depletion, participants displayed comparable impulse activation but were less proficient at suppressing the interference from this activation. These results provide evidence that the dopamine system is directly involved in the suppression of maladaptive response impulses.

### E38

### COGNITIVE MECHANISMS UNDERLYING AUDITORY SENSORY GATING

Laura Jones[1], Peter Bright[1]; [1]Anglia Ruskin University — Sensory gating is a neurological measure of inhibition conceptualized as the reduction in cerebral activity to a second identical stimulus presented within 1 second after the first. The objective of this work was to further our understanding of the underlying cognitive components involved in gating. Sixty participants underwent a battery of 10 cognitive tasks measuring several forms of inhibition, fluid intelligence, and working memory. Participants additionally completed a conditioning-testing paradigm (or paired-stimulus paradigm), during an electroencephalogram (EEG) recording as a measure of auditory sensory gating. Bivariate correlations revealed that sensory gating correlated with performance on five of these tasks including fluid intelligence. However, once working memory or fluid intelligence were controlled for, sensory gating remained significantly correlated with latent inhibition and the continuous performance task. After accounting for the unique characteristics of these tasks, we propose that sensory gating reflects perceived relevance of a stimulus to the current task, and/or the inhibition of the previously identified irrelevant stimuli during selective attention. Moreover, the correlation with fluid intelligence suggests the presence of top-down influences on the gating process.

## E39

### THE NEURAL CORRELATES OF DISTRACTION IN ADHD: EFFECTS OF TASK RELEVANT AND IRRELEVANT REWARD ASSOCIATIONS ON COGNITIVE CONTROL

Ili Ma[1], Mieke van Holstein[2], Gabry Mies[3], Maarten Mennes[2], Roshan Cools[2], Anouk Scheres[1]; [1]Behavioural Science Institute, Radboud University Nijmegen, [2]Donders Institute for Brain, Cognition and Behaviour, [3]KU Leuven — Beneficial effects of rewards on performance have been well established. This facilitation is typically associated with nucleus accumbens (NAcc) activity during reward anticipation. However, reward associations with task-irrelevant stimuli can impede performance. Refraining from response tendencies to such reward-associated task-irrelevant stimuli has been related to activity in cognitive control areas such as the presupplementary motor area (pre-SMA). Attention deficit hyperactivity disorder (ADHD) is a prevalent developmental disorder characterized by altered reward sensitivity and impaired cognitive control. We hypothesized that (1) irrelevant reward-associated stimuli would have more detrimental effects on cognitive control in individuals with ADHD than in controls; (2) task-relevant rewards would improve cognitive control in ADHD to a larger extent than in controls. Both behavioural effects were expected to be accompanied by altered activation in NAcc and cognitive control areas (pre-SMA, IFG, DLPFC). A motivation-modulated Stroop task was administered during fMRI to participants (14-17 years) with ADHD (n=29) and healthy controls (n=36). Task-relevant rewards led to performance improvement in all participants, while no effects of irrelevant reward-associations were present. The ADHD group was slower overall, and had higher error rates than controls, but reward effects did not differ between groups. We are currently testing whether the neural underpinnings of task-relevant reward-associations (NAcc) and overruling of task-irrelevant reward associations (pre-SMA, IFG, DLPFC) show different activation patterns in individuals with ADHD compared to controls.

## E40

### MEMORY-CONTROL INTERACTIONS INFLUENCE THE CONGRUENCY SEQUENCE EFFECT

Zoe Hawks[1], Daniel H. Weissman[1]; [1]University of Michigan at Ann Arbor — The size of the congruency effect in distracter interference tasks (e.g., the prime-probe task) is often reduced after incongruent relative to congruent trials. Further, prior work indicates that this congruency sequence effect (CSE) is influenced by both cognitive control and learning and memory processes. It remains unclear, however, whether these processes exert additive or interactive influences on the CSE. To make this distinction, we parametrically manipulated demands on these processes in a factorial design using a novel variant of the prime-probe arrow task. In Experiment 1, the CSE varied with an over-additive interaction between these processes, such that the largest CSE occurred when demands on both processes were relatively high as compared to relatively low. In Experiment 2, we replicated this interaction while ruling out the possibility that it was driven by conditional differences in the size of the congruency effect. These findings indicate for the first time that over-additive memory-control interactions influence the CSE, a result that has important implications for behavioral, cognitive neuroscience, and clinical studies of this phenomenon.

## E41

### EXAMINING HOW REGULAR MEDITATION PRACTICE INFLUENCES THE NEURAL OSCILLATORY ACTIVITY ASSOCIATED WITH REFOCUSING ATTENTION AFTER A MIND WANDERING EPISODE

Spencer Fix[1], Mark Faust[1], Johnson Susan[1]; [1]University of North Carolina at Charlotte — Mind wandering (MW) often interrupts goal directed behavior and negatively impacts mental and physical health. Several brain networks have been implicated in the generation and suppression of MW, including the default mode network (DMN), fronto-parietal control network (FPCN), and dorsal attention network (DAN). Furthermore, fMRI studies have found meditation practices are associated with increased activation in the FPCN and decreased activity in the DMN, both coinciding with an enhanced ability to suppress MW and maintain focused attention. The present study compared EEG activity in novice and experienced meditators that was associated with MW and focused attention during a period of eyes-closed rest and a focused attention meditation. An independent component analysis was conducted on EEG data to identify nodes of the DMN, FPCN, and DAN so that event-related spectral perturbations (ERSP) analyses could be used to estimate network activity. Significant group differences were apparent in two nodes of the FPCN, the dorsolateral prefrontal cortex and dorsal anterior cingulate, across several frequency bands suggesting experienced meditators more easily recruited their cognitive control capabilities to suppress MW and refocus attention. Additionally, activation group differences in the precuneus and posterior cingulate cortex lends support to the hypothesis that experienced meditators are more proficient in suppressing DMN activity and MW. Furthermore, group differences in nodes of the DAN were observed that may be linked to enhanced focused attention. The present investigation found EEG network activation differences between experienced and novel meditators that suggests regular meditation practice alters MW-related neural activity.

## E42

### CANNABINOID CB1 GENE VARIANT MODERATES NICOTINE WITHDRAWAL-RELATED NEURAL ENDOPHENOTYPES OF COGNITIVE DISRUPTION

Kade Jentink[1], Steve Sutton[2], David MacQueen[2], Hui-Yi Lin[2], Jong Park[2], David Drobes[2], David Evans[2]; [1]Colorado State University, [2]Moffitt Cancer Center — Nicotine withdrawal-related disruption of cognitive control contributes to the reinforcement of tobacco use. Identification of gene variants that predict who experiences greater disruption may lead to pharmacotherapy approaches that target this phenotype. Variation on the cannabinoid receptor 1 (CB1) gene has been shown to predict vulnerability to nicotine dependence, and CB1 antagonist increase attention and memory functioning. It was therefore of interest to examine CB1 gene variants as moderators of nicotine withdrawal-related cognitive disruption. We genotyped CB1 polymorphisms comprising the "TAG" haplotype (rs806379, rs1535255, and rs2023239) that are associated with reduced mRNA expression. We examined variants on the polymorphisms as moderators of neural phenotypes of nicotine withdrawal-related cognitive disruption, including reduced ERP target (P3b) and novelty (P3a) P300 component amplitudes and increased resting EEG theta and alpha-1 slow wave power. Caucasian Non-Hispanic dependent smokers visited the laboratory on two occasions following overnight smoking/nicotine deprivation. Two cigarettes (nicotine at one session and placebo during the other) were smoked prior to collecting EEG and ERP data at each session. rs806379 moderated the effects of nicotine deprivation on both P3b amplitude reduction ($p = .01$) and slow wave power (e.g., alpha-1 at midline sites , $p = .004$). Smokers homozygous for the major allele exhibited greater nicotine withdrawal-related cognitive disruption as measured by these neural indices. If the current findings are replicated and extended to additional CB1 gene variants, then future research may also examine cannabinoid receptor antagonists as an adjunct pharmacotherapy approach among individuals who exhibit greater nicotine withdrawal-related cognitive disruption.

## E43

### NEURAL REPRESENTATIONS OF COGNITIVE CONTROL MODULATED BY IMPLICITLY STRENGTHENED STIMULUS-RESPONSE ASSOCIATIONS

Tiansheng Xia[1], Hui Li[1], Ling Wang[1]; [1]South China Normal University — The dynamics of cognitive control have been investigated by the proportion congruency effect. However, the theory that this effect is due to attentional modulation has been challenged by contingency learning accounts. This raises the question of how the cognitive control system operates during and after increasing the strength of stimulus-response (S-R) associations. We employed a novel paradigm that elicits positive and reversed Simon effects via task rule manipulations, and combined it with a between subjects proportion congruency manipulation. The pattern of enhancement and reversal of the positive and reversed Simon effect across conditions suggested that participants used strengthened S-R associations to predict responses, supporting the contingency learning account. Functional neuroimaging identified proportion congruency effects that interacted with task S-R associations, showing greater activity when strengthened S-R associations conflicted with task-defined S-R associations in frontoparietal regions, including bilateral superior parietal lobule (SPL) and dorsal premotor cortex (dPMC), pre-supplementary motor area/anterior midcingulate cortex (Pre-SMA/aMCC), and left dorsolateral prefrontal cortex (DLPFC). Activity in the SPL was consistent with a role in representing the strengthened S-R associations. These results are consis-

tent with aMCC and DLPFC responding mainly to conflict induced by the strengthened S-R associations, and subsequently biasing processing in SPL and dPMC.

# EXECUTIVE PROCESSES: Other

## E44

### LATE BUT NOT EARLY BILINGUALS SHOW ADVANTAGE IN SUPPRESSION OF IRRELEVANT INFORMATION IN AN ERP GO/NOGO TASK

Debra Mills[1], Natalie Roch[1], Marissa Westerfield[2], Jeanne Townsend[2]; [1]Bangor University, [2]University of California, San Diego — Cognitive control over two competing languages is thought to lead to a bilingual advantage in executive function. An fMRI suggests bilingualism affects neural systems involved in suppression of irrelevant information but not response inhibition (Luk et al., 2010). Bialystok's hypothesis has been criticized for employing a limited set of tasks. We tested the bilingualism advantage hypothesis using a novel event-related potential (ERP) Go/No-Go spatial attention paradigm in monolinguals, early and late bilinguals. Participants (N=57) attended to a central fixation and instructed to press a button when they detected a brown gopher (Go), and to withhold responding to other stimuli (NoGo). Irrelevant distracter stimuli (bees) appeared at three, six and nine degrees from fixation. The bilingual advantage hypothesis predicts no group differences in ERP latencies or amplitude related to response inhibition (N2 to NoGo stimuli), or target detection (P3 to target). In contrast, bilinguals, particularly early bilinguals, should show attenuation of ERPs to the irrelevant stimuli. As predicted, there were no group differences in ERPs (N2/P3) related to Go/NoGo responses. The irrelevant stimuli elicited a positivity at 100 ms (P1) that varied in amplitude with distance from fixation. Moreover, the late bilinguals showed a smaller P1 to the irrelevant stimuli than did the monolinguals or early bilinguals, suggesting suppression of attention to the irrelevant stimuli. The results support Bialystok's hypothesis with respect to suppression and response inhibition. However the lack of differences between early bilinguals and monolinguals suggests that effortful cognitive control may be necessary to maintain the cognitive advantage.

## E45

### EEG PREDICTON ERROR SIGNALS ACCORD WITH HIERARCHICAL MODELS OF STRUCTURED REINFORCEMENT LEARNING AND TRANSFER

Anne Collins[1], Michael Frank[1]; [1]Brown University — Previous work has shown that when learning stimulus-action mappings through reinforcement, subjects construct abstract hierarchical rules, even when this structure does not afford any immediate advantage. Here we investigate how and why individuals build such rules by testing further predictions of our structured reinforcement-learning model. Subjects learned to select correct actions in response to colored shapes. The task design was such that two contexts (eg. colors) clustered around the same stimulus-action rule, whereas a third context signified a distinct rule for the same stimuli (eg. shapes). Two subsequent transfer phases introduced novel stimuli (with actions to be learned) in old contexts, and then novel contexts. Consistent with model predictions, subjects immediately benefitted from the initial structure during these new phases. In the first phase, they transferred learning of new stimulus-action associations across contexts indicative of the same latent rule. In the second phase, they recognized previously learned rules in novel contexts and transferred them to all stimuli in those contexts. Moreover, they exhibited greater such transfer for rules that had been most popular across multiple contexts, as predicted by our clustering model. We used electroencephalography to investigate the neural dynamics of structure learning and transfer. Model fitting allowed us to infer subjects' reward expectations and subsequent prediction errors. We found that feedback-locked components were sensitive to prediction errors, and that our structure learning model explained more variance in such signals than classical reinforcement-learning models. These results provide evidence for clustering models of structured reinforcement learning and generalization to novel situations.

## E46

### COGNITIVE FLEXIBILITY IN PARKINSON'S DISEASE: COMPENSATORY DOPAMINERGIC-CHOLINERGIC INTERACTIONS

Kamin Kim[1], Nicolaas Bohnen[1,2], Martijn Muller[1], Cindy Lustig[1]; [1]University of Michigan, [2]Veterans Affairs Ann Arbor Healthcare System — Decline of cognitive flexibility is one of the most prominent executive dysfunction in Parkinson's disease (PD) without dementia (see Robbins & Cools 2014 for review). We examined how different neural systems interact to cause or compensate for this impairment. The dual-syndrome hypothesis (Kehagia et al., 2013) attributes executive dysfunctions primarily to dopaminergic denervation, and associates cholinergic declines with early-stage visuospatial deficits and later dementia in PD. However, dopaminergic medication does not restore cognitive flexibility (Kehagia et al., 2010). Recent evidence that cholinergic denervation also correlates with executive decline (Bohnen et al., 2006; 2012), along with evidence from rodent lesion models (Kucinski et al., 2013), has led to the compensatory hypothesis: Fronto-parietal cortical cholinergic functions associated with top-down control may be recruited to compensate for executive dysfunctions associated with striatal dopaminergic declines, and vice versa. We tested this hypothesis by examining associations between nigrostriatal dopaminergic and neocortical cholinergic denervation (estimated using VMAT2 and acetylcholinesterase PET, respectively) and cognitive flexibility in 135 non-demented PD patients. Cognitive flexibility was assessed with a task-switching test with conflict (cued color vs word-naming using Stroop-like stimuli). Supporting the compensatory hypothesis, regression models controlling for age revealed an interaction between caudate dopamine and cortical cholinergic integrity: Cortical cholinergic integrity only predicted cognitive flexibility in patients with low caudate dopamine measures, and vice versa. These finding may lend support to the compensatory hypothesis and suggest that successful treatment of cognitive executive function deficits in PD will require not only dopaminergic but also cholinergic augmentation approaches.

## E47

### ASSOCIATIONS IN NEUROCOGNITIVE FUNCTIONING OF MOTHERS WITH DEPRESSION AND THEIR CHILDREN

Rowena Ng[1], Fred Rogosch[2], Dante Cicchetti[1,2]; [1]Institute of Child Development; University of Minnesota, Twin Cities, [2]Mt. Hope Family Center; University of Rochester, New York — The present study examined the associations and disassociations between neurocognitive functioning of depressed and nondepressed mothers and their elementary school-age children. Eighty-three mothers and their children were administered the assessments from the Cambridge Neuropsychological Test Automated Battery when their children were between age 9 to 13 years old. Of these, 41 mothers have a history of major depressive episodes during the child's first 20 months (DC; Mean Age of Mother = 40.2 years, SD = 5.3 years; Mean Age of Child = 10.6 years, SD = 1.1 years), and 42 are comparison mothers with no history of depression or other mental health disorder (NC; Mean Age of Mother = 44.1 years, SD = 3.6 years; Mean Age of Child = 11.2 years, SD = 1.4 years). No differences across cognitive indices were found across child and mother groups. However, differential relationships were observed between mother and child performances across neurocognitive indices as a function of depression history. Associations were observed between DC mothers' and their children's working memory and executive function. In contrast, no associations were observed in NC mothers and children. Broadly, results suggest cognitive functions subserved by prefrontal cortex may be more intimately associated in the DC mother and their children. Findings elucidate the specific neuropsychological faculties in which maternal depression confers risk on subsequent cognitive development.

## E48

### EXPLORING THE NEURAL MECHANISMS SUPPORTING SEQUENCE LEARNING AND LANGUAGE USING EVENT-RELATED POTENTIALS

Gretchen N.L. Smith[1], Sanjay D. Pardasani[1], Gerardo E. Valdez[1], Gwen A. Frishkoff[1], Christopher M. Conway; [1]Georgia State University — Sequence learning is a domain-general mechanism used to learn patterns of information in the environment in an automatic and unconscious manner (Cleeremans et al., 1998; Conway et al., 2010). Sequence learning abilities seem to be essential for learning motor, social, and linguistic knowledge;

however, there is little direct neural evidence supporting this claim. The purpose of this study was to explore the overlap between the neural mechanisms supporting sequence learning and language processing. Typically-developing adult participants completed a visual sequence learning task and a morpho-syntactic language task. Both tasks included violations of expected items occurring in a series. Event-related potentials (ERPs) were used to examine the underlying neurophysiological responses associated with these expectancy violations. The results indicated that the P3a component elicited by the visual sequence learning task and the P600 component elicited by the language task share similarities in their electrophysiological profiles. Of particular interest, the topography of the early phase of the P600 component (525-580ms) resembled the P3a (270-330ms) component, which was significant in frontal [$t(31) = 6.172$, $p < .001$], and right anterior [$t(31) = 4.020$, $p < .001$] regions. Furthermore, there was a positive correlation (Spearman's) between the P3a and the early P600 in these particular timeframes in the right anterior region that approached significance [$r(32) = .291$, $p = .106$]. These findings suggest some amount of overlap between the neural mechanisms supporting sequence learning and language and may have further implications toward the feasibility of improving language functions by improving sequence learning.

## E49

### HICK'S LAW IS MIRRORED IN THE BRAIN: AN FMRI STUDY OF THE CHOICE REACTION TIME

Tingting Wu[1], Alexander Dufford[1,2], Patrick Hof[2], Jin Fan[1,2]; [1]Queens College, City University of New York, [2]Icahn School of Medicine at Mount Sinai, New York — Hick's law states that there is a linear relationship between reaction time (RT) and information entropy for response selection, which is computed as the logarithm of the number of response alternatives. While many behavioral studies have provided evidence for Hick's Law, brain regions with information processing functionality have rarely been investigated. In this functional magnetic resonance imaging study, we utilized a choice reaction time task to manipulate the information entropy of response selection (0 to 2 bits) by varying the number of response alternatives and response reversal (1 bit). We found that RT and activity of the frontoparietal network linearly increased as a function of the information entropy of the response alternatives. Response reversal was related to a linear additive effect on RT and activity of the frontoparietal network. This additive effect was associated with more than 1 bit of additive information entropy. The behavioral interaction effect between response alternatives and the response reversal was accompanied by synergistic activation of the left anterior insula. These findings support the Hick's Law in the functionality of the frontoparietal network for information processing and suggest an integrative role of the anterior insular cortex in this network.

## E50

### CHANGES IN CONNECTIVITY PATTERN IN DEFAULT MODE NETWORK WITH DEVELOPMENT OF AUTOMATICITY

Farzin Shamloo[1], Sebastien Helie[1]; [1]Purdue University — The Default mode network (DMN) is a set of brain regions that are active during periods of unfocused attention and are suppressed when focusing on the external world. Many studies suggest that this network has a role in regulating attentional states and cognition (Pearson et al., 2011). There is evidence suggesting that the precuneus is the functional core of DMN (Utevsky et al., 2014). A seed-voxel coherence analysis was performed to explore how functional connectivity between the precuneus and other brain regions changes as a rule-based categorization task becomes automatic. We used functional magnetic resonance imaging (fMRI) data of 14 participants that were each trained in rule-based categorization for 20 sessions on consecutive workdays (Helie, Roeder, & Ashby, 2010). The coherence values of the 1st day of practice (with no previous practice) and 20th day of practice (after 11,040 trials of practice) were compared. The results show that there are no regions in which the coherence was higher in the 1st day compared to the 20th day. On the other hand, as categorization became more automatic, coherence between the precuneus and some DMN and non-DMN regions increased. Specifically, increases were observed in the left Middle Frontal gyrus (DMN), Premotor Cortex (non-DMN), left Inferior Parietal lobule (DMN), right Middle Temporal gyrus (DMN), Frontal Pole (non-DMN), and left Superior Parietal lobule (non-DMN). These results suggest that communication between the precuneus (DMN's functional core) and both DMN and task related regions becomes more efficient with extensive practice.

## E51

### LOWER AWARENESS OF BEHAVIORAL DEFICITS THAN UNIMPAIRED BEHAVIORS BY INDIVIDUALS WITH TRAUMATIC BRAIN INJURIES

Richard H. Bauer[1], Lisa C. Howser; [1]Middle Tennessee State University — Awareness of behavioral deficits by individuals with traumatic brain injuries (IWTBI) has been investigated by administering standardized questionnaires or interviews to the patient and a person knowledgeable of the patient. Discrepancies between the patient and the knowledgeable person are assumed to be due to impaired awareness by the patient. Unfortunately, responses to questionnaires and interviews may be biased. For example, in an attempt to be released from a rehabilitation facility, an IWTBI may rate themselves as less disabled, whereas in an attempt to have the IWTBI receive more rehabilitation services, a knowledgeable person may rate the IWTBI as more disabled. The present study appears to be the first to use more objective measures to assess awareness of both behavioral deficits and unimpaired behaviors of IWTBI. Three tasks from seven different behavioral categories were administered to 20 adult IWTBI and 20 nondisabled adults. On each trial (a) an example of the task was presented and the testing procedure was described, (b) a performance estimate was obtained, and (c) a trial was given. The IWTBI group performed significantly lower than the nondisabled group in 11 tasks, and the IWTBI group significantly overestimated their performance in 9 of these tasks. When performance by the two groups was not significantly different, estimated performance by the two groups was not significantly different. These findings suggest that, even when IWTBI have behavioral deficits, IWTBI base their estimates on preinjury performance levels. Therefore, IWTBI have apparently not yet become fully aware of their behavioral deficits.

## E52

### SOCIALLY EVALUATED COLD PRESSOR STRESS RENDERS STIMULUS-RESPONSE ASSOCIATIONS HABITUAL AFTER RESPONSE DEVALUATION IN HEALTHY CONTROLS

Theresa McKim[1], Samantha Dove[1], Akila Khan[1], Brian Witherspoon[1], Charlotte Boettiger[1]; [1]University of North Carolina at Chapel Hill — Habitual behaviors resist change and theoretically promote compulsive drug use and relapse susceptibility that characterize addiction; stress has been shown to be a predictor of relapse, although the mechanisms by which stress promotes a return to drug use are unknown. A socially evaluated cold pressor test (SECPT) enhances habitual actions, and elevates salivary cortisol/heart rate, but the effect of acute stress on overcoming habitual responses has not been tested empirically. We tested S-R learning and "re-learning" after response devaluation in healthy control participants (n=16) using a conditional S-R paradigm. Participants were shown abstract visual stimuli, and learned, through trial and error, rules associating the stimuli with manual responses. Prior to testing, participants learned 2 S-R sets (FAM) to a criterion of ≥90%. After ≥1 night's sleep, participants returned to show retention of FAM sets and learn 2 new S-R sets (NOV). After 6 blocks, responses for one FAM set and one NOV set were devalued to test the ability to re-learn S-R contingencies. Participants were assigned to one of three SECPT conditions during testing: (1) stress before NOV learning (n=4); (2) stress before re-learning (n=8); (3) no stress control (n=4). Preliminary analyses show no differences in accuracy for FAM and NOV sets prior to devaluation based on stress group (all $p$'s>0.08). In contrast, stress potentiates habitual responding that is selective to re-learning FAM associations ($p=0.03$), as demonstrated by increased perseverative responding in the stress groups compared to control. Future work may test the underlying neural substrates of these behavioral differences.

## E53

### PREPARING FOR (REWARDED) ACTION – ELECTROPHYSIOLOGICAL EVIDENCE THAT ACTION ANTICIPATION IS COUPLED TO PREPARATORY EFFORT

Hanne Schevernels[1], Klaas Bombeke[1], Ruth M Krebs[1], Carsten N Boehler[1]; [1]Ghent University, Faculty of Psychology and Educational Sciences — Usually reward effects are investigated using tasks in which motor responses are performed in order to receive a reward. However, recently several studies have elegantly crossed action requirements (execution and inhibition) and outcome valence (reward and punishment avoidance) during preparation to decouple valence from action effects and to investigate their interactions. These studies demonstrate that parts of the "reward

network" including the dopaminergic midbrain and the striatum predominantly encode action anticipation irrespective of valence. Although this distinction between action and valence is important, it seems to simultaneously entail differences in the state of preparation – a factor which has been linked to activity in the same brain areas. Here, we used EEG to track the amplitude of the contingent negative variation (CNV) component, which is believed to reflect preparatory processes sensitive to different levels of expected task demands during cue-target intervals. Moreover, in addition to the four original conditions (go to win, go to avoid losing, no-go to win and no-go to avoid losing) we included three control conditions (go neutral, no-go neutral as well as no-target cues as a neutral baseline). Importantly CNV amplitudes did not differ significantly from the baseline condition for any of the no-go conditions. In contrast, CNV modulations were clearly present in all three go conditions and similarly enhanced for loss avoidance and reward anticipation. Our results indicate that the dominance of action over valence during anticipation simultaneously entails differences in preparatory effort, and suggest that these factors are difficult to disentangle.

# LANGUAGE: Other

## E54

### HOW AND WHEN ARE NUMBERS AND LETTERS PROCESSED IN THE HUMAN BRAIN?

Sara Aurtenetxe[1], Nicola Molinaro[1], Doug Davidson[1], Manuel Carreiras[1]; [1]BCBL. Basque Center on Cognition, Brain and Language. Donostia-San Sebastian. — What are the temporal dynamics of number and word processing? Previous studies reported contrasting results: either a hemisphere specialization for numbers and letters or the same left occipital-temporal regions involved in recognizing both types of stimuli. In the current study native Spanish speakers were exposed to visually presented single numbers, letters and false fonts in a dot-detection task while their neuronal activity was recorded with magnetoencephalography (MEG). Event-related fields (ERFs) of the epochs (-0.25 to 1 s) were calculated and analyzed using a cluster-based permutation test at the sensor level (combined gradiometers). The resulting data showed early dissociations between the three type of stimuli: compared to false fonts, numbers elicited greater amplitude evoked fields (ERFs) on occipito-temporal sensors of the left hemisphere (100-150 ms) and on frontal sensors bilaterally (150-200ms), and lower evoked ERFs on medial-frontal sensors (100-150 ms). Compared to false fonts, letter ERFs were larger on left temporal sensors (100-150 ms) and left frontal sensors (150-200 ms), and smaller on frontal medial sensors (100-150 ms). The critical comparison between numbers and letter stimuli showed a left temporal dominance for letters (100-150 ms) but a left occipital (150-200 ms) and right occipito-parietal (250-300 ms) dominance for numbers. Overall, the current results suggest a temporal dissociation of numeracy and literacy in the human brain.

## E55

### NEUROPHYSIOLOGICAL EFFECTS OF TDCS ON LANGUAGE PRODUCTION: A TMS EEG STUDY

Alberto Pisoni[1,2], Leonor J Romero Lauro[1,2], Giulia Mattavelli[1], Costanza Papagno[1]; [1]Department of Psychology, University of Milano - Bicocca, [2]NeuroMi, Milan center for Neuroscience — Several studies report an improvement in language production after anodal-tDCS (a-tDCS) applied over the left Inferior Frontal Gyrus (LIFG). We investigated the neurophysiological correlates of this effect by means of TMS-EEG coupled with a verbal-fluency task. Two TMS-EEG recordings for session were acquired before and after a-tDCS. In one session a-tDCS was delivered over F5 (20 minutes, 0.75 mA, 16 cm2), with standard cephalic reference, applying TMS over left BA6, an area involved in the behavioral task. During the last 5 minutes of a-tDCS, phonemic and semantic verbal fluencies were administered. In a control session, the same paradigm was used with sham tDCS. Local mean field power (LMFP) of TMS-evoked potential (TEPs), a measure of cortical excitability, was computed for seven different anatomically defined electrodes clusters. Behavioral results confirmed an enhanced verbal fluency after real tDCS. Moreover, only after real tDCS, LMFP increased in post as compared to sham sessions. In particular, LMFP increased over the TMS site and in anatomically connected areas in a late time-window, reflecting a network activity enhancement. Conversely, in the tDCS site LMFP increased in an early time-window, indicating an increment in local cortical excitability. A further control session, applying the same tDCS protocol but targeting with TMS the left BA7, an area not involved in the task, confirmed the site specificity of the results, showing no increment in LMFP. Interestingly, the increment in verbal fluency significantly correlated with the increment of LMFP over F5, thus directly linking the behavioral results with tDCS physiological effects.

## E56

### INDIVIDUAL DIFFERENCES IN PROCESSING EMOTIONAL LANGUAGE: OR HOW YOU FEEL INFLUENCES HOW YOU COMPREHEND

Amy Cohen[1], Connie Shears[1], Maisy Lam[1], Adriana Ariza[1]; [1]Chapman University — Individual differences contribute to the variability observed in emotional inferencing tasks. We examined whether an individual's perception of an emotional word would influence their formation of a causal inference. In a post-hoc survey following an emotional inferencing task, participants were asked to rank a list of fourteen ambiguous emotions on a scale of -3 (completely negative) to +3 (completely positive). Participants who ranked positive and negative emotions as extreme (+3 or +2 and -3 or -2, respectively) were compared to participants who ranked positive words (i.e., satisfaction) as +3 or +2, and participants who ranked negative words (i.e., anger) as -3 or -2. We hypothesized that the differences between participants who made extreme rankings versus those inclined to moderate rankings (either positively or negatively skewed) would reveal differences in the formation of inferences from positive versus negative stories. Analysis indicated a hierarchical structure, with participants who ranked the emotions as negative making the most causal inferences, followed by participants who ranked emotions as extreme. Individuals who ranked emotions as positive were least likely to form causal inferences. Our findings demonstrate that pre-existing feelings influence how a person comprehends emotional language.

## E57

### THE BAIT AND SWITCH: DIFFERENCES IN SHIFTING ATTENTION BETWEEN MONOLINGUALS AND BILINGUALS

Eva Gjorgieva[1], Valerie Flores[1], Vanessa R. Rainey[2], Riley Sticca[1], Robert G. Morrison[1], Rebecca L. Silton[1]; [1]Loyola University Chicago, [2]University of West Florida — Bilingualism has been associated with an advantage in task shifting since speaking two languages requires frequent shifting between contexts. Among three key aspects of executive functions, shifting is the last to develop, relying upon a complex network of brain regions, including prefrontal, anterior cingulate, and parietal cortices. The frontocentral P2 event-related potential is thought to reflect the ability to detect task-relevant cue information involved with shifting between cognitive sets (Finke, Escera, & Barceló, 2012). The present study hypothesized that bilinguals would show cognitive and neural advantages in shifting attention. Shifting ability in monolinguals (n=19) and Spanish-English bilinguals (n=51), with similar reading span scores, was evaluated using a shifting Stroop task that utilized a trial-by-trial explicit cue to direct participants between identifying ink color or word naming. Counter to our predictions, we found that bilinguals had longer RTs than monolinguals on shifting trials ($p<.001$). Event-related potentials calculated from EEG recordings likewise showed that bilinguals had later frontocentral P2 latencies compared to monolinguals on switching trials ($p<.05$). P2 latencies were positively correlated with RTs on switching trials ($r=.42$, $p<.001$). Bilinguals' later P2 latency and subsequent longer RT during shifting trials suggest that switching may be more effortful for bilinguals. While our result may seem counter to previous studies of task switching in bilinguals, one possible explanation may be that bilinguals are less able to disengage from the linguistic information involved in the switching task, thus our findings may be related to the linguistic nature of the stimulus.

## E58

### THE ROLE OF DISCOURSE CONTEXT IN PRONOUN RESOLUTION: EVIDENCES FROM EVENT RELATED POTENTIALS (ERPS)

Kyra Krass[1], Christian Navarro-Torres[1], Judith Kroll[1], Eleonora Rossi[1]; [1]Penn State University — A recent ERP study[1] demonstrated that native Spanish speakers are sensitive to morpho-syntactic violations of grammatical gender occurring between the antecedent and its clitic pronoun (i.e., la manzanafem. sing….lomasc.sing; the apple…it), as revealed by an enhanced P600. At the same time, recent data suggest that discourse context can modulate the pro-

cessing of local grammatical information[2]. Here, we use ERPs to test if preceding discourse context information can modulate the neurophysiological response to a local grammatical gender violation between an antecedent and its clitic pronoun. EEGs were recorded while native Spanish speakers (mean age=22; 22 female) read materials consisting of a context sentence, followed by a target sentence containing a local gender mismatch between the antecedent and the clitic pronoun (as in the example above). Critically, the context sentences comprised two additional antecedents, which did or did not match in gender the incorrect clitic pronoun presented in the target sentence. We hypothesized that if contextual information can modulate the reanalysis process of the local ungrammaticality, a modulation of the P600 amplitude should be observed. In line with our predictions, we observed a reduction of the P600 in response to the local morpho-syntactic gender violation, only in the condition in which the preceding context contained a possible antecedent. We conclude that context information is utilized by native speakers to guide and reevaluate grammatical processing. References: [1] Rossi et al., (2014). Neuropsychologia, 62, 11-25. [2] Brown, et al., (2000). Journal of Psycholinguistic Research, 29, 53–68.

### E59

### LATE SECOND LANGUAGE PROCESSING OF ENGLISH FOCAL STRESS BY L1 MANDARIN SPEAKERS

Ellen Guigelaar[1], John Drury[1]; [1]Stony Brook University — Comprehension and production of linguistic prosody is notoriously difficult for late second language (L2) learners. We contrasted the performance of native (L1) English speakers and late L2 learners (L1-Mandarin/L2-English) in an eye-tracking/truth-value-judgment study probing the processing of prosodically marked focus under "only". Note that in "Steve only gave Boris the SPINACH last week", focal stress on "SPINACH" has truth-conditional effects: this is false if Boris was given both the spinach and something else, but true so long as the spinach was the only thing Boris was given. Sentences like these were played over computer speakers while matching/mismatching pictures were displayed on a monitor. Eye movements were monitored while L1-English (N=14) and L1-Mandarin (N=32) participants performed a sentence/picture (truth-value) matching task. Sentences were either Dative or Double-Object constructions, had focal stress on either the Direct or the Indirect object, and occurred with either True or False pictures (2x2x2). On the TVJT nonnative speakers performed worse than natives overall and performed worse on double object sentences than on datives constructions. The eye-tracking data revealed a corresponding set of group differences. Whereas the groups differed only marginally in the cumulative fixation time patterns for the datives, they did for the double object constructions with significantly later match/mismatch effects on the non-native than native fixation times. We situate these results in the context of a discussion of L1-influences of prosody, syntax, and lexicon on L2 auditory comprehension.

### E60

### NETWORK ANALYSIS OF RESTING STATE ELECTROENCEPHALOGRAPHIC RECORDINGS: DETECTING ACUTE AND RESIDUAL EFFECTS OF CONCUSSION

Rene Utianski[1], Julie M. Liss[2], Amaal Starling[1], Rashmi Halker Singh[1], Bert Vargas[1], David Dodick[1], John Caviness[1]; [1]Mayo Clinic-Arizona, Department of Neurology, [2]Speech and Hearing Science, Arizona State University — The recent spotlight on concussion has illuminated deficits in the standard of care of addressing acute and persistent cognitive deficits. This stems from the complex nature of the injury, which does not to produce focal cognitive or behavioral deficits that are easily attributed to specific physiologic processes. Here, a joint behavioral- electroencephalography paradigm was employed, looking at individuals with concussion in acute injury and recovery, as well as a cohort of controls with no history of concussion. A sentence verification task with speech comprehension at various levels of degradation imposes the need for higher-order cognitive processes; corresponding activation is analyzed via network analysis. A multiple linear regression was utilized to assess if network measures could predict performance of individuals with concussion; a significant model was built, demonstrating sensitivity of modularity and number of clusters (theta band), and path length (lower alpha) in predicting task accuracy. Logistic regressions were conducted to assess the sensitivity of measures in classifying individuals with concussions and persisting pathophysiology from controls. Results demonstrate network measures can differentiate between healthy and concussed individuals, utilizing cluster number (of upper alpha) and phase lag index (gamma band). Interestingly, path length of the beta band differentiates between controls and individuals who report recovery from symptoms of concussion. Measures of network connectivity show promise as a neurophysiological proxy both for otherwise undetected higher-order cognitive deficits in individuals with concussion and for neurological recovery from concussion.

## LANGUAGE: Semantic

### E61

### AN EVENT-RELATED POTENTIAL STUDY OF THE ENGLISH RESULTATIVE CONSTRUCTION

Gina R. Kuperberg[1,2], Margarita Zeitlin[1], Chelsey R. Ott[1], Eva Wittenberg[1], Ray Jackendoff[1], Edward W. Wlotko[1]; [1]Tufts University, [2]Massachusetts General Hospital — We examined the neurocognitive mechanisms engaged in processing the English resultative construction using event-related brain potentials (ERPs). ERPs were recorded as 28 participants read sentences containing adjectival resultatives following either real or false direct objects. The real objects were consistent with the preceding verb's selection restrictions ('Bill wiped the table…'), and therefore constrained for many possible upcoming constructions, including resultatives ('Bill wiped the table…clean…'). The false objects were inconsistent with the verb's selection restrictions and therefore constrained strongly for a resultative construction ('The team ran their shoes..thin …'). Incoherent resultatives were also included, yielding a fully-crossed design (Bill wiped the table clean/*thin; The team ran their shoes thin/*clean). There were no differences in ERPs evoked by the real and false objects. However, coherent resultatives following false objects evoked a smaller N400 than those following real objects, suggesting that the false objects cued comprehenders to predict a resultative event structure (as opposed to other types of structures) with relatively high probability. This led to facilitated processing of adjectives whose semantic features were consistent with this prediction. Moreover, incoherent resultatives following false objects elicited a larger anterior negativity than those following real objects, which we interpret as reflecting costs of suppressing the predicted resultative construction. These data suggest that comprehenders are able to use verb-argument relationships to anticipate upcoming structure and constrain semantic expectations of upcoming words.

### E62

### OUT OF THE CORNER OF MY EYE: EVENT RELATED POTENTIALS REVEAL EFFECTS OF FOVEAL LOAD ON PARAFOVEAL WORD PROCESSING IN READING

Brennan R. Payne[1], Mallory C. Stites[2], Kara D. Federmeier[1]; [1]University of Illinois at Urbana-Champaign, [2]SUNY Binghamton — Readers obtain information not only from the currently fixated word, but also from words in parafoveal vision. In English, this span ranges from four characters to the left of fixation to upwards of 15 characters to the right. While the nature of parafoveal representations is an oft-investigated topic, little is known about how the dynamics of parafoveal processing are modulated by current foveal load. In the current study, event-related brain potentials were used to track the time course of foveal-on-parafoveal effects. In a flanker RSVP paradigm (central words flanked 2° bilaterally by preceding and following words), subjects read constraining sentences in which a target word N was expected, unexpected but plausible, or anomalous. When N was central, the right flanker (N+1) was an invalid (non-word) or valid preview. N+1 was valid on the next triad, when it appeared centrally. If foveal expectancy impacts parafoveal processing, differences between ERPs to valid and invalid previews should be larger when N is expected versus unexpected or anomalous. When N was expected and appeared centrally, a widespread sustained negativity was observed for parafoveal non-words relative to words. This negativity was substantially reduced when N was unexpected or anomalous. When N+1 appeared centrally and N was expected, a sustained positivity to previously invalid non-words was observed. When N was unexpected or anomalous, this effect was reduced. Taken together, these findings suggest that sentential context modulates visual attention such that covert shifts of attention to parafoveal words are delayed when foveal words are inconsistent with predictions.

## E63

### EFFECTS OF CULTURAL CONTEXT AND FAMILIARITY ON LANGUAGE ACTIVATION

Matthias Berkes[1], Zehra Kamani[1], Ellen Bialystok[1]; [1]York University — The present study investigated the role of cultural cues and object familiarity on linguistic activation and word accessibility in monolinguals and bilinguals. Twenty-two high- and 22 low-proficiency Korean-English bilinguals and 22 English monolinguals were presented with a picture and audio cue and indicated via button press whether the heard label named the depicted object while event-related potentials were recorded. In the critical blocks, the pictures represented exemplars that were more typically North American or Korean, even though both exemplars took the same name in both languages (e.g., North American "soup" vs. Korean "soup"). English or Korean labels for the pictures were presented in separate blocks; monolinguals only completed the English blocks. RTs were significantly faster for trials in which the auditory stimulus correctly named the object and the language matched the cultural bias. For bilinguals, there was an attenuation of the N400 when the label matched the picture, regardless of cultural bias. In contrast, monolinguals showed this attenuated N400 for correct labels but also revealed larger attenuation for North American items. To test the role of familiarity in these results, a subset of participants completed a further block presenting culturally neutral objects that were familiar or unfamiliar (e.g., the label "monkey" applying to both the common squirrel monkey and the less familiar saki monkey). The N400 results mimicked those of the cultural blocks, but a late positive component depended only on the level of familiarity. Therefore, the effect of cultural context, object familiarity, and semantic integration appear to be separate.

## E64

### DOES A PREDICTION BENEFIT OUTLAST GRAMMATICAL VIOLATIONS? A DOUBLE-VIOLATION ERP-STUDY.

Dominik Freunberger[1]; [1]University of Salzburg — Prediction in language comprehension is known to have beneficial effects on the processing of incoming information, be it in terms of facilitated lexical-semantic access/ retrieval, easier integration, or – on a behavioral level – reduced reaction times for predictable versus unpredictable words. In an event-related potential (ERP) experiment we tested whether this benefit survives in ungrammatical sentences. Therefore, we manipulated the grammaticality of verbs (grammatical, ungrammatical) that were either highly predictable (high cloze probability; CP) or unpredictable (low CP) from the preceding context. It has been demonstrated that highly predictable words engender a P300 rather than a reduced N400 ERP-component in certain contexts and – crucially – this paradigm enabled us to test whether the P300 reflects rather lexical ("word form") or semantic prediction, because the two highly predictable verbs differ with respect to word-form (grammatical versus ungrammatical), but not with respect to semantics (same semantic features irrespectively of grammaticality). Both highly predictable verbs led to a P300, both unpredictable to an enhanced N400, irrespectively of grammaticality. However, in a later time-window, a reduced late positivity for high versus low-CP was only present in the grammatical condition. Thus, results indicate that high predictability also facilitates lexical-semantic processing when the input is erroneous. However, the subsequent integration process benefits from greater predictability only, when the input is grammatical. Additionally, the comparable P300 in both high-CP conditions shows that the functional underpinning of the P300 goes beyond bare word-form matching and rather reflects the recognition of a semantically pre-activated element.

## E65

### QUANTIFIERS ARE INCREMENTALLY INTERPRETED IN CONTEXT, MORE THAN LESS

Thomas P. Urbach[1], Katherine A. Delong[1], Marta Kutas[1]; [1]Universtity of California, San Diego — Language interpretation is often assumed to be incremental. However, our previous studies of quantifier expressions in isolated sentences found N400 event-related brain potential (ERP) evidence for partial but not full immediate quantifier interpretation (Urbach & Kutas, 2010). Here we tested similar quantifier expressions in pragmatically supporting discourse contexts (Alex was an unusual toddler. Most / Few kids prefer sweets / vegetables...) while participants made plausibility judgments (Experiment 1) or read for comprehension (Experiment 2). Control Experiments 3A (plausibility) and 3B (comprehension) removed the discourse contexts. Quantifiers always modulated typical and/or atypical word N400 amplitudes. Critically, the real-time N400 effects in Experiment 2 mirrored offline quantifier and typicality crossover interaction effects for plausibility ratings and cloze probabilities. We conclude that quantifier expressions can be interpreted fully and immediately, though pragmatic and task variables appear to impact the speed and/or depth of quantifier interpretation.

## E66

### EXAMINING THE N400 SEMANTIC CONTEXT EFFECT ITEM-BY-ITEM: RELATIONSHIP TO CORPUS-BASED MEASURES OF WORD CO-OCCURRENCE

Cyma Van Petten[1]; [1]Binghamton University — Understanding the organization of semantic memory is one of the fundamental goals of cognitive science. With increasing availability of digital text, there has been an explosion of computational methods designed to turn patterns of word co-occurrence in large text corpora into numerical scores expressing the "semantic distance" between any two words. The success of such methods is typically evaluated by how well they predict human judgments of similarity. Here, I examine how well corpus-based methods predict amplitude of the N400 component of the event-related potential (ERP), an online measure of lexical processing in brain electrical activity. ERPs elicited by the second words of 303 word pairs were analyzed at the level of individual items. Three corpus-based measures (mutual information, distributional similarity, and latent semantic analysis) of semantic distance were compared to a traditional measure of free association strength. In a regression analysis, corpus-based and free association measures each explained some of the variance in N400 amplitude, suggesting that these may tap distinct aspects of word relationships (similarity versus thematic relations between actors, actions and objects). Lexical factors of concreteness of word meaning, word frequency, number of semantic associates, and orthographic similarity to other words also explained variance in N400 amplitude at the single-item level.

## E67

### EFFECTS OF CROSS LANGUAGE AMBIGUITY ON WORD LEARNING AND PROCESSING

Chelsea Eddington[1,2], Natasha Tokowicz[1,2,3]; [1]University of Pittsburgh, [2]Center for the Neural Basis of Cognition, [3]Learning Research and Development Center — Semantic ambiguity within a language and across languages (called translation ambiguity) have been found to affect processing and learning (e.g., Eddington & Tokowicz, 2013; Elston-Güttler & Friederici, 2005; Rodd, Gaskell, & Marslen-Wilson, 2002). In this study we examine how naïve learners of German acquire words that are translation ambiguous and how they process the different types of translation-ambiguous words semantically. We are interested in how learners acquire translation ambiguous words that are due to near-synonmys in the target language (e.g., fruit–Frucht and Obst), polysemy in the source language (e.g., paper–Aufsatz (content) and Papier (material)), and homonymy in the source language (e.g., trunk–Baumstamm (tree) and Kofferraum (car)). We examined how easily participants acquired German vocabulary words with vocabulary tests, and examined their performance on two tasks. In a German-to-English translation production task, participants were less accurate at translating words that were homonyms compared to the other word types. In a semantic-processing task, participants showed a processing advantage for the near-synonymous and polysemous types of translation-ambiguous words, suggesting that greater semantic similarity facilitates processing. Overall, type of ambiguity impacts vocabulary learning and also affects semantic processing, depending on the meaning similarity of the ambiguous words. In a follow-up study, we will investigate the neural correlates of vocabulary learning using event-related brain potentials. Specifically, the test task will be focused on the N400 component to examine semantic processing. We will discuss the results with respect to how they relate to semantic ambiguity processing and to models of bilingual memory.

## E68

### THE MODULATION OF REPETITION PRIMING EFFECTS BY SENTENCE CONTEXT: AN ERP STUDY WITH AMBIGUOUS WORDS

Mariya Chernenok[1], Barry Gordon[1,2], Kerry Ledoux[1]; [1]Cognitive Neurology/Neuropsychology, Department of Neurology, Johns Hopkins University, Baltimore,

MD, [2]Department of Cognitive Science, Johns Hopkins University, Baltimore, MD — The repetition of word forms results in repetition priming, the processing benefit on subsequent presentations of a word relative to the first. In event-related potentials (ERPs), repetition priming effects in lists and in sentences have been observed as a reduction in the amplitude of the N400 component; this may also be accompanied by changes in the amplitude of the late positive component (LPC). We wished to further explore repetition priming effects by using ambiguous words whose meaning must be derived from their sentence context. We examined lexical repetition priming in prime and target sentence pairs that biased the same or different meanings of ambiguous words to determine the extent to which repetition priming depends on the repetition of lexical form versus lexical semantics, and to look at interactions between repetition priming and sentence context. Across 24 participants, we found N400 priming effects to repeated ambiguous words, but only when the target context biased the dominant meaning of the word; when the subordinate meaning was biased, repetition resulted in a larger amplitude N400, relative to the control. In the dominant condition, a reduction of the LPC was observed to ambiguous word targets that repeated form, meaning, or both from the prime sentence; in the subordinate condition, a reduction in the amplitude of the LPC was observed only for targets that repeated both form and meaning. Thus, we observed an interaction between lexical semantics and sentence context in determining the magnitude of repetition priming effects for ambiguous words.

# LANGUAGE: Syntax

## E69

### CROSS-LINGUISTIC COMPARISON OF THE PROCESSING OF CLASSIFIERS IN MANDARIN AND ENGLISH

Zhiying Qian[1], Susan Garnsey[1]; [1]University of Illinois at Urbana-Champaign — Classifiers are words like "sheet" in "a sheet of paper". In both Mandarin and English, the meaning of a classifier and its noun must match. Mandarin requires that all quantified noun phrases include classifiers (e.g., two animal-classifier cat), while English only requires them with quantified mass nouns (e.g., two sheets of paper). In both languages, classifiers vary in specificity: some fit with many nouns (e.g., a piece of) while others fit with only a few nouns (e.g., a head of). The present study investigated 1) whether Mandarin and English classifiers are processed similarly, and 2) whether the additional constraint supplied by specific classifiers facilitates the processing of the nouns following them. In separate studies, native Mandarin and English speakers read sentences containing specific or general classifiers and nouns that matched them or did not (There is a {cup / sheet} of coffee on the table) while EEG was recorded. In both languages a sustained anterior negativity beginning at the P2 response to the classifier was larger for general than for specific classifiers, suggesting that readers found the additional constraint supplied by specific classifiers helpful. Even though violations of other kinds of agreement in English trigger effects on P600 rather than N400, mismatching nouns following classifiers elicited larger N400s than matching nouns in both languages, indicating similar semantic processing of classifier-noun agreement in the two languages. In addition, ungrammatical Mandarin sentences that were missing their required classifiers triggered P600 effects early in the experimental session, shifting to an Anterior Negativity later.

## E70

### RHYTHMIC EFFECTS OF SYNTAX PROCESSING IN MUSIC AND LANGUAGE

Harim Jung[1], Samuel Sontag[1], YeBin Shiny Park[1], Psyche Loui[1]; [1]Wesleyan University — Music and language are human cognitive and neural functions that share structural similarities. Past theories posit shared neural resources between syntax processing in music and language (Patel, 2003), and a dynamic attention network that governs general temporal processing (Large and Jones, 1999). Experiment 1 of this study focuses on interactions between rhythmic expectancy and musical and linguistic syntax in a reaction time paradigm. Stimuli adapted from (Slevc et al., 2009) were presented as sentence segments of one or two words paired with musical chords, and RT was recorded for each segment. Linguistic syntax expectancy violations appeared in a garden-path design, harmonic expectation violations, presented as out-of-key chords, and rhythmic expectancy violations, through early and late temporal perturbations, were manipulated at the critical region. Results show a three-way interaction ($F(2,499) = 3.59$, $p < .05$) with main effects of rhythmic expectancy ($F(1,508) = 4.04$, $p < .05$) and linguistic syntax expectancy ($F(1,523) = 4.15$, $p < .05$) on RT. Experiment 2 investigated rhythmic and linguistic expectancies, independently of musical syntax, and replicates main effects from Experiment 1. Ongoing work also extends the behavioral results in an EEG study. Overall, the novel effects of rhythm suggest an expansion of the Shared Syntactic Integration Resource Hypothesis (SSIRH), as well as dynamic models of attentional entrainment. The different interactions and simple effects of these three factors across different timescales also suggest asymmetric sampling across these complex stimuli (Poeppel, 2003) and give insight into the integration of musical and linguistic syntax processing with attentional entrainment.

## E71

### THE PROCESSING OF WORD ORDER VARIATIONS IN AUSTRIAN SIGN LANGUAGE (ÖGS) – AN ERP - STUDY ON "SUBJECT PREFERENCE"

Julia Krebs[1], Ronnie Wilbur[2], Dietmar Roehm[1]; [1]University of Salzburg, [2]Purdue University — In transitive structures, sentence-initial ambiguous argument NPs are preferentially interpreted as the „subject". Therefore, SOV is favored over OSV leading to the effect that sentence-initial ambiguous object-NPs have to be reinterpreted towards a non-preferred OSV-structure. This reanalysis is reflected e.g. in lower acceptability ratings, longer reaction times and different ERP-patterns for OSV compared to SOV. In ÖGS the basic word order is SOV. However, OSV-orders are possible. In an ERP-study we presented SOV- and OSV-orders involving two verb types (agreeing verbs and plain verbs) to deaf signers to test whether these structures are processed differently. Data evaluation revealed lower acceptability ratings, longer reaction times as well as a biphasic N400-late positivity-ERP pattern for OSV in comparison to SOV for both verb types measured at a time point before the verb sign has been established. Like Haupt et al. (2008) we consider the observed ERP pattern as an instance of a "reanalysis N400" followed by a "late positivity" - a pattern which previously has been observed for grammatical function reanalysis [1]. Furthermore, the visual-(non)manual modality of sign languages allows earlier disambiguation compared to reanalysis effects described for spoken languages. All in all, these findings indicate that signers use the "subject"-first strategy for the processing of sentence-initial ambiguous arguments. [1] Haupt et al. (2008). J Mem Lang, 59(1), 54-96.

## E72

### THE ROLE OF MORPHOLOGICAL MARKEDNESS IN THE PROCESSING OF NUMBER AND GENDER AGREEMENT IN SPANISH: EVIDENCE FOR PREDICTIVE PROCESSING FROM EVENT-RELATED POTENTIALS

José Alemán Bañón[1], Jason Rothman[1]; [1]University of Reading — Syntactic features such as number and gender are thought to be asymmetrically represented. For example, in Spanish, plural and feminine are assumed to be marked for number and gender, whereas singular and masculine are argued to lack a number/gender specification. We used event-related potentials to examine how these differences in markedness impact agreement resolution. Agreement was examined between inanimate nouns and predicative adjectives across a relative clause boundary (...CATEDRAL que parecía INMENSA… "…cathedral-FEM-SG that looked huge-FEM-SG…"). Markedness was examined by manipulating the gender of the nouns (half masculine/half feminine) and their number specification (half singular/half plural). For each feature, half of the violations involved an underspecified adjective (singular or masculine) in a context that required a marked one (plural or feminine noun). The other half involved the opposite pattern. Overall, subjects read 240 sentences and 240 distractors presented word by word (450ms on/300ms off). Results (n=27) showed that both number and gender violations elicited a posteriorly-distributed P600, a component associated with morphosyntactic repair. Markedness did not impact the P600, which was equally robust across violations. Number and gender violations also yielded a small centro-parietal N400, an effect argued to reflect prediction of specific forms. This effect was modulated by markedness, as it was only significant for violations which involve an underspecified adjective (singular or masculine) in a context that required a marked one (plural or feminine noun). These results are consistent with the possibility that markedness on the noun is used to predict the number/gender specification of the agreeing adjective.

### E73

### THE ROLE OF PHONOLOGICAL SALIENCE IN THE DETECTION OF MORPHOSYNTACTIC ERRORS: ERP EVIDENCE

Brigitta Fodor[1], John E. Drury[1]; [1]Stony Brook University — Language ERP studies examining morpho-syntactic violations (e.g., "He *walk/They *walks") reliably find P600 effects which are often, but not always, preceded by left anterior negativities (LANs). However, the reasons why LAN effects are less consistently found are still not understood. Marcinek et al. (2014) showed that the presence of an illicit suffix (e.g., "They *walks") elicits a later onset P600 than an expected but absent affix (e.g., "He *walk"). The present study asked whether the phonological saliency (i.e syllabicity) of the affix affects P600 onset latency and/or amplitude, both for present illicit affixes and predicted but absent ones. We visually presented grammatical/ungrammatical sentences containing verbs with present/absent third person agreement affixes (non-syllabic [-s/-z], e.g. STARTS vs. syllabic [-Iz], e.g. BROWSES), and with past tense/perfective affixes (non-syllabic [-t/-d], e.g. BROWSED vs. syllabic [-Id], e.g. STARTED). Violations were always more positive going then their grammatical counterparts, but suffixed forms also generally elicited a larger positivity than their non-suffixed counterparts. As for onset latency, only the non-syllabic illicit affixes evoked a later P600; in every other condition, the positivity came earlier, even in the syllabic illicit case. Only the cases eliciting later onset P600 effects seemed to show any indication of prior LAN-type responses. These data provide important new information about the factors which determine P600 onset and amplitude in morpho-syntactic violation paradigms, and thus contribute directly to our understanding of the circumstances under which we may expect these (large amplitude) ERP effects to either co-occur (or not) with prior LANs.

### E74

### PROCESSING RELATIVE CLAUSES AND RIGHT-BRANCHING SENTENCES IN CHINESE: AN ERP STUDY

Talat Bulut[1], Shih-kuen Cheng[1], Denise H. Wu[1]; [1]National Central University, Taiwan — There is extensive literature on English relative clauses that consistently shows that subject relative clauses (SRC) are easier to process than object relative clauses (ORC). Most of the studies in typologically different languages such as Korean and Japanese also revealed similar results. However, previous studies on Chinese relative clauses have been controversial and inconclusive. In this study, event-related potentials were recorded when native speakers of Chinese read three types of Chinese sentences with different syntactic complexity: SRC, ORC and right-branching sentences. By minimizing the surface differences among the sentences in these conditions and treating the processing of right-branching condition as a baseline, we aimed to examine whether Chinese relative clauses exhibited a SRC or ORC advantage. The behavioral results showed that comprehension questions of syntactically simple (right-branching) sentences were answered more accurately and quickly than those of syntactically complex (relative clauses) sentences, while no difference of these off-line measurements was observed between SRC and ORC sentences. Importantly, the P600 component elicited by the head noun of the SRC sentence was significantly different from that elicited by the head noun of the ORC sentence, which did not differ from the P600 component elicited by the corresponding noun phrase in the right-branching sentence. In line with the findings from Basque, the current results from Chinese challenge the universality of SRC advantage. Instead, they support processing accounts based on linear distance between dependents, as Chinese SRCs are characterized with more distant dependency relationship between the noun phrase and the verb phrase than ORCs.

### E75

### PERFUSION AND RECOVERY OF SYNTACTIC COMPREHENSION IN CHRONIC AGRAMMATIC APHASIA

Ellen Fitzmorris[1], Yufen Chen[1], Todd B. Parrish[1], Cynthia K. Thompson[1]; [1]Northwestern University — Emerging evidence suggests that functional recovery after stroke can be predicted by cerebral hemodynamics (e.g. Hillis et al. 2000; Fridriksson et al., 2010). The present study examined longitudinal relations between baseline perfusion and lesion volume in regions of the brain involved in sentence processing, and treatment-related improvement in noncanonical sentence comprehension. Ten individuals with chronic agrammatic aphasia underwent neuroimaging and language evaluation before and after treatment for noncanonical sentence processing. We measured improvement in sentence comprehension and baseline perfusion and lesion volume within: a) primary syntactic processing areas engaged by healthy individuals, b) compensatory areas recruited in individuals with agrammatism in previous studies (Thompson et al., 2010), c) perilesional tissue (within 15mm of the lesion), and d) a domain-general control region. In primary syntactic areas, neither perfusion nor lesion volume predicted recovery, though we found marginally significant negative correlations with lesion volume in Broca's area ($\rho$ = -.5, p = .19). Across compensatory areas, smaller lesion volume predicted recovery ($\rho$ = -.7, p < .05). In perilesional tissue, recovery was predicted by, surprisingly, slower perfusion ($\rho$ = -.6, p = .06), and this relation became significant in stepwise linear regression when baseline comprehension was controlled for ($\beta$ = -2.65, p < .001). These results contradict prior claims of a beneficial role of perilesional tissue in recovery after stroke. Perilesional tissue may be maladaptive to recovery of noncanonical sentence comprehension, for which the neural computations may be too complex for abnormally functioning perilesional tissue to carry out successfully.

## LONG-TERM MEMORY: Development & aging

### E76

### USE OF CONJUGATED ESTROGEN, PREMARIN, MAY PRESERVE BRAIN STRUCTURE

Christina Boyle[1], Cyrus A Raji[1,2], Kirk I Erickson[3], Oscar L Lopez[3], James T Becker[3], H Michael Gach[3], W T Longstreth[4], Mikhail Popov[3], Lewis Kuller[3], Owen T Carmichael[5], Paul M Thompson[1]; [1]University of Southern California, [2]University of California at Los Angeles, [3]University of Pittsburgh, [4]University of Washington, [5]Pennington Biomedical Research Center — Controversy continues over hormone therapy (HT) and its risks and benefits. By 1992, the most prescribed conjugated estrogen in the U.S. was Premarin. In the Women's Health Initiative (WHI) Study, Premarin users had higher risk of heart disease, breast cancer and dementia. Subsequently, HT usage declined dramatically. Questions remain about its medical effects. Contrary to the WHI study, some evidence suggests that HT benefits may outweigh the risks, but Premarin may be an exception. Here we study whether Premarin use predicts brain volumetric measures that may indicate clinically silent brain injury. Many studies suggest that such injury increases risk of dementia, stroke, and early mortality among elderly individuals. We studied 562 female subjects from the multi-site Cardiovascular Health Study - 79 with AD, 58 with MCI, and 425 healthy controls (mean age (at scan): 73.8±4.2 years). We acquired volumetric T1-weighted MRI scans and performed tensor-based morphometry to assess regional brain volumes. We performed a voxelwise multivariate analysis, regressing use of Premarin, assessed by current prescriptions and self-reported past usage, on brain volume. We controlled for covariates including study site, age, education, MCI/AD diagnosis and body mass index (BMI). Women taking conjugated estrogen had significantly greater volumes in distributed brain regions including the frontal and temporal lobes. This evaluation of HT and neuroimaging is one of the largest voxel-based studies of a human population. Premarin use was associated with greater regional brain volumes independent of co-morbid MCI/AD status and BMI. Conjugated estrogen may help preserve brain tissue, as reflected on MRI.

### E77

### MEDIAL TEMPORAL LOBE MATURATION IS RELATED TO THE DEVELOPMENT OF VERBAL MEMORY

Qijing Yu[1], Dana Anderson[1], Mayu Nishimura[1], Noa Ofen[1]; [1]Wayne State University — Human ability to memorize and recall information improves dramatically from childhood to adulthood. The correspondence between memory development and brain maturation, however, is not well understood. In this study we measured memory functioning using the California Verbal Learning Test (CVLT-C) in 81 participants, aged 8-25 years (M=16.25, SD=5.00). Memory functioning was assessed by recall (number of correctly recalled words) and semantic mnemonic strategy use (number of semantic clusters during recall). Structural brain development was assessed by measures of hippocampal (HC) volume and cortical thickness in the parahippocampal gyrus (PHG) and prefrontal cortex (PFC). Older participants recalled more words and used more semantic clustering (ps<=.001). HC volume was not associated with age or recall but differentially related to semantic clustering use across age

(F(1,71)=4.90, p=.009); smaller HC was associated with more strategy use only in older participants. PHG cortical thickness was not associated with age but differentially related to recall across age (F(1,74)=6.35, p=.008); thinner PHG in younger participants, but thicker PHG in older participants was associated with better recall. PHG cortical thickness also showed differential relation with semantic clustering use across age (F(1,71)=7.19, p=.022); thicker PHG was related to more strategy use only in older participants. PFC thickness was associated with age but not with recall and it was marginally differentially associated with semantic clustering use across age (F(1,71)=3.25, p<.10); thicker PFC was related to more strategy use only in older participants. Overall, these findings suggest that variability in structural maturation differentially account for variability in memory performance across development.

## E78

### PREDICTING COGNITIVE DECLINE IN THE ELDERLY FROM 500+ HETEROGENEOUS BIOMARKERS USING MACHINE LEARNING

Sarah K. Madsen[1], Greg Ver Steeg[2], Adam Mezher[1], Neda Neda Jahanshad[1], Talia N. Nir[1], Xue Hua[1], Boris A. Gutman[1], Aram Galstyan[2], Paul M. Thompson[1]; [1]Imaging Genetics Center, USC, Los Angeles, CA, USA, [2]USC Information Sciences Institute, Marina Del Rey, CA — Identifying biomarkers for cognitive decline is a major goal of Alzheimer's disease (AD) research. We used a novel data-driven machine learning approach to rank an extensive list (500+) of blood biomarkers for predicting cognitive decline in 1688 older adults from the Alzheimer's Disease Neuroimaging Initiative (ADNI). Laboratory data included 195 blood tests related to cardiovascular health, oxidative stress, liver function, inflammation and immunology, hormones, growth factors, nutrition, metabolism and diabetes, cancer risk, and amyloid and tau levels. AD risk genotypes and cerebrospinal fluid tests for amyloid and tau levels were also included. MRI biomarkers included regional summary measures of white matter tract integrity, cortical and subcortical gray matter, and measure of longitudinal brain change. Cognitive decline was defined by longitudinal change in Mini-Mental State Exam score over one and two-year intervals. We applied the novel unsupervised machine learning method CorEx to discover latent factors and a hierarchical structure that best explain correlations among clusters of biomarkers. We ranked the predictive power of factors using decision tree regression (in terms of mean squared error). APOE4 was the most predictive individual biomarker and a cluster including temporal gray matter measurements was the most predictive cluster of biomarkers for cognitive decline. Canonical genetic and neuroanatomical biomarkers may outperform other biomarkers in predicting age-related cognitive decline. Prediction was improved by combining multiple brain MRI biomarkers, compared to using any one MRI biomarker alone. This novel method has broad applications for assessing and ranking large numbers of potential biomarkers for various cognitive processes.

## E79

### EXAMINING THE RELATIONSHIP BETWEEN PHYSICAL FITNESS AND COGNITIVE FUNCTIONS IN OLDER ADULTS

Hanna Fang[1], Ilana B. Clark[1], Jennifer J. Heisz[1]; [1]McMaster University — Alzheimer's disease is the most common form of dementia, causing progressive neural decline leading to the deterioration of memory and the loss of functional independence. There is currently no cure for Alzheimer's disease and thus, it is paramount to identify protective mechanisms that may prevent or delay the onset of the disease. Physical activity may help to preserve aspects of cognitive function that decline with age and reduce the risk of Alzheimer's disease; however, physical fitness has been found to benefit only certain aspects of cognition such as executive functions and processing speed, while the link between physical fitness and memory remains unclear. The purpose of the study was to determine the relationship between physical fitness and memory by examining both subjective and objective memory. Higher physical fitness was associated with better subjective memory, better executive functions, and faster processing speed but was not related to objective memory. Interestingly, subjective memory was not related to objective memory indicating poor meta-memory awareness. However, subjective memory was associated with executive functions and when controlling for executive functions the relationship between physical fitness and subjective memory was eliminated. Taken together the results suggest that physical activity may not directly support memory to reduce the risk of Alzheimer's disease. Instead, physical fitness may reduce the risk of Alzheimer's disease by improving other aspects of cognition, which may compensate for memory loss and artificially increase older adults' beliefs about their memory ability.

## E80

### SPECTRAL GRAPH THEORY SHOWS BRAIN NETWORK DISCONNECTION IN APOE-4 RISK GENE CARRIERS

Madelaine Daianu[1], Derrek Hibar[1], Neda Jahanshad[1], Talia Nir[1], Adam Mezher[1], Clifford Jack[2], Michael Weiner[3], Matthew Bernstein[2], Paul Thompson[1]; [1]Imaging Genetics Center, Keck School of Medicine, University of Southern California, Marina del Rey, CA, USA, [2]Department of Radiology, Mayo Clinic, Rochester, Minnesota, USA, [3]Department of Radiology, Medicine, and Psychiatry, University of California San Francisco, CA, USA — Diffusion weighted imaging (DWI) can detect subtle changes in white matter integrity in the nervous system and was used here to study 42 Alzheimer's disease (AD) participants scanned at 3-Tesla (41 diffusion weighted and 5 b0 images) as part of the Alzheimer's Disease Neuroimaging Initiative (ADNI). Using whole brain tractography, we reconstructed structural connectivity networks describing fiber density between 68 distinct cortical regions and tested their relationship to the apolipoprotein E epsilon 4 allele (APOE-4) – a well know genetic risk factor for late-onset AD. We assessed – the first time in this context, the spectrum of the brain network, which is a topic of study in a branch of mathematics known as spectral graph theory or algebraic connectivity. The spectrum of a graph was obtained from the Laplacian matrix computed on the brain network. We assessed the association between the zero eigenvalues of the Laplacian matrix, which reflect disconnections in the network, and the APOE-4 risk factor using a linear regression with age and gender as covariates. We found that the number of disconnected components increased with the number of copies of the APOE-4 allele in people with AD (FDR p-value=0.04). Disconnections were detected in the entorhinal, frontal and temporal poles bilaterally, regions that typically show AD pathology. Each additional copy of the APOE-4 risk gene may weaken connections in the brain network, providing evidence for the previously hypothesized 'disconnection syndrome' that may lead to cognitive decline in AD.

## E81

### DISSOCIABLE CONTRIBUTIONS OF REPRESENTATIONAL SPECIFICITY AND RETRIEVAL PROCESSES TO AGE-RELATED DECLINES IN RECOGNITION MEMORY

Alexandra Trelle[1], Richard Henson[2], Jon Simons[1]; [1]University of Cambridge, [2]MRC Cognition and Brain Sciences Unit — Memory decline for the specific details of previous events is characteristic of cognitive aging. Recent evidence suggests that the mechanisms underlying this deficit may vary among sub-groups of the elderly population, and may include impoverished stimulus representations, impaired retrieval processes, or a combination. The present study investigated this question by comparing performance of younger adults (18-30 yrs), young-older adults (60-70 yrs), and old-older adults (71-80 yrs) on an object recognition memory test. Participants were asked to discriminate between studied objects and similar lures that shared either a high or low degree of perceptual overlap. Recognition was tested using both old/new (ON) and forced choice (FC) formats, thereby varying demands on representational specificity and controlled retrieval processes in a factorial design. We found that younger adults exhibited reliance on retrieval support for high similarity discriminations only, whereas young-older adults benefited from retrieval support for both low and high similarity discriminations, suggesting greater dependence on the reinstatement of stimulus details at retrieval. In contrast, old-older adults displayed a benefit of retrieval support for low but not high similarity discriminations, suggesting that the reinstatement of stimulus details was insufficient to support memory at a high level of specificity, perhaps due to a reduction in the complexity of stimulus representations. These results suggest that both factors of representational quality and retrieval control contribute to memory deficits in old age, but differentially even among healthy older adults, highlighting the importance of considering the heterogeneity of the elderly population in studies of cognitive aging.

### E82

**DEVELOPMENTAL DIFFERENCES IN RELATIONS BETWEEN EPISODIC MEMORY AND HIPPOCAMPAL SUBREGION VOLUME DURING EARLY TO MIDDLE CHILDHOOD** Elizabeth Mulligan[1], Sarah L Blankenship[1], Katherine Leppert[1], Stephanie Merwin[1], Lea Dougherty[1], Tracy Riggins[1]; [1]University of Maryland College Park — The hippocampus is shown to be fundamental for episodic memory ability in school-aged children and adults. Previous research suggests that age-related differences in episodic memory are related to developmental differences in hippocampal structure along the longitudinal axis (anterior to posterior) during middle childhood (DeMaster et al., 2013). However, relatively little is known about the how the development of hippocampal subregions contributes to episodic memory performance earlier in life, when improvements in memory are quite rapid. In the present study, we collected volumes of the hippocampal head, body, and tail, and episodic memory measures in children ages 5-10 years (mean = 7.22 years, SD=.85, n=57, 30 females, oversampled for offspring of parents with a depression history). Because prior research suggests associations between hippocampal subregion volumes and memory vary according to age, we grouped children into younger (5-7.11 years, n=28) and older (7.11-10 years, n=29) age groups using a median split and examined associations in hippocampal subregion volumes and episodic memory performance in each group separately. In younger children, negative correlations were observed between episodic memory performance and bilateral hippocampal body and tail. In older children, a positive correlation was observed between episodic memory performance and right hippocampal body. These results suggest age-related improvements early in life may be attributed to the development of specific hippocampal subregions. Future analyses on the larger sample will examine the role of experience, particularly exposure to parental depression and familial liability for major depressive disorder, on relations between memory and hippocampal subregion volume across development.

### E83

**INVESTIGATING THE IMPACT OF A FAMILY HISTORY OF ALZHEIMER'S DISEASE ON NEURAL CORRELATES OF EPISODIC MEMORY AT MIDLIFE** Lindsay Wallace[1,3], Elizabeth Ankudowich[1,3], Alexander Swierkot[2,3], Stamatoula Pasvanis[3], Diana Kwon[1,3], David Maillet[4], M Natasha Rajah[2,3]; [1]Integrated Program in Neuroscience, McGill University, Montreal, Canada, [2]Department of Psychiatry, McGill University, Montreal, Canada, [3]Brain Imaging Centre, Douglas Mental Health University Institute, Montreal, Canada, [4]Harvard University, Boston, USA — Episodic memory impairment is a consistent, pronounced deficit reported in pre-clinical stages of sporadic Alzheimer's Disease (AD). Changes in the neural correlates of episodic memory are present at midlife, decades before the onset of AD. Context memory tasks are sensitive to memory decline at midlife and may facilitate exploration of brain changes associated with AD risk factors, such as family history, in middle-aged adults. Objective: Investigate the effects of age and AD risk (family history of AD) on the neural correlates of episodic memory retrieval. Methods: Middle-aged participants with no family history of AD (MA-FH; n=29), and those with a family history of AD (MA+FH; n=23) performed a context memory task while undergoing fMRI. Results: There were no significant performance differences between MA-FH and MA+FH across all contextual memory tasks. A behavioural partial least squares analysis adjusted for age identified two significant latent variables. The first was driven by the MA-FH group and identified increased activity in prefrontal cortex (PFC) and medial temporal lobe (MTL) regions were positively correlated with retrieval accuracy and negatively correlated with age in this group. The second was driven by the MA+FH group, this latent variable indicated increased activity in PFC and MTL regions were positively correlated with age in the MA+FH. These findings suggest that age-related changes differ across middle aged adults as a function of whether they have a family history of AD, a prominent AD risk factor.

### E84

**EXAMINING CHANGES IN CORTICAL THICKNESS AND CONTEXT MEMORY AT MIDLIFE** Alexander Swierkot[1,2], Mallar Chakravarty[1,2], Raihaan Patel[2], Elizabeth Ankudowich[1,2], Lindsay Wallace[1,2], Stamatoula Pasvanis[2], Maria Natasha Rajah[1,2]; [1]McGill University, [2]Douglas Mental Health University Institute, Montreal, Canada — Episodic memory is the ability to remember an item in rich contextual detail. Recent studies indicate that as early as midlife, adults start to exhibit declines in episodic memory as measured by tasks requiring the recollection of spatial and/or temporal context (context memory tasks). However, it remains unclear what neural changes underlie these early signs of memory deficits at midlife. In the current study we aimed to examine if regional cortical thickness changes were associated with context memory decline at midlife. Thirty-six young adults, aged 20-35 years, and 52 middle-aged adults, aged 40-58 years, participated in spatial and temporal context memory tasks for faces. Between groups repeated measures ANOVA found that young significantly outperformed middle-aged adults as measured by accuracy. All participants underwent a structural MRI scan and a fully automated pipeline (CIVET) was used to measure cortical thickness across the whole brain (Y. Ad-Dab'bagh et al., 2006). A general linear model, accounting for gender, age, accuracy and age by accuracy interaction terms, found that cortical thinning in left ventrolateral prefrontal cortex (VLPFC) is significantly related to age, and that a positive relationship between task accuracy and left VLPC thickness was increasingly more important with age. These results suggest that cortical thinning in the left VLPFC may be an initial neurological change that may be implicated in the onset of episodic memory deficits as measured by context memory tasks.

## LONG-TERM MEMORY: Episodic

### E85

**DOMINANT EPISODE ELEMENTS ORGANIZE RELATIONAL BINDING TO SHAPE COHESIVE MEMORY REPRESENTATIONS** Donna J. Bridge[1], Joel L. Voss[1]; [1]Northwestern University Feinberg School of Medicine — Of the many elements that comprise an episode, are any particularly important for coherent memory binding? We hypothesized that some dominant elements are disproportionately bound with less-dominant elements, and therefore organize memory binding. We tested this hypothesis using a multi-element episodic memory task. Subjects (N=31) studied three objects at specific locations. One object location was retrieved after a brief delay, which we hypothesized would increase dominance of that object. Memory was later tested for the other, less-dominant objects. When high-dominance objects served as reminder cues, retrieval of less-dominant objects was significantly more accurate than when less-dominant objects were reminder cues. Binding of all objects therefore was strongest to the high-dominance object. Further, dominance was associated with rapid viewing of high-dominance objects followed by subsequent viewing of less-dominant objects. A control condition involving passive manipulation of objects rather than active retrieval established the specificity of these dominance effects on eye movements and behavior. Active retrieval therefore selectively increases dominance of specific episode elements and thereby organizes episodic memory. Previously, we showed that active high-dominant cues yielded ERP correlates of recollective processing and that these neural signals were modulated by dominance-related eye-movements during encoding. Here, we examined fMRI correlates of these dominance-specific effects to test the hypothesis that the hippocampus is uniquely involved in the selection of dominant elements available for binding with other less-dominant event elements. In sum, binding is not equipotent, but rather dominant elements have disproportionately strong binding and therefore serve as effective retrieval cues for coherent episodes.

### E86

**MEMORY AS DECISION-MAKING: THE SUCCESSFUL RETRIEVAL EFFECT TELLS US ALMOST NOTHING ABOUT MEMORY ACCURACY** Tyler Santander[1], Brian A. Lopez[2], Misty Schubert[2], Craig Bennett[2], Michael B. Miller[2]; [1]University of Virginia, [2]University of California, Santa Barbara — The successful retrieval effect—the differential neural response when correctly identifying old versus new items—is a highly robust and reliable finding in the neuroimaging literature, emerging across memory studies

with considerably different experimental paradigms. This contrast is of massive theoretical importance because it is thought to indicate the mental representation (i.e. the ecphory) of the decision evidence. In this study, we attempted to determine the extent to which successful retrieval-related brain activity is indicative of actual memory accuracy versus one's monitoring of the retrieval evidence; recognition behavior and associated brain activity were thus examined during an fMRI task involving criterion shifting. The degree of shifting between a liberal and conservative criterion in High- and Low-target-probability conditions was variable across participants, but memory accuracy (d-prime) was equitable across conditions. While whole-brain, mass-univariate analyses yielded typical frontoparietal activations that are a hallmark of successful episodic retrieval, subsequent ROI analyses across 6 frontoparietal regions demonstrated consistent modulation of activity by criterion placement only. We therefore employed a sparse Bayesian learning technique, relevance vector regression (RVR), in an effort to decode inter-individual variability in d-prime and criterion from whole-brain, multivariate patterns of Hit > CR activity. Although RVR failed to decode individual differences in d-prime across conditions, it spectacularly approximated both liberal criterion placement and conservative criterion placement. Taken together, these results imply that the activations we typically understand as "the successful retrieval effect" may tell us little about memory accuracy itself—rather, they may only indicate the extent to which one is monitoring memory evidence.

## E87

### NEURAL EVIDENCE FOR THE ROLE OF ATTENTION IN ENCODING PRECISE MEMORIES

Stephanie A. Gagnon[1], Rosanna K. Olsen[2,1], Jonathan H. Drucker[3,1], Nicolas Davidenko[4,1], Anthony D. Wagner[1]; [1]Stanford University, [2]Rotman Research Institute, [3]Emory University, [4]University of California, Santa Cruz — The ability to detect subtle differences between an experienced stimulus and a highly similar, but novel test probe partially rests on having encoded a precise representation of the stimulus. Top-down attention is likely a critical component of precise stimulus encoding, and thus may be central to protecting against similarity-based memory errors. The present fMRI experiment examined how trial to trial variations in attention at encoding can enable future accurate recognition of studied items (i.e., precise memory) relative to false recognition of similar lures (i.e., general memory) by parametrically modulating the perceptual similarity between study items and retrieval cues. This manipulation provided a controlled measure of study-test similarity that allowed us to probe the neural correlates of attention during precise vs. general encoding, and across levels of study-test similarity at retrieval. At encoding, subjects viewed abstract objects while performing a size judgment task; each object was studied three times. At retrieval, subjects viewed objects that were either identical, perceptually near to, or perceptually far from the studied object, and indicated if each object was old or new using a 1-5 confidence rating. During encoding, neural activation in regions implicated in top-down visual attention (superior parietal lobule, medial intraparietal sulcus) and object representation (lateral occipital cortex) decreased with study repetitions. Critically, these regions were more active during the successful formation of precise vs. general memories. These findings suggest that increased visual attention during encoding supports the ability to subsequently perform fine-tuned mnemonic discriminations between studied items and similar lures.

## E88

### RESIDUAL EFFECTS OF PICTORIAL CONTEXT ON MEMORY: AN ERP STUDY

Holly J. Bowen[1], Elizabeth A. Kensinger[1]; [1]Boston College — Many studies have examined the ERPs elicited by episodic memory however less is known about the ERPs associated with emotional memory, particularly for neutral memoranda previously encoded in an emotional context. In the current experiment participants studied neutral nouns simultaneously with a positive, negative or neutral image. After a brief retention interval participants completed a remember, know, guessing or new judgment to old and new nouns. Importantly, the emotional context previously paired with words at encoding was not re-presented at retrieval. Old-new effects were strongest in fronto-central and central-parietal regions between 600 and 800 ms post stimulus onset. When examining effects of previous emotional context within these electrodes and time period, ERPs elicited by correctly recognized words learned in a negative or positive context became more positive-going, particularly in the left fronto-central electrodes. ERPs elicited by hits previously associated with a neutral context do not show this same pattern. The results suggest that even when retrieval cues are neutral, there are residual effects of valence that influence retrieval and ERPs.

## E89

### ELECTRICAL STIMULATION OF DORSOLATERAL PREFRONTAL CORTEX AT RETRIEVAL INCREASES EPISODIC RECOLLECTION ACCURACY

Stephen Gray[1], Geoffrey Brookshire[1], Daniel Casasanto[1], David Gallo[1]; [1]The University of Chicago — Neuroimaging studies show dorsolateral prefrontal cortex (dlPFC) is activated during recollection. Here, we used transcranial direct current stimulation (tDCS) to test whether dlPFC is causally involved in recollection by administering anodal tDCS to left or right dlPFC just prior to recollection tests. In all conditions, participants first studied a list of words, with some words associated with a red font, some words associated with a corresponding picture of the object, and some words associated with both formats. Following this study phase, participants in the electrical stimulation conditions received tDCS to either left or right dlPFC, whereas participants in the no-stimulation control conditions received a sham (placebo) procedure. All participants then took a series of criterial recollection tests, whereby words were presented as retrieval cues and participants needed to recollect the associated study format (e.g., "Was this item studied in red font?" on the Font Test, or "Was this item studied with a picture?" on the Picture Test). Replicating behavioral work, recollection accuracy was greater when tested for pictures than font color, demonstrating a distinctiveness effect on recollection accuracy. Critically, stimulation of dlPFC significantly boosted recollection accuracy for font color relative to sham, but did not affect picture recollection. The overall effect of stimulation laterality was not significant. Thus, stimulation boosted recollection accuracy when the to-be-remembered information was relatively nondistinctive and hence difficult to retrieve. These brain stimulation results extend previous fMRI results with this task, providing some of the first evidence that dlPFC plays a causal role in episodic recollection.

## E90

### THE RELATION BETWEEN SPATIAL AND AUTOBIOGRAPHICAL MEMORY IN PEOPLE WITH MEDIAL OR POSTERIOR TEMPORAL LOBE DAMAGE

Jessica Robin[1,2], Josée Rivest[3,4], R. Shayna Rosenbaum[2,5], Morris Moscovitch[1,2,3]; [1]University of Toronto, [2]Rotman Research Institute, Baycrest Hospital, [3]Psychology Department, Baycrest Hospital, [4]Glendon College, York University, [5]York University — The hippocampus has long been associated with both spatial (O'Keefe & Nadel, 1978) and episodic (Scoville & Milner, 1957) memory. Some theorize that it is necessary for the spatial (O'Keefe & Nadel, 1978), or relational (Eichenbaum & Cohen, 2014) aspects of memory representations, while others state that it is not necessary once the memories become remote (i.e. very old; Zola-Morgan & Squire, 1990). We studied the retrieval of spatial and autobiographical (i.e. personal, episodic) memory based on remotely known real-world locations in individuals with global amnesia relating to medial temporal lobe (MTL) damage, including the hippocampus. The MTL group's performance was compared to that of an individual whose memory was relatively preserved but had topographical disorientation resulting in an inability to navigate in both new and familiar places, relating to more posterior ventral temporal lobe damage. Compared to controls, all were impaired in memory for detailed representations of remote spatial scenes and autobiographical episodes. However, individuals with MTL damage performed more poorly on the autobiographical task than the individual with ventral temporal lobe damage. No one was impaired at a task requiring comparison of coarse spatial relations between remotely known locations when named verbally, indicating that remote, schematic spatial memories are spared following hippocampal and posterior temporal damage. Together, the results suggest that structures, such as the hippocampus, and possibly the posterior temporal cortex, support detail-rich spatial representations and are also needed for detailed autobiographical memory (Winocur & Moscovitch, 2011).

## E91

### TMS OVER THE FRONTAL EYE FIELD AFFECTS MEMORY RECALL

Andrea L Wantz[1,2], Corinna S Martarelli[1,2], Dario Cazzoli[3], Roger Kalla[4], René Müri[2,4], Fred W Mast[1,2]; [1]Department of Psychology, University of Bern, [2]Center for Cognition, Learning and Memory, University of Bern, [3]ARTORG Center for Biomedical Engineering Research, University of Bern, [4]Department of Neurology, University Hospital Bern — Scene memory consists of objects and spatial information about their location. Recently, it has been demonstrated that eye movements are especially important for the retrieval of location compared to object information (Johansson & Johansson, 2014). Spatial memory performance declined when participants' gaze during recall was restricted to an area that was incongruent to the area where the stimuli were encoded. It has been concluded that eye movements are functionally involved in memory recall. However, it remains open whether the results are caused by a spatial mismatch during encoding and recall or whether oculomotor mechanisms underlie the change in performance. The right frontal eye field (FEF) is a key structure in the cortical representation of the oculomotor system. Thus, in order to manipulate the activity of this key oculomotor area directly, we used a temporary interference approach by means of inhibitory transcranial magnetic stimulation (TMS) over the right FEF and studied its influence on short- and long-term recall of object and location information in a scene context. Participants encoded a complex scene and performed a retrieval task either immediately after encoding or after 24h (between-design). Before recall was tested, half of the sample received TMS over the right FEF, the other half received sham stimulation. Preliminary analyses (n = 49) suggest that oculomotor mechanisms are functionally involved in long-term memory recall, especially for object information.

## E92

### COMMON AND DISTINCT NEURAL NETWORKS UNDERLYING VOLUNTARY AND INVOLUNTARY EPISODIC MEMORY RETRIEVAL

Shana Hall[1], Dawei Li[1], Banafsheh Sharif-Askary[2], Phillip Kragel[1], Minkung Hong[1], Katherine Zhu[1], Roberto Cabeza[1], David Rubin[1], Dorthe Berntsen[3]; [1]Duke University, [2]National Institute of Health, [3]Aarhus University — Involuntary memories, memories that occur without the intent to retrieve, commonly occur in all individuals and play an important role in mental disorders such as post-traumatic stress disorder. Both voluntary and involuntary memories are associated with activity in the default mode network (DMN), specifically parahippocampal gyrus, inferior parietal cortex, precuneus, and posterior midline regions. Voluntary memories show greater activity than involuntary memories in left dorsolateral prefrontal cortex (DLPFC), a region associated with retrieval effort. In the current study in which we analyzed fMRI activity during involuntary and voluntary memory retrieval, we predicted that regions showing similar activity across memory type would also show similar profiles of connectivity and that voluntary memories alone would elicit increased connectivity between the left DLPFC and DMN regions. We used independent component analysis to determine similarities and differences in functional connectivity between voluntary and involuntary retrieval. We found a component common to both memory types that included the regions from the DMN. Also included in this component were regions within lateral and medial prefrontal cortex. We also found a component related only to voluntary memories that included left DLPFC, as well as the DMN regions. The overlap between the two components included DMN regions and lateral PFC. However, the overlap within lateral PFC did not contain the left DLPFC region previously associated with voluntary memory retrieval. This indicates that there is a common network engaged during voluntary and involuntary memories and there is a separate network associated with voluntary memories that includes DLPFC.

## E93

### RESTING STATE FUNCTIONAL CONNECTIVITY OF THE PRECUNEUS AND HIPPOCAMPUS IS DIFFERENTIALLY RELATED TO MENTAL ROTATION AND EPISODIC MEMORY PERFORMANCE IN MEN AND WOMEN

Eva Stening[1], Jonas Persson[1], Hedvig Söderlund[1]; [1]Uppsala University, Sweden — Earlier research has identified associations between resting state functional connectivity (rsFC) and cognitive performance. Some cognitive functions, such as mental rotation and episodic memory, show consistent sex differences. The precuneus is an important structure for visual imagery, and whereas mental rotation typically activates the precuneus, episodic memory often co-activates the hippocampus and the precuneus. The aim of the present study was to assess whether the way the rsFC of these regions relates to mental rotation and episodic memory performance differs between men and women. We found indeed different patterns for men and women in how rsFC within and between these two regions related to mental rotation and episodic memory performance. Intraregional precuneal rsFC was related to mental rotation performance in men only, while intraregional hippocampal rsFC was related to episodic memory performance in women only. Interregional rsFC between the hippocampus and precuneus was related to performance in both tasks in men, but not in women. Our findings demonstrate a sex difference in how rsFC between the precuneus and hippocampus relates to performance. The fact that precuneal-hippocampal rsFC relates to both spatial and episodic performance in men but not in women could indicate that men benefit from an intrinsic hippocampus-precuneus circuit when processing episodic memory and that their episodic memory is possibly more spatial in nature. Taken together, these findings also show that sex differences in rsFC mirrors, and can perhaps help explain, sex differences in cognitive performance.

## E94

### PATTERN SEPARATION IN ANXIETY DISORDERS

Daniel Bjornn[1], Brigham Wright[1], Shawn Gale[1], Brock Kirwan[1]; [1]Brigham Young University — Individuals with an anxiety disorder suffer from persistent worry that can cause significant impairment in everyday life. These worries may come about because of overgeneralization, which several theorists propose may be due to deficits in pattern separation. Pattern separation is the computational process of orthogonalizing potentially overlapping stimuli to avoid interference in storing and retrieving memory representations. In order to test the hypothesis that pattern separation deficits underlie anxiety disorders, we collected data using a recognition memory task with high pattern separation demands. Data were analyzed from 58 individuals (27 anxiety, 31 control). Previous diagnoses of anxiety disorders were confirmed using the Mini International Neuropsychiatric Interview. Individuals were presented pictures of every-day objects one at a time on a computer screen and were asked to indicate whether the image was repeated, similar to one they had seen before, or new to the study. Anxiety symptom ratings confirmed group assignments. No significant difference was found between groups on mnemonic specificity performance, suggesting that anxiety is not characterized by pervasive pattern separation deficits. The present study examined anxiety disorders as a whole. Further research may help to determine whether specific anxiety disorders (such as post-traumatic stress disorder) show deficits in this process. The use of emotionally salient stimuli may also shed further light on the subject since the present task used images of everyday objects.

## E95

### CONSERVATIVE RESPONSE BIAS AND THE SUCCESSFUL MEMORY EFFECT IN RECOGNITION: AN EEG INVESTIGATION

Misty Schubert[1], Justin Kantner[2], Jean Vettel[3,1], Benjamin Turner[1], Thomas Bullock[1], Jeanne Li[1], James Elliot[1], Barry Giesbrecht[1], Michael Miller[1]; [1]University of California, Santa Barbara, [2]Washington University in St. Louis, [3]U.S. Army Research Lab — The successful retrieval effect in recognition memory refers to an increased neural response to items correctly called "old" relative to items correctly called "new." fMRI studies implicate regions of lateral prefrontal and parietal cortex in successful retrieval, but recent work suggests that these regions are also active when participants set a conservative decision criterion, requiring a greater amount of memory evidence before test items are called "old". If a strict criterion drives brain activity rather than successful retrieval, a "successful retrieval effect" should be observed even when available memory evidence is completely non-diagnostic of old-new status, as long as participants maintain a conservative criterion. We tested this prediction in an EEG study, measuring the mid-frontal old/new (FN400) effect, an ERP component of successful recognition (hits > CRs) that is increased under conservative criterion conditions and is typically observed in experiments with medium-to-high levels of d'. In our paradigm, old-new discrimination (d') was close to chance and response criterion was manipulated by instruction. Contrary to our hypothesis, we obtained the FN400 in neither the conservative nor the liberal response conditions. In a subse-

quent experiment, we manipulated d' within-subjects and found a successful retrieval effect when d' was modestly above chance (M = .67) but not when d' was near chance (M = .09). These results indicate that although the neural correlates of successful memory and response conservatism overlap substantially, at least some amount of diagnostic memory evidence is required before an ERP successful memory effect will be observed.

### E96

### MULTI-VOXEL PATTERN SIMILARITY PREDICTS GIST-BASED FALSE RECOGNITION IN A DRM PARADIGM

Lucas Jenkins[1], Hannula Deborah[1]; [1]University of Wisconsin - Milwaukee — When participants in a typical Deese-Roediger-McDermott (DRM) experiment are asked to study lists of semantically related words (e.g., bed, dream, nap, pillow, snooze), they show a strong tendency to falsely recognize semantically related lures (e.g., sleep). Indeed, the false alarm rate for related lures is often equal to or greater than the hit rate for words that were actually studied. One explanation for this false memory effect is that participants encode an abstract representation of the similarities among list words – a gist representation – during study. Related lures are incorrectly endorsed as "old" at test, it is argued, because they are consistent with the encoded gist representation. Here, we use fMRI multivariate statistical analyses to determine whether similarities among the activation patterns associated with semantically related words during encoding predict false recognition of semantically related lures. Participants were scanned while encoding lists of words containing five groups of five semantically related words presented in random order. During a subsequent test, participants were presented with studied words and unstudied lures that were semantically related to one of the previously studied word groups. We predicted that regions supporting gist-based false recognition would exhibit greater pattern similarity among words related to falsely recognized lures than among words related to correctly rejected lures. Preliminary data finds evidence for this pattern of results in anterior and medial temporal regions.

## LONG-TERM MEMORY: Other

### E97

### MEMORY COMPRESSION AND MENTAL SPACE TRAVEL: COMPRESSION VARIES WITH ROUTE LENGTH

Kyra McKelvey[1,2], Joseph Blommesteyn[1], Morris Moscovitch[1,2]; [1]University of Toronto, Toronto, Canada, [2]Rotman Research Institute at Baycrest Hospital, Toronto, Canada — In rodents, the compressed replay of hippocampal firing patterns has been suggested to underlie consolidation and recall of spatial memories. Since the hippocampus is also thought to support spatial memory in humans, our goal was to investigate such compression and replay of spatial information in people. In this study we asked participants to use their imaginations to navigate well-known routes around the University of Toronto campus, while we recorded how long it took to mentally travel each route. Afterwards, participants rated their familiarity with the routes, as well as the level of detail they recalled, and their 'presence' during mental navigation. We found that the compression of routes in memory (a factor found by dividing the actual time it would take to walk each route over the time it took each participant to mentally navigate the route), was strongly correlated with route length, but unaffected by familiarity, detail, or presence. This correlation between route length and a behavioural measure of compression corresponds well to results in the rodent literature that find a correlation between route length and neural compression. We propose that such compression of information also occurs for episodic event memory. More generally, compression may be critical for memory consolidation through spike-dependent plasticity, as well as the organization of information in memory. Thus, compression may support not only efficient navigation, but also recollection, planning, imagination, and problem solving.

### E98

### HIGH CONFLICT DURING A NOVEL APPROACH-AVOIDANCE TASK IS ASSOCIATED WITH INCREASED HUMAN HIPPOCAMPAL ACTIVITY.

Edward B O'Neil[1], Iris H Li[1], Rachel N Newsome[1], Sathesan Thavabalasingam[1], Rutsuko Ito[1], Andy C H Lee[1,2]; [1]University of Toronto, [2]Rotman Research Institute — Recent theories suggest that the anterior hippocampus resolves approach-avoidance conflict. Extant data in support of this view are limited, however, and past findings are confounded by mnemonic or spatial factors known to impact hippocampal processing. To address this, we used functional magnetic resonance imaging (fMRI) to investigate hippocampal involvement during a novel approach-avoidance paradigm. Participants repeatedly viewed a set of scene-face pairs during a pre-scanning contingency acquisition phase. Following each presentation, participants indicated an approach or avoid response and a running score was displayed, increasing when 'positive'-designated pairs were approached, or decreasing when 'negative'-designated pairs were approached. Scores remained unchanged if the alternate response was selected. During scanning, previously shown items were presented in novel pairings without feedback. Critically, some pairings were comprised of items from both positive and negative trials (mixed pairs) leading to high conflict. Behavioral performance indicated that this manipulation was effective: participants approached 'positive' and avoided 'negative' pairings at test, and responses to ambiguous mixed pairs reflected conflict in terms of longer reaction times and a tendency to respond in a varied manner. Data-driven analysis of the fMRI data using multivariate partial least squares revealed a reliable pattern of brain activity that differentiated high and low conflict conditions. Greater involvement of a number of regions was observed during high as compared to low conflict pairings, including the anterior hippocampus, amygdala, and caudate. Our findings indicate that the human anterior hippocampus contributes to approach-avoidance conflict resolution even when mnemonic and spatial demands are controlled.

### E99

### INDIVIDUAL DIFFERENCES IN RECOGNITION MEMORY: RELATING THEORY, BEHAVIOR, AND NEURAL MEASURES

Benjamin O. Turner[1], Elizabeth N. Davison[2], Kimberly J. Schlesinger[1], Mary-Ellen Lynall[3], Scott T. Grafton[1], Jean M. Carlson[1], Danielle S. Bassett[4], Michael B. Miller[1]; [1]University of California, Santa Barbara, [2]Princeton University, [3]University of Oxford, [4]University of Pennsylvania — It has previously been established that the degree to which people are able to adaptively shift their criterion in recognition memory experiments—for instance, to adopt a liberal or conservative response bias based on task demands—varies widely across individuals. Moreover, this variability can be partially explained on the basis of a number of individual difference factors, including demographics, state of mind, cognitive style, and even personality (Aminoff et al., 2012). Our focus here is twofold: first, we present additional analyses of these data (which were collected during an fMRI experiment), demonstrating that differences in patterns of neural activity can likewise be explained by individual difference factors (see, e.g., Miller et al., 2012); and critically for recognition memory researchers, these differences relate to constructs such as d' in theoretically relevant ways. Second, in addition to standard GLM-derived SPMs of task-related activity, we examined several graph-theoretic properties of these data, including a dynamic measure based on analyzing the hypergraph structure of task functional connectivity. Our results demonstrate that there is information in these measures above and beyond more traditional graph-theoretic or GLM-based metrics: that is, individual differences along all of these dimensions—hypergraph measures, more traditional functional connectivity measures, GLM results, and behavioral and personality factors—all carry unique information, and all can inform our understanding of the mechanisms underlying recognition memory performance. In particular, any attempt to relate brain regions to cognitive processes must consider the broader individual context. This research was supported by the Institute for Collaborative Biotechnologies under grant W911NF-09-D-0001.

### E100

### DIFFERENTIAL NEURAL NETWORK CONFIGURATION DURING VISUAL PATH INTEGRATION IN HUMANS

Aiden Arnold[1,2,3], Ford Burles[1,2], Signe Bray[1], Richard M Levy[1], Giuseppe Iaria[1,2]; [1]University of Calgary, [2]Hotchkiss Brain Institute, [3]University of California, Davis — Path integration is a fundamental skill for navigation in both humans and animals. Despite recent advances in unraveling the neural basis of path integration in animals, little is known about how it operates at a neural level in humans. Previous attempts to characterize the neural mechanisms used by humans to visually path integrate suggest a central role of the hippocampus, broadly resembling results from animal data. However, in recent years both the

central role of the hippocampus and the perspective that animals and humans share similar neural mechanisms for path integration has come into question. This study used a data driven partial least squares analysis to investigate the neural systems engaged during visual path integration in humans. Our results suggest that humans employ common task control, attention and spatial working memory systems distributed across a fronto-parietal network during path integration. However, individuals differed in how these systems configured into functional networks. High performing individuals more broadly expressed spatial working memory systems in prefrontal cortex, while low performing individuals engaged an allocentric memory system in medial occipito-temporal regions. These findings suggest that visual path integration in humans can operate through a spatial working memory system engaging primarily the prefrontal cortex and that the differential configuration of memory systems coupled with task control networks may help explain individual biases in spatial memory. Additionally, our results show that visual path integration in humans may not rely on the hippocampus, but rather be best explained through the topological configuration of functional networks.

### E101

### HIPPOCAMPAL AND STRIATAL MEMORY IMPLICITLY FACILITATE VISUAL SEARCH

Elizabeth V. Goldfarb[1], Marvin M. Chun[2], Elizabeth A. Phelps[1]; [1]New York University, [2]Yale University — We developed a novel task to concurrently measure the implicit contributions of multiple memory systems. In this visual search task, both spatial context (an index for hippocampal memory) and stimulus-response cues (S-R, designed to measure striatal memory) significantly and implicitly facilitate performance. Participants showed significantly faster reaction times on Context or S-R cued trials compared to Uncued (baseline) trials but have no explicit memory for these associations. Our fMRI data support our hypothesis that memory for these cues relies on distinct neural systems. We anatomically defined a priori hippocampal and striatal (caudate and putamen) regions of interest in each subject and examined contrasts between Context vs Uncued as well as S-R vs Uncued trials. When comparing Context vs Uncued activity, the amount of hippocampal activity in the first half of the experiment predicted the extent to which participants were faster on Context search trials in the second half. Contextually cued search did not correlate with early striatal activity. For S-R learning, the amount of striatal activity on S-R v Uncued trials in the second half of the experiment correlated with the extent to which participants were faster on S-R trials in the second half, while hippocampal activity did not. This task provides an ideal framework to study factors that differentially impact multiple memory systems.

## METHODS: Neuroimaging

### E102

### STABILITY OF THE FMRI BOLD SIGNAL IN READING DISABILITY: INSIGHTS WE CAN GAIN FROM BETA SERIES ANALYSIS

Anish Kurian[1,2], W. Einar Mencl[1,3], Jeffrey Malins[1], Brian A. Parbhu[1], Peter Molfese[1,2], Bryan Cort[1], Stephen J. Frost[1], Kenneth R. Pugh[1,2,3]; [1]Haskins Laboratories, New Haven, CT, [2]University of Connecticut, Storrs, CT, [3]Yale University, New Haven, CT — We explored individual differences in the stability of the BOLD response and how these stability differences correlated with performance on behavioral measures of reading and language skill. This study (N=27) applied a novel analysis technique to a previously published study (Pugh et al., 2008), which examined the effects of repetition on printed word identification. Participants saw words on a screen (repeated 1-6 times) and had to make an animacy judgment by button press. The initial report suggested a disordinal pattern of activation between non-impaired (NI) and reading disabled (RD) individuals as the number of repetitions increased. In the current study, we focused on the variability of the BOLD response (the standard deviation of beta values on a trial to trial basis within the same condition) and used this measure as an index of trial-wise stability. We correlated the standard deviation (SD) of the beta-weights with behavioral data and identified significant correlations between BOLD response variability and language skills. Specifically, we observed strong negative correlations in putamen and thalamus between BOLD response variability and language performance. The correlations in putamen and thalamus compared SD and WJ Spelling ($r = -0.53$, $p < 0.01$; $r = -0.50$, $p < 0.01$; respectively) as well as SD and an overall reading composite score ($r = -0.50$, $p < 0.01$ for thalamus). These findings provide further insight on how instability in the BOLD response may help better quantify what has been referred to as a "noisy brain" in those individuals with RD when being compared to their NI peers.

### E103

### SIMULTANEOUS MULTI-SLICE/MULTIBAND ACQUISITION ALLOWS WHOLE-BRAIN, SUB-SECOND DATA COLLECTION WITH LITTLE COST FOR TASK-EVOKED FMRI STUDIES

Stephanie McMains[1], R. Matthew Hutchison[1,2], Ross Mair[1,2]; [1]Harvard University, [2]Massachusetts General Hospital — Slice-accelerated EPI using multiband (MB) RF pulses that allow for simultaneous multi-slice (SMS) acquisition of BOLD images can significantly enhance the temporal and spatial resolution of fMRI by acquiring up to 8 non-contiguous slices simultaneously, thus enabling whole-brain sub-second TRs. Here we studied visual cortex response at a variety of MB accelerations and TR reductions to investigate costs associated with whole-brain, sub-second data collection. 6 subjects were scanned (3.0T Siemens Tim Trio) while blocks of flashing checkerboards were presented to alternating visual fields. BOLD scans were acquired at 3mm and 2mm isotropic resolutions, and MB accelerations of 0 (conventional BOLD), 1, 4 and 8 (Siemens WIP 770A). Beta and t-statistics were extracted from visual cortex. TR= 3.0/1.25/0.75/0.7s, allowing acquisition of 91/184/307/328 timepoints. There were no significant differences in betas for any parameters, or in t-statistics for levels of MB when holding the TR constant. Shortening the TR increased t-statistics significantly. This advantage was reduced when temporal autocorrelations in the noise were modeled. An event-related study was also conducted to compare 3s TR (MB1) versus 750ms TR (MB8). Betas were larger for the MB8 scans, likely due to improved characterization of the hemodynamic response, even though stimulus onset was jittered to the TR. The results suggest that whole brain coverage with high spatial and temporal resolution can be achieved using SMS with little to no significant cost in terms of BOLD signal sensitivity, as measured by betas and t-statistics, even though time-series SNR was significantly decreased at high MB factors.

### E104

### DOES SNR OF VISUALLY EVOKED BOLD RESPONSES CHANGE WITH RAPID MULTIPLEXED FMRI?

Peter J. Kohler[1], Anthony M. Norcia[1]; [1]Stanford University — Multiplexed fMRI allows for sub-second acquisitions of whole-brain images (Feinberg, 2010), much faster than standard fMRI protocols. What happens to the signal-to-noise ratio (SNR) of fMRI BOLD responses as acquisitions get faster? We address this question by showing participants a flickering grating undergoing periodic contrast modulation, while acquiring multiplexed fMRI. This protocol yields a direct measure of a stimulus-evoked BOLD response (unlike resting-state-based measures of data quality, e.g. Smith et al. 2013). Stimulus frequency and acquisition rate were varied independently. SNR was quantified using spectral analysis as the ratio of the response amplitude at the stimulus frequency to the non-stimulus-related background at neighboring frequencies. Our first experiment used a stimulus period of 24s, combined with four different multiplexing factors that yielded TRs of 2000ms, 1200ms, 800ms and 400ms. SNR did not change with different TRs, and there was no interaction between TR and region-of-interest in retinotopic visual cortex, although there was a main effect of region-of-interest. In our second experiment, we looked for an interaction between stimulus frequency and TR. We used TRs of 2000ms and 400ms to sample the response to the stimulus modulating over 12s, 8s and 6s periods. We again found little effect of TR on SNR, except that 400ms acquisitions tended to yield better SNR at the fastest stimulus frequency. These results demonstrate that, at least for visually evoked BOLD-responses, SNR does not decrease when acquiring multiplexed sub-second fMRI, and fast acquisitions may in fact yield higher SNR at fast stimulus modulations.

### E105

### THE NEUROIMAGING INFORMATICS TOOLS AND RESOURCES CLEARINGHOUSE (NITRC)

Christian Haselgrove[1], Robert Buccigrossi[2], David Kennedy[1], Nina Preuss[2], Jon Riehl[3], Giorgio Ascoli[4], David Boas[5], Steven Bressler[6], Arnaud Delorme[7], Randy Gollub[5], Li Shen[8]; [1]University of Massachu-

setts Medical School, [2]Turner Consulting Group, Inc, [3]Resilient Science, [4]George Mason University, [5]Harvard Medical School/Massachusetts General Hospital, [6]Florida Atlantic University, [7]University of California, San Diego, [8]Indiana University — We report on the use and continued development of the Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC; www.nitrc.org), a neuroimaging informatics knowledge environment for MR, PET/SPECT, CT, EEG/MEG, optical imaging, genetics/genomics imaging, and clinical neuroinformatics. Initiated in October 2006 through the NIH Blueprint for Neuroscience Research, NITRC's mission is to foster a user-friendly knowledge environment for the neuroinformatics community. NITRC is centered around the Resource Repository (NITRC-R), an on-line catalog of software tools and other resources valuable to the community. NITRC-R promotes software, vocabularies, test data, databases, communities, and other resources, thereby extending the impact of previously funded neuroimaging informatics contributions to a broader community. NITRC's Image Repository (NITRC-IR) hosts raw and processed data to facilitate data sharing. Its structured database allows for downloading cross-sections of data for analysis, meta-analysis, and validation of techniques, and other uses. NITRC-IR hosts 12 community-generated data sets (as of November, 2014) and continues to grow. NITRC's Computational Environment (NITRC-CE) is a cloud-based, standard environment for neuroimaging computation. Built on NeuroDebian and available through Amazon Web Services and Microsoft Azure, NITRC-CE provides ready-to-use environment for data analysis. It has been successfully used by both small studies with a few subjects and by large efforts with thousands of data sets to analyze. Together, NITRC-R, -IR, and -CE are an established and trusted environment serving a number of needs of the neuroimaging community.

## E106

### ACTIVATION OF SELECTED BRAIN REGIONS CORRELATES WITH HUNGER SUBSCALE OF THREE FACTOR EATING QUESTIONNAIRE

Laura Gramling[1], Katherine Flemming[1], Aaron D Jacobson[1], Nobuko Kemmotsu[2], Erin Green[3], Lori Haase[3], Claire Murphy[1,2,3]; [1]San Diego State University, [2]University of California San Diego, [3]SDSU/UCSD Joint Doctoral Program — Obesity has become a worldwide epidemic. We investigated dimensions of eating behavior measured by the Three Factor Eating Questionnaire (TFEQ), which measures cognitive restraint of eating, disinhibition, and hunger. Participants (N = 85) were divided into control (n = 45) or metabolic syndrome (MetS) (n =40) groups. Participants were assigned to the MetS group if they met three of seven cardiovascular risk factors outlined by the International Diabetes Federation. Participants were administered the TFEQ and completed two fMRI scans. Before each scan participants fasted, and completed one scan hungry and one scan sated, after a preload. Participants rated the pleasantness of aqueous solutions of sucrose, saccharine and caffeine during the scan; water was used as a rinse and baseline comparison. Correlations were run on participants' TFEQ hunger subscale and activation levels of specific brain regions known to be affected by taste, hunger and reward processes. When rating saccharine there was a significant positive correlation between TFEQ hunger and activation in the hippocampus, entorhinal cortex and parahippocampus during the hunger condition, and in the entorhinal cortex and parahippocampus during the satiety condition for middle-aged adults. In response to sucrose, there was a significant positive correlation between hunger and activation in the hippocampus in the hunger condition and in the caudate and posterior cingulate in the satiety condition for middle-aged adults. These findings could have implications for memory deficits in later life, due to hyper activation in these regions. Supported by NIH grant # AG004085-26 from NIA to CM.

## E107

### MAPPING ABNORMAL SUBCORTICAL BRAIN MORPHOMETRY IN AN ELDERLY HIV+ COHORT

Benjamin Wade[1], Victor Valcour[2], Lauren Wendelken-Riegelhaupt[2], Pardis Esmaeili-Firidouni[2], Shantanu Joshi[3], Yalin Wang[4], Paul Thompson[1]; [1]Imaging Genetics Center, University of Southern California, [2]Memory and Aging Center, Department of Neurology University of California, San Francisco, [3]Ahmanson-Lovelace Brain Mapping Center, Department of Neurology, University of California Los Angeles, [4]School of Computing, Informatics, and Decision Systems Engineering, Arizona State University — Introduction: Over 50% of HIV+ individuals show cognitive impairment in psychomotor functioning, processing speed, working memory and attention. Patients receiving combination antiretroviral therapy may still have subcortical atrophy, but the profile of HIV-associated brain changes is poorly understood. It is important to develop biomarkers to track viral effects on the brain. With surface-based shape analyses, we mapped the 3D profile of subcortical morphometry in 63 elderly HIV+ subjects (4 female; age=65.35± 2.21) and 31 uninfected elderly controls (2 female; age=64.68 ± 4.57) scanned with MRI as part of the UCSF HIV Over 60 Cohort study. We additionally investigated an association of morphometry with nadir CD4 counts and illness duration. Methods: The thalamus, corpus striatum, hippocampus, amygdala, brainstem, callosum and ventricles were segmented from brain MRI scans using FreeSurfer. To study subcortical shape, we analyzed: (1) the Jacobian determinant (JD; a measure of surface shrinkage) indexed over structures' surface coordinates and (2) radial distances (RD) of structure surfaces from a medial curve. A JD less than 1 reflects regional tissue atrophy and greater than 1 reflects expansion. Results: RD maps revealed atrophy of the left thalamus in HIV+ participants and expansion of the cerebral aqueduct. RD and JD maps of the right pallidum identified tissue expansion associated with illness duration. Volumetrically, HIV+ participants showed significant reduction of the bilateral thalami, left pallidum and corpus callosum along with enlarged left lateral and third ventricles. Conclusions: Our results characterize the subcortical brain shape and regional volume abnormalities in older HIV+ people.

## E108

### PCA-BASED AUTOMATIC SEGMENTATION OF HIPPOCAMPAL LONGITUDINAL AXIS

Garikoitz Lerma-Usabiaga[1], Juan Eugenio Iglesias[1], Pedro M. Paz-Alonso[1]; [1]BCBL. Basque Center on Cognition, Brain and Language — The human hippocampal formation is a crucial brain structure for memory and cognitive function that is connected to other subcortical and cortical brain regions. Recent neuroimaging studies have found differences along the hippocampus longitudinal axis in terms of function, structure and connectivity, stressing the importance of improving the precision of the available segmentation methods typically used to divide it into anterior and posterior parts. Hereof, current segmentation conventions present two main sources of variability related to how separating planes along the longitudinal axis are chosen and how the in-scanner head position is corrected and equated across subjects. These issues are typically addressed by manually aligning the brain for roll, pitch, and yaw rotations along the inter-hemispheric fissure, AC-PC line and orbits. Here, we propose an automated method based on estimating the longitudinal axis with principal component analysis (PCA). The estimated direction is used to define the orientation of the separating planes, which removes the variability associated with the manual alignment of the in-scanner brain position. The output obtained with the PCA-based alignment was compared with the segmentations given by manual alignments provided by two trained and independent judges on a sample of 100 young adults. The results reveal that the automatized procedure minimizes the inconsistencies generated by the accumulation of manual operations, thus ensuring the reproducibility of the results between different sites. The automatic method also provides higher statistical power than the manual alignments when detecting well-known effects. A Matlab implementation will be made publicly available.

## E109

### CORRELATIONS BETWEEN DISINHIBITION SUBSCALE OF THE THREE FACTOR EATING QUESTIONNAIRE AND ACTIVATION OF SELECTED BRAIN REGIONS

Katherine Fleming[1], Laura Gramling[1], Aaron D Jacobson[1], Nobuko Kemmotsu[2], Erin Green[3], Lori Haase[3], Murphy Claire[1,2,3]; [1]San Diego State University, [2]University of California San Diego, [3]SDSU/UCSD Joint Doctoral Program — Worldwide, rates of obesity have reached epidemic proportions, with numbers of obese adults expected to reach 700 million by 2015. Understanding the connection between eating behavior and neural processes becomes paramount. The Three Factor Eating Questionnaire (TFEQ) measures three dimensions of eating behavior – cognitive restraint of eating, disinhibition, and hunger. The current study examined the correlation between participant disinhibition scores and activation in brain

regions involved in taste and reward processing. Participants (N = 85) were divided into control (n = 45) or metabolic syndrome (MetS) (n = 40) groups. The MetS participants had three of seven risk factors for cardiovascular disease and diabetes outlined by the International Diabetes Federation. Participants were administered the TFEQ and completed two fMRI scans on separate days. Before each scan participants fasted for 12 hours, and completed one scan hungry and one scan satiated, after having consumed a nutritional preload. Participants rated the pleasantness of aqueous solutions of sucrose, saccharine and caffeine during the scan; water was used as a rinse and baseline comparison. Across age there was a significant positive relationship between scores on the TFEQ disinhibition scale and activation in the posterior cingulate in both control and MetS subjects for saccharine. In MetS older adults there was a significant positive correlation between disinhibition and activation in the parahippocampus when rating saccharine and sucrose. These results may have implications for obesity in middle age as a risk factor for dementia. Supported by NIH grant # AG004085-26 from NIA to CM.

# PERCEPTION & ACTION: Motor control

## E110

### CORTICAL CONTROL OF VOCAL PITCH FEEDBACK

Gottfried Schlaug[1], Charles Li[1], Psyche Loui[1,2], Gus Halwani[1], Frank Guenther[3]; [1]Beth Israel Deaconess Medical Center/Harvard Medical School, [2]Wesleyan University, [3]Boston University — Speaking and singing require rapid and automatic coupling between feedforward and feedback processes of the auditory-motor system, but the critical regions of this brain network remain unclear. Here we investigated neural sensitivity to pitch-shifted auditory feedback in a combined behavioral and sparse-temporal sampled fMRI study using 19 non-musicians. Auditory feedback was perturbed in randomly selected trials by shifting the participants' (n = 19) vocal pitch by 1 and 2 semitones (ST) in either direction while participants were performing a pitch-matching task. Behavioral recordings of vocal pitch production showed that participants compensated for the ±1ST perturbations by varying their F0 production in the direction opposite to the experimental manipulation, and while responses to the ±2ST perturbations seemed to vary more between compensation and a pitch following behavior (i.e., they varied their production in the same direction as the perturbation). Functional MRI for all production compared to no production conditions showed a vocal-motor network including feedback and feedforward sensorimotor integration and control regions, while the 1ST vs. non-perturbed contrast revealed a network that included left superior temporal sulcus (STS), planum temporale (PT), premotor cortex (PMC), ventral motor cortex (vMC), supplementary motor area (SMA), and right Heschl's gyrus (HG). The 2ST vs. non-perturbed contrast, however, only showed activation in the SMA. Results implicate a network of auditory, motor, and auditory-motor integration regions in controlling vocal pitch feedback with the posterior ventral premotor cortex emerging as a nodal point of this network, while the SMA may be more involved in vocal-motor matching behavior.

## E111

### EFFECTS OF SHORT-TERM CYCLING EXERCISE ON FUNCTIONAL MEASURES OF AGING RELATED CHANGES IN UPPER EXTREMITY FUNCTION.

Keith McGregor[1,2], Joe Nocera[1,2], Bruce Crosson[1,2], Andrew Butler[1,3]; [1]Atlanta VA Medical Center - Center for Visual and Neurocognitive Rehabilitation, [2]Emory University, [3]Georgia State University — Aerobic fitness has long been associated with better upper extremity function (Spirduso, 1975), yet the neural changes largely responsible for these improvements are not well understood. It has been proposed that alteration of inhibitory systems in the cortex have strong effect on plasticity in aging and regular aerobic exercise may be prophylactic in preventing aging-related changes in cortical inhibition (McGregor et al., 2013). In the current study, we enrolled sedentary older adults (60 years+) in a short-term (12-week) exercise program to explore if improvements in aerobic capacity alter upper extremity motor control. We evaluated changes in neural activity using transcranial magnetic stimulation. Participants improved estimates of VO2max by 10-15% on average as a result of the aerobic exercise intervention. Preliminary results show behavioral improvements in affective, cognitive and motor dexterity measures as a result of the exercise intervention. Pre/Post session TMS results indicate an increase in interhemispheric inhibition, though additional data analysis is required.

## E112

### NEURAL RESPONSES DURING SPEECH PRODUCTION AT VOCALIZATION ONSET DEMONSTRATE CORTICAL SELF-MONITORING.

Naomi Kort[1], Maria Ventura[1], John Houde[1], Srikantan Nagarajan[1]; [1]University of California, San Francisco — The act of speaking is accompanied by concurrent sensory consequences- somatosensory feedback associated with the movement of articulators, and auditory feedback resulting from the movement, but the neural correlates of the monitoring of this sensory feedback are complex and not well understood. In this study, we examined cortical monitoring of self-produced vocalizations in human subjects across the cortex and frequency bands using magnetoencephalography. Past studies have implied suppression of activity in sensory areas is indicative of this monitoring. But for suppression to represent self-monitoring, the suppression should be reduced in the presence of a feedback error. In this study, we have shown neural responses were suppressed to self-produced vocalizations in bilateral temporal lobes, frontal and cerebellar regions. The largest extent and greatest magnitude of suppression was in the beta band. When the pitch of the auditory feedback was altered during speaking, creating a feedback error, the suppression was reduced and in some regions eliminated. This reduction of suppression was driven by increased cortical activity during speaking with altered auditory feedback. The cortical network showing increased activity during speaking with altered auditory feedback was modulated with the amount of deviation in the perceived auditory feedback from the expected auditory feedback. This study shows that suppression during vocalization contributes to cortical self-monitoring that is sensitive to single features of the auditory signal.

## E113

### FUNCTIONAL MANIPULABILITY OF OBJECTS INTERACTS WITH MOTOR PROCESSING INSTRUCTIONS: A BETWEEN-SUBJECTS EEG STUDY

Christopher Madan[1], Yvonne Chen[1], Anthony Singhal[1]; [1]University of Alberta — An object's motor-related properties can influence later memory of the object, particularly when motor aspects of the object were not intentionally attended-to. To better understand this effect we recorded electroencephalography (EEG) while participants made judgments about images of objects that were either high or low in functional manipulability (e.g., violin vs. vase). Using a between-subjects design, participants judged the objects on whether they (a) could manipulate the object using their hand (Functionality group; N=31) or (b) have seen the object in the past three days (Personal Experience group; N=30). We found main effects of MANIPULABILITY and GROUP on the ERP waveforms at electrodes C3 and CPz, respectively. Since C3 is situated above the contralateral hand-region of M1, this waveform difference converges with findings of differential M1 activation due to manipulability in fMRI studies. We additionally observed an interaction of MANIPULABILITY (high/low) x GROUP (personal experience/functionality) in the P300 amplitude at CPz. Here we found a significantly greater P300 for low-manipulability images, but only in the Functionality group. As P300 is thought to index attentional recruitment, greater P300 for low-manipulability images suggests that they may have received more attention when being processed, but only in the Functionality group. This differential recruitment of attention may have also played an important role in effects of manipulability on memory. This significant interaction provides neural evidence that effects of manipulability on stimulus processing are further mediated by task requirements on automatic vs. deliberate motor-related processing.

## E114

### HOW TO EXPLAIN INDIVIDUAL VARIABILITY IN SPEECH MOTOR CONTROL

Clara Martin[1,2], Caroline Niziolek[3], Jon Andoni Duñabeitia[1], Manuel Carreiras[1,2], John Houde[3]; [1]BCBL. Basque Center on Cognition, Brain and Language, San Sebastian, Spain, [2]IKERBASQUE, Basque Foundation for Science, Spain, [3]UCSF, San Francisco, USA — When a speaker's auditory feedback is altered, he compensates for the perturbation by altering his own production, which demonstrates the role of auditory feedback in speech motor control. In the present study, we explored the role of hearing competence

and executive control in this process. Thirty two Spanish native speakers performed (1) an altered feedback adaptation experiment, (2) executive control (Stroop, Simon and Flanker) tasks, and (3) hearing competence tasks (loudness, pitch and auditory pattern discrimination). (1) In the adaptation experiment, subjects had to produce the pseudoword "pep" while perceiving their auditory feedback in real time through earphones. The auditory feedback was first unaltered and then progressively altered in F1 and F2 dimensions until maximal alteration (F1 -150 Hz; F2 +300 Hz). The normalized distance of maximal adaptation ranged from 3 to 138 Hz (averaged of 77 ±35). (2) Individual measures of inhibition of conflicting information capacities (obtained from the executive control tasks) did not correlate with adaptation. (3) Additionally, adaptation highly correlated with each individual score of hearing competence: Better auditory discriminators compensated more to the alteration. We concluded that speech motor control depends on hearing competence but not on executive control capacities. Being good at inhibiting conflicting information does not make participants better at dealing with conflicting altered feedback. This reveals that participants compensate to altered feedback and do not inhibit it. Moreover, being good at auditory discrimination makes participants better at detecting the altered auditory feedback, leading to a larger adaptation.

### E115

### FEEDBACK-RELATED NEGATIVITY PREDICTS ADAPTATION OF A NEWLY LEARNED SKILL TO NOVEL TASK CONSTRAINTS

Matthew Miller[1], Kirk Grand[1], Alessandro Bruzi[2], Ford Dyke[1], Maurice Godwin[1], Amber Leiker[1], Andrew Thompson[1], Taylor Buchanan[1], Marcos Daou[1], Keith Lohse[1]; [1]Auburn University, [2]Universidade Federal de Lavras — The feedback-related negativity (FRN) component of the event-related potential (ERP) has been associated with performance improvement in several motor learning paradigms, but never in a 24 h-delay-retention/transfer test paradigm, which is the 'gold standard' of motor learning. To address this shortcoming, we recorded electroencephalography from 28 right-handed participants using their left arm to practice 60 beanbag tosses towards a target with a bull's eye 300 cm away. Participants' view of the target was occluded, and they received feedback after approximately two-thirds of their tosses (as part of a larger study, half of the participants received feedback per their request, and half received feedback at the experimenter's discretion; results were not significantly affected by whether participants controlled when they received feedback). Feedback was presented on a computer monitor as a rectangle, the color of which corresponded with how close participants' tosses came to the target's bull's eye. FRN mean amplitude was derived from ERPs time-locked to feedback onset. To index skill acquisition, participants resumed the study 24 h later and completed 12 'retention' tosses (from 300 cm) and 12 'transfer' tosses (from 200 cm), all with no feedback. Separate linear regressions revealed FRN amplitude predicted performance on the transfer test ($\beta$ = -.096, R2 = .263, p = .009), but not the retention test ($\beta$ = -.029, R2 = .012, p = .580). Results suggest that enhanced feedback processing during the acquisition of a motor skill is associated with one's ability to adapt the newly learned skill to novel task constraints.

### E116

### EFFECTS OF SHORT- AND LONG-TERM MOTOR LEARNING ON BRAIN STRUCTURE

Aaron Trefler[1], Cibu Thomas[2], Elizabeth Aguila[1], Carlos Pierpaoli[2], Chris I. Baker[1]; [1]Laboratory of Brain and Cognition, NIMH, Bethesda, MD, [2]National Institute of Child Health and Human Development, Bethesda, MD — A large number of studies have used magnetic resonance imaging (MRI) to infer structural changes in the adult brain following training regimes spanning from hours to weeks. However, the strength of the evidence from these MRI-based studies is often limited, particularly with regard to the specificity of any training effect on brain structure (Thomas and Baker, 2012). Here, we used a longitudinal within-subjects design to investigate the topography of short-term (1 hour) and long-term (1 hour/day for 1 week) training-dependent structural changes in a group of 20 healthy adults. To test the specificity of training-related changes in the brain, we used a lateralized motor-sequence learning task that required participants to master the ability to rapidly input a specific 8-digit sequence, using only the left hand. For each participant, we acquired T1-weighted structural MRI data, (a) before any training (baseline), (b) after short-term motor learning and, (c) after long-term motor learning. For each participant, we compared structural properties before and after training with those before and after equivalent control time periods, using both measures of cortical thickness and Voxel Based Morphometry (VBM). As expected, participants showed strong training effects in terms of reaction time and accuracy. Though longitudinal analysis of both cortical thickness and VBM data suggested apparent changes in brain structure, these changes were not specific to task-relevant regions. These findings suggest that the robust and specific behavioral training effects were not matched by similarly robust and specific changes in measures of structural properties.

## PERCEPTION & ACTION: Vision

### E117

### PROBING BINOCULAR RIVALRY: PRE-STIMULUS ALPHA DETERMINES WHETHER SUPPRESSED-EYE PROBES ELICIT A SWITCH IN PERCEPTUAL DOMINANCE

Brian A. Metzger[1,2], Kyle M. Mathewson[3], Monica Fabiani[1,2], Gabriele Gratton[1,2], Diane M. Beck[1,2]; [1]University of Illinois at Urbana-Champaign, [2]Beckman Institute for Advanced Science and Technology, [3]University of Alberta — Binocular rivalry occurs when disparate images are shown simultaneously but separately to each eye. Perceptual dominance reverses over time with one image temporarily dominating perception while the other is suppressed. Probes presented to the suppressed eye are typically seen by participants and tend to cause perception to shift to the suppressed-eye image. Here we ask what determines whether and how quickly perception switches. We combine behavior and EEG (ERPs) to test the hypotheses that 1) suppressed-eye probes elicit a shift in attention to the suppressed-eye image and 2) the degree to which probes are processed influences how rapidly perception switches. We find that suppressed-eye probes elicit larger N1 and P3b activity relative to dominant-eye probes, suggesting that suppressed-eye probes draw attention to the image in the suppressed-eye. A comparison of suppressed-eye probe trials leading to fast versus slow perceptual switches reveals two novel findings. First, single-trial P3b component amplitudes are negatively correlated with reversal latency, such that as P3b amplitude increases, reversal latency decreases. Second, probes presented to the suppressed eye at a moment in which alpha power is low and at a peak (excitatory phase) are associated with faster reversals than probes presented when alpha is high and at a trough (inhibitory phase). Taken together, these results suggest that the level of cortical excitability (indexed by the amplitude and phase of alpha) influences the probability that the probe attracts attention to the suppressed-eye image, leading to a switch in perceptual dominance.

### E118

### THE AMYGDALA SHOWS A GREATER SELECTIVITY FOR DYNAMIC FACES THAN STATIC FACES

Geena Ianni[1], David Pitcher[1], Leslie Ungerleider[1]; [1]Laboratory of Brain and Cognition, National Institute of Mental Health — Prior fMRI studies have identified multiple face-selective regions in the human cortex but the functional division of labor between these regions is not yet clear. One hypothesis that has gained some empirical support is that face-selective regions in the superior temporal sulcus (STS) preferentially respond to the dynamic aspects of faces, whereas the fusiform face area (FFA) computes the static or invariant properties of faces (Pitcher et al., 2011). We further tested this hypothesis by examining how face-selective regions in the occipitotemporal cortex and the amygdala respond to dynamic and static face stimuli. Preliminary analyses from 18 healthy adult subjects indicated that the right FFA and right occipital face area (OFA) responded equally to dynamic and static faces. In contrast, the amygdala showed a two-fold increase in response to dynamic faces, as compared to static faces. A high-field strength (7 Tesla) and high resolution (1.25 mm isotropic) scan allowed us to functionally define face-selective voxels in the amygdala in almost all participants. This two-fold increase in response to dynamic faces was also seen in the right posterior STS region, while the right FFA and right OFA responded equally to dynamic and static faces. This pattern of responses in the amygdala and right posterior STS suggests that the two regions may be preferentially involved in computing the changeable aspects of faces, compared to the FFA and OFA.

## E119

### THE BIAS IN OUR VISION: LOWER VISUAL FIELD ADVANTAGES FOR GRASPING REVEALED THROUGH GAZE ANALYSIS

Scott Stone[1], Jason W. Flindall[1], Claudia L. R. Gonzalez[1]; [1]University of Lethbridge — We perform numerous grasps in the upper and lower visual fields (UVF, LVF) every day, whether to pick up an object off of a shelf at the grocery store or to grab a glass of water from the counter. Previous studies investigating visuomotor control have demonstrated advantages when individuals are asked to point or to grasp in the LVF when compared to the UVF. Individuals are faster and they perform fewer fixations when pointing at a target in the LVF. With respect to grasping, more accurate grip apertures are produced when picking up objects located in the LVF. It is likely that visual attention plays a pivotal role in these differences between visual fields. We used an eye-tracking environment in a search-to-reach-to-grasp task to determine if biases are detectable through gaze analysis. Eleven participants (eight female) grasped small cubic blocks placed in the UVF and LVF (seven in each field) while wearing an EyeLink II eye-tracking headset. Analysis of length and number of fixations revealed a pronounced difference between visual fields. Grasping in the UVF required significantly longer fixation times, and a larger number of fixations when compared to grasping in the LVF. These results are consistent with previous behavioural and neuroimaging studies that have shown advantages in visuomotor control in the LVF. Furthermore, the results suggest that grasping in the LVF require less visual attention, and thus fewer cognitive resources.

## E120

### INCREASED SELECTIVITY IN VENTRAL VISUAL CORTEX FOLLOWING 24H SLEEP DEPRIVATION

Jia Hou Poh[1,3], Danyang Kong[2], Michael W.L. Chee[1]; [1]Duke-NUS Graduate Medical School, Singapore, [2]Stanford University, [3]National University of Singapore Graduate School for Integrative Sciences and Engineering — Total sleep deprivation (TSD) for 24h can result in selective attention deficits whereby the modulation of activation in ventral visual cortex (VVC) is impaired (Lim et al, 2010). Beyond the reduction of top-down selectivity, we predicted that responses of VVC neurons might be dedifferentiated similar to cognitive aging. To test this, we reanalyzed data from Kong et al (2012), where participants were required to attend to faces or houses when viewing individuated face, house images or ambiguous overlapping face-house images. We analyzed trials where participants were required to attend to single Face or House images. We identified voxels in the VVC showing greater selectivity for houses or faces and compared the difference in response magnitude when a preferred or non-preferred stimulus was shown. Contrary to expectation, the difference metric in TSD suggested greater selectivity relative to the rested state. We further compared the voxels' response during the passive viewing of composite images, and a graded response was observed in both RW and TSD (i.e. Face voxels: tface > tcomposite > thouse ; House voxels: thouse > tcomposite > tface ). Critically, the decrease in response from viewing preferred to ambiguous images, was significantly greater for both house and face voxels in TSD. In sum, contrary to expectation, de-differentiation was not observed within the VVC. Instead, selectivity of target related activation in voxels already showing category-specificity appears elevated in TSD.

## E121

### WHEN YOU SMILE, THE WORLD SMILES AT YOU: SELF-EXPRESSION EFFECTS ON FACE PROCESSING REVEALED BY VISUAL ERPS

Beatriz Calvo-Merino[1,2], Alejandra Sel[3], Bettina Forster[1]; [1]City University London, [2]Complutense University of Madrid, [3]Royal Holloway — Emotion simulation models suggest that the intentional pose of a facial expression can lead to changes in one's subjective feelings, which in turn influences the processing of visual input. However, how visual cortical responses underlying observation of other's facial expressions are modulated by our own facial emotion remains unknown. This study aims to understand how one's facial emotion affects visual processing by measuring participants' visual evoked potentials (VEPs) during a facial emotion judgment task of positive and neutral faces. We controlled for the effects of facial muscles (facial feedback) on VEPs by asking participants either to smile adopting an expression of happiness (self-happy facial expression) or to pose a neutral face (self-neutral facial expression) in two separate blocks. Results showed that self expression modulates face specific early visual processing components (N170/vertex positive potential-VPP) to watching other facial expression. Specifically, when holding a happy facial expression, neutral faces are processed similarly to happy faces. While when holding a neutral expression, neutral and happy face activations are significantly different. This effect was source localized within multisensory associative areas, angular gyrus and associative visual cortex, and somatosensory cortex. Overall our data provide novel evidence that one's emotional expression acts as top-down influence at early stages of visual processing modulating low-level neural encoding of faces.

## E122

### LOWERING SPATIAL FREQUENCIES THROUGH EXTRA LETTER SPACING FACILITATES WORD RECOGNITION: EVIDENCE FROM EYE TRACKING AND ERP DATA

Sebastian Korinth[1], Christian Fiebach[1]; [1]Goethe University Frankfurt — It was recently proposed that increased letter spacing facilitates reading in dyslexics. The mechanisms underlying this improvement and its specificity to dyslexia, however, are unclear. Here, we measured eye-movements (n = 24) during silent reading of multiline newspaper texts, to explore whether extra letter spacing improves reading speed among young normally-reading adults. Only relatively slower readers profited in the sense of showing shorter Total Reading Times whereas faster readers were slowed down when spaces between letters were wider; comprehension was generally unaffected. To investigate the neuronal underpinnings of this effect, two ERP experiments (n = 20) were conducted. In experiment 1 participants performed a semantic task on words presented either in standard spacing or with extra space between letters. Representing a non-linguistic control condition, experiment 2 required a perceptual decision on strings of the characters "i" and "!", which appeared in two length conditions of five (e.g., !ii!i) or seven characters (e.g., !!i!i!!) and two inter-character spacing conditions (narrow vs. wide). Independent of stimulus type, wider letter spacing led to stronger amplitudes of the N170 ERP-component. It can be excluded that this effect is merely driven by differences in overall stimulus width, since in experiment 2 wide-spaced five-character items produced significantly greater N170 than narrow-spaced seven-character items, while both covered the same width on the screen. Since an increase of inter-character space leads effectively to a decrease of spatial frequencies, we propose that for our non-dyslexic readers the spacing-related facilitation of word recognition is caused by lower spatial frequencies.

## E123

### NAVON MOVEMENTS: A NEW PARADIGM TO INVESTIGATE LOCAL AND GLOBAL FEATURES IN BIOLOGICAL MOTION PERCEPTION.

Santiago Fernandez[1], Almudena Capilla[2], Isabelle Duplan[2], Estefania Sánchez - Pastor[1], Daniella Massias[3], Beatriz Calvo-Merino[2,3]; [1]Department of Basic Psychology II (Cognitive Processes) Complutense University of Madrid, [2]Department of Biological and Health Psychology, Universidad Autonoma de Madrid, [3]Department of Psychology, City University London — Configural and analytical styles of processing play a role in different aspects of biological motion (BM) perception. Different task such as action, identity, gender or emotion recognition of point lights displays (PLD) need to access different global or local features to be correctly performed. The inversion effect paradigm has been also used in biological motion to understand how much of a canonical configuration is necessary to extract different BM information. However, the debate of how global/local action features interact in BM is still open. Here we developed new BM stimuli that allow investigating attention to different action features in point light displays. Inspired by the principle of global precedence described by Navon (Navon 1977, Forest before trees: the precedence of global features in visual perception, Cog Psychology, 9,353-83), we created a set of BM displays that resemble the Navon letters: a large stimulus, in this case, a PLD, is formed by 12 small stimulus (small PLD –placed in main joints and head). We performed two behavioral studies where we manipulated (a) congruency –big and small PLD could depicted the same action (congruent) or different actions (incongruent), (b) focus of attention –big/small PLD, (c) orientation (up/inverted). Analysis of participant's performance (accuracy, RT, d prime) on an action recognition task and a BM visual discrimination task suggest an interaction between congruency and focused attention, similar to the effects

previous reported using the Navon letters. This provides a new biological motion tool to further understand styles of processing action information. (Funding-PSI2012-34558).

### E124

### RETINOTOPIC MAPPING OF VISUAL EVOKED POTENTIALS

Almudena Capilla[1], María Melcón[1], Dominique Kessel[1], Rosbén Calderón[1], Paula Pazo-Álvarez[2], Luis Carretié[1]; [1]Universidad Autonoma de Madrid, [2]Universidad de Santiago de Compostela — Visual stimulation is very commonly used in Cognitive Neuroscience research. In this field, electroencephalography (EEG) is one of the techniques of choice when investigating the brain correlates of cognitive processes. However, despite its broad use, we lack information about how the morphology of the visually evoked potentials (VEPs) varies according to the spatial location of stimulation. Hence, the aim of this study was to perform a systematic retinotopic mapping of VEPs. EEG activity was recorded using a cap with 59 tin electrodes (10-10 international system). Twenty-nine voluntary participants were visually stimulated with 60 pattern-reversal checkerboards. Checkerboards were placed in six concentric rings of radius 1.2°, 2.6° (foveal region), 5.8°, 9.8° (perifovea), 14.9° and 22.2° (periphery). We employed independent component analysis (ICA) and beamforming to extract both the temporal dynamics and the brain localization of the main VEP components. Our results show four components elicited by the pattern reversal: C1 (~70 ms), P1-N1 (~105-180 ms), and P2 (~220 ms). As expected, C1 exhibited a clear polarity inversion between upper and lower hemifields, consistent with sources in primary visual cortex. The P1-N1 complex, of extrastriate origin, showed greater amplitude and lower latency to stimuli located in the contralateral lower quadrant. P2, in contrast, showed higher amplitude to stimuli presented in the periphery of the upper visual hemifield. This study highlights the significant retinotopic differences of key VEP components, offering a guide of optimal spatial locations for visual stimulation to be displayed in EEG studies. [Funded by MICINN/MINECO: PSI2011-26314, PSI2012-34558]

# THINKING: Decision making

### E125

### FMRI INVESTIGATION OF THE ACCUMULATION OF PROBABILISTIC CATEGORICAL INFORMATION

Kurt Braunlich[1], Carol Seger[1]; [1]Colorado State University — Our task required participants to categorize different "amoeba" based upon the probabilistic evidence provided by different "flagellum" and "nuclei" features, which were presented, one-by-one, over four discrete steps. By precisely controlling the instrumental contingencies between each feature and reward, and by temporally-jittering their onsets, we were able to build and compare several computational models of processes occurring during the deliberation, commitment and feedback epochs of each trial. Of note, our results provide evidence of two mechanisms subserving the flexible modulation of the speed-accuracy trade-off: gain modulation of the striatum, and gain modulation of accumulated effector-specific evidence. We also found that activity within distinct regions of the striatum tracked the temporal evolution of different decision-related variables. Activity within regions of the putamen reciprocally connected with the somatomotor network tracked effector-specific evidence (e.g., evidence towards a response with the left hand), while regions of the putamen associated with the ventral-attention network tracked the precision of the exogenous information (i.e., the strength of evidence for either response).

### E126

### PERFORMANCE MONITORING AND ERROR PROCESSING ARE ATTENTION-DEPENDENT

Felix Bacigalupo[1], Steven Luck[1]; [1]University of California - Davis — Introduction: Performance monitoring and error processing have been studied through two response-locked event-related potential components (ERPs): an early post-response negativity (ERN) and a later positivity (Pe). Both components have been used to study error awareness with conflicting results. Whereas some researchers have found that error awareness modulates Pe but not ERN, other reports have shown that ERN is sensitive to awareness of errors, but Pe is not. Moreover, these studies have relied on subjective reports of error awareness or stimulus perception. However, subjective reports can be unreliable. Although it is difficult to objectively measure awareness, it is possible to objectively measure attention, which is often linked to awareness. Objective: The goal of this study was to examine the relationship between visuo-spatial attention and performance monitoring using an objective measure of attentional selection. We tested the hypothesis that error processing depends on attention. Methods: We used ERPs to measure visuo-spatial attention and the relationship with performance monitoring. Visuo-spatial attention was measured through the N2pc component, whereas error processing was measured through the ERN and Pe components. We used a visual crowding paradigm to study attentional selection through a wide spatial range. Results: Target discrimination accuracy decreased whereas reaction time increased at small target-flanker distances, which is the typical behavioral pattern in crowding. The N2pc reached maximum amplitude at intermediate distances, and decreased dramatically at small target-flanker distances. Both ERN and Pe decreased significantly in the most crowded conditions. Conclusion: These results suggest that performance monitoring and error processing are both attention-dependent.

### E127

### VALUE-BASED MODULATION OF EFFORT AND REWARD EXPECTATION ON THE MOTOR SYSTEM IN ABSENCE OF CHOICE

Eliana Vassena[1,2], Stephanie Cobbaert[1], Michael Andres[1,3], Wim Fias[1,2], Tom Verguts[1,2]; [1]Ghent University, [2]Ghent Institute for Functional and Metabolic Imaging, [3]Catholic University of Louvain — Human actions are driven by the pursuit of goals, especially when achieving these goals entails a reward. Accordingly, recent work showed that anticipating a reward in a motor task influences the motor system, boosting motor excitability and increasing overall readiness. Attaining a reward typically requires some mental or physical effort. Neuroimaging research showed that both reward expectation and effort requirements are encoded by the same brain regions. Moreover, reward and effort information are combined in an integrative value signal. However, whether mental effort is integrated with reward also at the motor level during task preparation, remains unclear. To address these issues, we implemented a mental effort task where reward expectation and effort requirements were manipulated. During task preparation, TMS was delivered on the motor cortex and motor-evoked potentials (MEPs) were recorded on the right hand muscles to probe motor excitability. The results show that expectation of mental effort and expectation of reward are integrated in a net-value signal (reward discounted by effort cost). More precisely, an effort-by-reward interaction was obtained in which the highest motor excitability was recorded for the highest net-value option (high reward / low effort). Interestingly, this signal influenced the excitability of the motor system in absence of a value-based decision or task-relevant action to be performed. Interestingly, effort-related motor excitability was also modulated by individual differences in tendency to engage in (and enjoy) mental effort, as measured by the Need for Cognition questionnaire, underlining a pivotal role of subjective effort experience in value-driven preparation for action.

### E128

### THE INFLUENCE OF AROUSAL ON RISKY DECISION-MAKING

Joseph Moran[1,2,3], Tad Brunye[2,3], Amanda Holmes[2], Julie Cantelon[2], Bernd Figner[4], Leah Somerville[1], Holly Taylor[2]; [1]Harvard University, [2]Tufts University, [3]US Army Natick, Soldier, Research, Development, and Engineering Center, [4]Radboud University — Human decision-making under uncertainty involves a calculus of risk and return. Both individual and situational influences on risky decisions exert powerful effects on our behavior. Research using the Columbia Card Task (CCT; Figner et al., 2009), a dynamic risky choice task in which trial-by-trial odds information changes as a function of variable win amounts, loss amounts, and odds of losing, reveals that people high in need for arousal take more risks, but only in the immediate-feedback, 'hot' affective processing version of the task, relative to the no-feedback, deliberative, 'cold' version of the task. We investigated whether experimentally-inducing high and low arousal states would increase or decrease risk-taking differentially in Hot and Cold decision contexts. In Experiment 1, participants (N=32) underwent mood induction through music (Arousal X Valence: Positive/Negative), and then completed counterbalanced Hot and Cold CCTs. Inducing high versus low arousal increased risk-taking overall, increased risk-taking under low gain, and interacted with feedback such that in the Hot CCT participants under high arousal took more risks even when they could gain only a low amount. There was no effect of induced mood valence on risk-taking behavior. Experiment 2 (N=48) com-

pared a no-arousal control and high arousal conditions, and revealed no differences in risk-taking behavior, suggesting that in Experiment 1, differences in risk-taking between high and low arousal may have arisen from low, rather than high, arousal states. Taken together, these results argue that feedback-mediated arousal instituted in the hot CCT may be moderated by pre-task induction of low-arousal.

## E129

### SUB-SECOND DOPAMINE FLUCTUATIONS IN HUMAN STRIATUM ENCODE SUPERPOSED ERROR SIGNALS ABOUT ACTUAL AND COUNTERFACTUAL REWARD.

Kenneth T. Kishida[1], Ignacio Saez[1,2], Terry Lohrenz[1], Mark P. Witcher[3], Adrian W. Laxton[3], Stephen B. Tatter[3], Jason P. White[1], Thomas L. Ellis[3], Paul E. M. Phillips[4], P. Read Montague[1,5,6]; [1]Virginia Tech Carilion Research Institute, [2]University of California, Berkeley, [3]Wake Forest University Health Sciences, [4]University of Washington, Seattle, [5]Virginia Tech, [6]University College London — In the mammalian brain, dopamine is a critical neuromodulator whose actions underlie learning, decision-making, and behavioral control. Degeneration of dopamine neurons causes Parkinson's disease while dysregulation of dopamine signaling is believed to contribute to psychiatric conditions such as schizophrenia, addiction, and depression. Experiments in animal models support the idea that dopamine release in the striatum encodes reward prediction errors (RPEs: the difference between actual and expected outcomes) during ongoing decision-making. To date, there have been no measurements of dopamine release with the requisite temporal resolution or cognitive challenges required to test this hypothesis directly in the human brain. We monitored sub-second dopamine fluctuations in the striatum of humans with Parkinson's disease and found that dopamine transients did not simply encode RPEs, but were consistent with a signal that superposes these errors with counterfactual prediction errors (CPEs). CPEs act to adjust valuation estimates: gains that 'might have been better' are reduced in value and losses that 'might have been worse' are increased in value. Notably, this compositional encoding of error terms – via sub-second dopamine fluctuations – corresponds with how subjects should feel about an outcome and thus may be one way the brain couples computations over outcomes to feelings about experience in the context of alternative possibilities. Using a novel adaptation of fast-scan cyclic voltammetry we demonstrate that dopamine transients are detectable in humans with Parkinson's disease. We show that longstanding hypotheses generated and supported by work in animal models are incomplete for explaining the neurobiology underlying human cognition.

## E130

### SPONTANEOUS EYEBLINK RATE MODIFIES THE RELATIONSHIP BETWEEN DEPRESSION AND DECISION-MAKING

Kaileigh Byrne[1], Dominique Norris[1], Darrell Worthy[1]; [1]Texas A&M University — Depressive symptomatology has been associated with alterations in decision-making, although the conclusions have been mixed with depressed individuals showing impairments in some contexts, but advantages in others. The dopaminergic system may link depressive symptoms with decision-making performance. In the present study, we assess the role of spontaneous eyeblink rate, a marker of central dopaminergic activity, in moderating the relationship between depressive symptoms and decision-making performance. A non-clinical sample of college-aged students (N=48) completed the spontaneous eyeblink rate recording, the Center for Epidemiological Studies Depression (CES-D) Scale, and the Iowa Gambling Task (IGT) to assess decision-making ability. Regression results revealed that eyeblink rate moderated the relationship between depressive symptoms and advantageous decisions on the IGT in which individuals with more depressive symptomatology and a faster EBR performed better on the task. Further regression analyses of IGT performance for each deck showed that EBR specifically modified selection of Deck D, the advantageous high magnitude, low frequency loss deck, among individuals with more depressive symptomatology. Computational modeling results showed that the Value Plus-Perseveration (VPP) model best fit the data. Correlational analyses between VPP model parameters and EBR and depressive symptoms demonstrated that depressive symptoms alone were associated with enhanced loss aversion behavior, while individuals with a faster EBR and more depressive symptoms exhibited an increased tendency to persevere in selecting options with net gains. These findings suggest that depressed individuals have altered dopamine availability, which may contribute to differences in decision-making behavior.

## E131

### DISSOCIATION OF LOSS AVERSION AND DELAY DISCOUNTING IN TWO VARIANTS OF FRONTOTEMPORAL DEMENTIA

Winston Chiong[1], Kristie Wood[1], Alex J Beagle[1], Ming Hsu[2], Andrew S Kayser[1], Bruce L Miller[1], Joel H Kramer; [1]University of California, San Francisco, [2]University of California, Berkeley — Frontotemporal dementia comprises three clinical variants with linked etiologies that cause progressive degeneration of the frontal and temporal lobes. A behavioral/frontal variant is associated with dramatic changes in personality and behavior. Meanwhile, a semantic/temporal variant, often classified as a language disorder, is also known to cause profound personality changes. Behavioral differences between these variants have not been formally characterized. We presented healthy older control subjects and patients with the behavioral/frontal variant, the semantic/temporal variant, or Alzheimer's disease with two decision-making tasks. In a loss aversion task, participants were endowed with $30 and decided whether to accept 36 gambles offering equal chances of winning or losing more real money, with win:loss amount ratios ranging from 0.6-2.2. In a delay discounting task, participants made 128 hypothetical choices between smaller immediate rewards ($3-90) and larger rewards ($5-100) delayed between 1 week and 6 months. Both tasks included control conditions to exclude patients who could not understand the task. In a general linear model controlling for age, gender, education and MMSE, patients with the behavioral/frontal variant were less loss averse ($\lambda$=1.05, p=0.037) than controls ($\lambda$=1.49), while patients with the semantic/temporal variant were more loss averse ($\lambda$=1.69, p=0.044) than controls. In a second general linear model with the same covariates, patients with the semantic/temporal variant (74.6%, p=0.020), but not patients with the behavioral/frontal variant (53.1%, p=0.107), were more likely to choose smaller immediate rewards than controls (47.3%). Our findings suggest dissociable contributions of frontal and anterior temporal networks to impaired decision-making in neurological disease.

## E132

### ACUTE STRESS AND AGE-RELATED DIFFERENCES IN NEURAL REWARD PROCESSING

Stephanie Potts[1], Travis McCuddy[1], Anthony J. Porcelli[1]; [1]Marquette University — Recent research indicates brain regions involved in processing reward-related information exhibit marked functional changes under acute stress, no longer differentiating between positive and negative monetary outcomes (Porcelli et al., 2012). Further evidence suggests that reward processing capabilities change as a function of age, particularly for negative outcomes (Samanez-Larkin et al., 2007). However, interactions between acute stress and age have not been examined together in this context. This study examined neural reward processing under acute stress between young (18-30; current n = 16) and older adults (over 60; current n = 13). Participants were either exposed to acute stress (social evaluative cold pressor; Schwabe et al., 2008) or a no-stress control before engaging in a novel variant of a well-documented "card guessing task" involving actual monetary rewards and punishments (e.g., Delgado et al., 2000) during fMRI scanning. Choice and fMRI data, psychophysiological measures (blood pressure, skin conductance, and EKG), and salivary cortisol were collected. Preliminary analysis indicates that only stressed participants exhibited elevated psychophysiological measures of sympathetic nervous system reactivity. Salivary cortisol data are currently being assayed; it is expected that only participants exposed to acute stress will demonstrate a significant increase. Consistent with the literature, preliminary fMRI analysis confirms significantly higher striatal responses to monetary gains over losses; more power is needed to examine the role of acute stress. It is expected that in stressed participants striatal and orbitofrontal regions will no longer differentiate between monetary outcomes, and that this pattern will be enhanced in older adults.

## E133

### COMPUTATION AND UPDATE OF NEURAL VALUE SIGNALS ARE BIASED BY ATTENTION IN A MULTIDIMENSIONAL DECISION-MAKING TASK

Yuan Chang Leong[1,2], Reka Daniel[2], Angela Radulescu[2], Yael Niv[2]; [1]Stanford University, [2]Princeton University — Activity in the ventromedial prefrontal cortex (VMPFC) and the posterior cingulate cortex (PCC) has been shown to track measures of subjective value in simple choice tasks. We explored how these neural representations of value are constructed and updated in multidimensional environments. 25 participants performed a decision-making task with multidimensional stimuli and probabilistic rewards. In this task, only one stimulus dimension was relevant for predicting reward. Participants were not told in advance which was the reward-relevant dimension, and had to figure it out via trial-and-error learning. Using eye tracking and multivariate pattern analysis of fMRI data, we measured participants' attention as they performed the task. Participants' trial-by-trial behavior was best explained by a computational model where attention biased how value was computed and updated. Accordingly, we found that value-related activity in the VMPFC and PCC reflected both attentional biases. We further found that participants' focus of attention was dynamically modulated by learned values, and activity in a frontoparietal network, including the dorsolateral prefrontal cortex (dlPFC) and intraparietal sulcus (IPS), was higher when attention switched across dimensions. Taken together, our results suggest that trial-and-error value learning is biased by attention, and that this bias is reflected in signals in medial brain areas (VMPFC and PCC) and might be implemented in lateral control (DLPFC, IPS) regions.

# Poster Session F

## ATTENTION: Other

### F1

**IMPAIRED ATTENTIONAL CONTROL DURING WORKING MEMORY IN PARKINSON'S DISEASE** David Everling[1], Clara Warden[1], Sophie York-Williams[2], Kathleen Poston[1]; [1]Stanford University, [2]University of Colorado Boulder — Working Memory (WM) deficit and Attention Control (AC) impairment are common symptoms in Parkinson's disease (PD). Our previous research revealed WM deficits in PD during a modified-Sternberg task (Poston,2013). These deficits could arise from impairment in AC, which is difficult to disentangle from WM. Striving for this distinction, we employed two WM tasks, each with and without visual distractor conditions. In Task 1 participants memorized five numbers, shown either with alphabetic distractors (High-AC) or without alphabetic distractors (Low-AC). In Task 2 participants memorized 'landscapes' with (High-AC) or without (Low-AC) overlaid 'face' distractors (Gazzaley,2012). Thereby, WM-load was consistent across trials while AC-load varied. That is, High-AC conditions involved equivalent memorization of relevant stimuli as Low-AC conditions, but additionally required increased AC to suppress irrelevant stimuli. We tested 18 PD and 10 age- and education-matched Controls (HC). PD were tested both ON and OFF dopaminergic medications. Task 1 results: PD-OFF (p=0.01), but not HC (p=0.8), had decreased WM accuracy in High-AC compared to Low-AC. AC-related accuracy (High-AC) was improved slightly with dopamine (PD-ON,p=0.08). No reaction time (RT) differences were observed between High-AC and Low-AC in any group. Task 2 results: Both HC (p=0.04) and PD-OFF (p=0.001) had decreased WM accuracy in High-AC compared to Low-AC. AC-related accuracy (High-AC) did not improve with dopamine (PD-ON,p=0.001). PD were slower with distractors present, regardless of medication state (PD-OFF p=0.003;PD-ON p=0.01;HC p=0.8). Our findings help to isolate the influence of AC during WM in PD, and further, indicate that dopamine-replacement may be inconsequential to observed deficits.

### F2

**THE BENEFITS OF VISUO-ATTENTIVE TRAINING ON A MULTIPLE OBJECT TRACKING (MOT) TASK TRANSFER TO ATTENTIONAL, BUT NOT VISUO-PERCEPTUAL TASK PERFORMANCE: THE ROLE FOR FEEDBACK.** Chiara Perico[1,2], Jocelyn Faubert[3], Armando Bertone[1,2]; [1]Perceptual Neuroscience Lab (PNLab) for Autism and Development, McGill University, [2]School/Applied Child Psychology, Dept of Educational and Counseling Psychology, McGill University, [3]Visual Psychophysics and Perception Laboratory, School of Optometry, Université de Montréal — Introduction. Attention plays an integral role in learning, affecting performance on most cognitive tasks. Although tools exist to assess and improve attention, few studies determine the transferability of attentional capacities acquired during training to other cognitive domains. Although feedback plays a critical role during learning, its effects with regards to transfer are not often empirically assessed. Goals. To assess whether attentional capacities acquired during training on a Multiple Object Tracking (MOT) task are transferrable to other measures of attention and perception. The role of feedback was investigated to determine its effect on performance, and subsequent transferability. Methods. Thirty typically developing adults participated in 4 testing sessions. On day 1, intellectual, attentional (CPT-II) and perceptual (sensitivity to motion and form) baseline abilities were assessed along with a baseline MOT performance without feedback. On day 2 and 3, participants were placed into 2 groups; only one group received feedback during MOT training. On day 4, participants were re-assessed on the same attentional and perceptual measures, along with MOT performance. Results. MOT performance at day 4 was higher for the feedback group, defined by increased speed threshold for tracking 4 of 8 items. In addition, improved MOT performance was found to transfer within-domain to other attention tasks (MOT to CPT-II), specifically for the feedback group, but not across domain [i.e., from MOT to form / motion sensitivity] whether or not feedback was available during training. Conclusion Results demonstrate that feedback is important during learning, and that it may affect transferability of cognitive abilities.

### F3

**NEURAL CASCADE OF CONFLICT PROCESSING: NOT JUST TIME-ON-TASK!** Cameron C. McKay[1], Berry van den Berg[1,2], Marty G. Woldorff[1]; [1]Center for Cognitive Neuroscience, Duke University, [2]BCN Neuroimaging Center, University of Groningen, Groningen — In a visual conflict task, such as the Stroop or Eriksen flanker task, participants generally have longer response times (RTs) on trials involving conflict (incongruent trials) compared to congruent trials. Two event-related-potential (ERP) components classically associated with the processing of stimulus conflict are the Ninc (incongruency-related negativity) and LPC (late-positive complex), which are derived from the ERP difference wave of incongruent minus congruent trials. It has been questioned, however, whether the Ninc and LPC, or for that matter other neural measures from conflict tasks (e.g., fMRI), reflect true conflict processing, or whether such effects derive mainly from differential time on task, as it is difficult to distinguish these factors in a conflict task. Here, we leveraged high-temporal-resolution ERP measures of brain activity while participants performed two behavioral tasks, administered in randomized order. The first task, a modified Erikson flanker paradigm (with congruent and incongruent trials), was used to evoke the classic RT and ERP effects associated with conflict. In the second task, a non-conflict comparison condition, participants visually discriminated the sizes of two gaps in a circle (either easy or hard discrimination). Behaviorally, we titrated the parameters to yield virtually identical effects of conflict and difficulty on the RTs (27 ms). Neurally, we found a brief Ninc-like component in the hard-easy trial ERP difference wave, with the corresponding incongruent-congruent Ninc effect featuring a much longer-duration, two-peak structure. These results provide clear evidence that the Ninc incongruency effect does not just reflect time on task, but includes a true conflict-processing component.

### F4

**ATTENTIONAL MODULATION IN THE CEREBELLUM REVEALED BY A MULTIPLE OBJECT TRACKING TASK AND CEREBRO-CEREBELLAR FUNCTIONAL CONNECTIVITY** E.J. Levin[1], J.A. Brissenden[1], K.J. Devaney[1], M.L. Rosen[1], D.E. Osher[1], M.A. Halko[2], D.C. Somers[1]; [1]Boston University, [2]Harvard Medical School and Beth Israel Deaconess Medical Center — Increasing evidence from behavioral and neuroimaging studies supports the involvement of the cerebellum in higher-order cognitive processes. Cerebellar lesions have been associated with attentional deficits (Schweizer et al., 2007), and intrinsic functional connectivity has been established between human cortical networks and specific nodes of the cerebellum (Buckner et al., 2011). Here, we used functional magnetic resonance imaging (fMRI) to investigate cerebellar correlates of attention using a multiple-object tracking task. Additionally, we employed resting-state functional connectivity using cortical seeds (Yeo et al., 2011) to localize cerebellar nodes of cortical networks in individual subjects. Our results indicate a robust attentional effect within cerebellar regions functionally connected to the cortical dorsal attention network. Conversely, cerebellar regions functionally connected to the cortical default mode network show a reliable pattern of deactivation across subjects. These results parallel the patterns simultaneously observed in cortical networks. There is a strong relationship between blood-oxygen-level-dependent (BOLD) signal and the strength of connectivity to the cortical dorsal attention network within individual cerebellar voxels. Taken together, our results demonstrate that regions of the cerebellum co-activate with the cortical dorsal attention network, and suggest that the functional topography of the cerebellum can be accurately characterized by individual connectivity. This work was supported by the National Institutes for Health (NIH R01EY022229).

## F5

### CEREBRO-CEREBELLAR FUNCTIONAL CONNECTIVITY PREDICTS CEREBELLAR ACTIVATION DURING VISUAL WORKING MEMORY TASK PERFORMANCE

J.A. Brissenden[1], E.J. Levin[1], D.E. Osher[1], K.J. Devaney[1], M.A. Halko[2], D.C. Somers[1]; [1]Boston University, [2]Harvard Medical School and Beth Israel Deaconess Medical Center — The study of cerebellum function has traditionally been limited to the motor domain. Recent research has begun to characterize the cerebellum's role in cognition (see Schmahmann, 2010) and has demonstrated intrinsic functional connectivity between cerebral cortical networks and distinct cerebellar regions (Buckner et al., 2011). Here, we investigate cerebellar contributions to visual working memory (VWM). During functional magnetic resonance imaging (fMRI), subjects performed a change detection task in which memory load was parametrically varied. Additionally, we employed resting-state functional connectivity analysis using cortical network seeds (Yeo et al., 2011) to parcellate cerebro-cerebellar networks in individual subjects. A region-of-interest analysis revealed (1) strong load-dependent activation in cerebellar regions functionally connected to the dorsal attention network, and (2) consistent deactivation within cerebellar regions functionally connected to the default mode network. These results mirror the activation patterns observed in cerebral cortical networks. Across the cerebellum, the strength of intrinsic functional connectivity with either the dorsal attention network or the default mode network significantly predicted the response of individual cerebellar voxels. Lastly, we observed a clear left hemisphere bias in cerebellar responses during VWM, consistent with a well-documented right-hemisphere VWM bias seen within the cerebral dorsal attention network. Taken together, our results indicate that cerebellar nodes of the dorsal attention network meaningfully contribute to overall network function. This work was supported by the National Institutes for Health (NIH RO1EY022229) and the National Science Foundation Graduate Research Fellowship Program (DGE-1247312).

## F6

### THE ROLE OF TEMPORAL AND SPATIAL PREDICTABILITY FOR EARLY-ATTENTIONAL ADJUSTMENTS AFTER COGNITIVE CONFLICT

Klaas Bombeke[1], Wout Duthoo[1], Hanne Schevernels[1], Wim Notebaert[1], C. Nico Boehler[1]; [1]Ghent university — Cognitive control refers to our ability to adjust information processing in order to optimize future action outcomes. An often-studied phenomenon is the congruency sequence effect - the finding that congruency effects in conflict tasks are smaller after incongruent trials. This effect is commonly explained by a transient, conflict-induced increase in selective attention, wherein the amount of conflict on the next trial is reduced by enhancing task-relevant information, inhibiting task-irrelevant information, or both. While fMRI data exists to support this claim, information about the temporal dynamics of such effects is very limited, in part because it is difficult to distinguish responses to the simultaneously presented relevant and the irrelevant stimulus dimension with EEG. Here, we addressed this problem by systematically varying the temporal onset of the relevant and the irrelevant stimulus dimension. Moreover, we manipulated whether irrelevant information was temporally predictable or not and included both Stroop and Flanker tasks to compare feature and spatial attention, respectively. Results show that when task-irrelevant stimulus information was consistently presented 200 milliseconds before the relevant stimulus information, we found a significant posterior difference around 140 milliseconds (visual N1) depending on the previous trial's congruency. This effect only appeared in the flanker task, indicating a role for spatial attention. Taken together, these results suggest that attentional adjustments only occurred when irrelevant, potentially conflicting information was both temporally and spatially predictable. As such, our study identified an attentional control mechanism that seems to lie at the crossroads between reactive, conflict-induced and proactive, strategic control adjustments.

## F7

### ATTENTION AND MEMORY FUNCTIONING IN SCHOOL-AGED CHILDREN AND YOUNG ADULTS WITH BRAIN AND CNS TUMORS AFTER PROTON RADIATION THERAPY

Casey L. Evans[1], Julie A. Grieco[1], Brendan H. Pulsifer[1], Torunn I. Yock[1]; [1]Massachusetts General Hospital — Purpose: Radiation is integral in treatment of brain and central nervous system (CNS) tumors. However, conventional photon radiation is associated with negative cognitive sequelae. Proton radiotherapy (PRT), which enables better targeting of tumors, might entail fewer sequelae. This study examined neurocognitive functioning after PRT, specifically attention and memory due to their relevance for academic success. Method: 65 patients, ages 5–21 (Mean=11.2;SD=4.3) were evaluated at PRT initiation and ≥1 year after (Mean=2.5 years;SD=2.0). Intelligence, sustained attention, and memory were assessed with age-appropriate standardized measures. Results: Subjects were 46% medulloblastoma, 17% craniopharyngioma, 9% ependymoma, 28% other; 51% received whole brain radiation; 61% chemotherapy; 82% had resection; 53% were infratentorial. Baseline and follow-up mean scores were all within the average range. IQ, working memory, sustained attention, and verbal and visual memory for the total sample were unchanged at follow-up (ns). Age at baseline, histology, chemotherapy, resection, and location were unrelated to cognitive outcomes. Mean scaled scores for females were lower than males in verbal immediate (p=0.03) and delayed memory (p=0.01) at follow-up. Conclusion: Nearly 2½ years after PRT, attention, memory and intelligence were largely stable. Younger patients did not fare worse, a favorable outcome to photon radiation. Females did not make steady gains in verbal memory, although no decline was observed. PRT shows promise as a treatment for CNS tumors, avoiding many negative neurocognitive sequelae and increasing the potential for academic success.

## F8

### THE PHYSICAL SALIENCE AND REWARD VALUE OF A TARGET IMPROVE VISUAL SEARCH THROUGH DIFFERENT MECHANISMS

Lingling Wang[1], Marissa L. Gamble[1], Molly M. Pearlstein[1], Sam N. Brudner[1], Marty G. Woldorff[1]; [1]Duke University — In visual search tasks, targets associated with reward have been found to improve performance. One possible explanation is that increased target value facilitates attentional capture and orienting similarly to increasing physical salience. We tested this hypothesis by manipulating target salience and value in a visual search task, while recording behavior measures and ERPs, with a focus on the attentional-orienting-sensitive N2pc component. In three experimental phases, participants searched visual arrays for color-singleton targets of either a high-salience color or one of two low-salience colors. In the baseline phase, which offered no rewards, the response times (RTs) and N2pc latencies were shorter for high- than low-salience targets, indicating faster attentional selection and orienting. In the equal-reward phase, participants received monetary rewards for fast and correct responses at the same low-level reward rate for all target types. This reward context improved the overall search performance, similarly shortening RTs for both high- and low-salience targets, whereas no change was observed on the N2pc latencies. In the selective-reward phase, the reward rate was made selectively higher for one of the two low-salience colors, which resulted in the RTs to these low-physical-salience targets becoming as fast as the high-physical-salience targets. In spite of the equally fast behavioral performance, the N2pc for low-salience, high-reward targets was still later than that for high-salience targets, although it was significantly larger. These findings suggest that target reward associations can rapidly modulate visual selection, but the underlying mechanisms are different than those related to true physical salience.

## F9

### THE ROLE OF CONTEXT IN GAZE-TRIGGERED ORIENTING TO HAPPY AND DISGUSTED GAZING FACES

Rachel Layton[1], John Treffalls[1], Natalie Ceballos[1], Reiko Graham[1]; [1]Department of Psychology, Texas State University — Evidence regarding the moderating role of facial expression on gaze-triggered orienting has been mixed, suggesting that experimental context and task demands are important factors in these effects. This study examined how experimental context influences gaze and expression interactions in an attentional orienting task with expressive gazing cues (disgusted and happy faces) and targets depicting prosocial or antisocial acts. Seventy-three participants (Mage = 19.0 years) completed a Posner-style cuing task wherein expressive faces (disgusted vs. smiling) either validly or invalidly cued the location of targets. Repeated measures ANOVA of mean reaction times to identify targets revealed that participants were faster to identify prosocial vs. antisocial targets, and faster to detect targets

cued by happy faces. These main effects of cue expression and target type were mitigated by an interaction, driven by the fact that participants were faster to identify antisocial acts cued by disgusted faces. There was also a cue expression by validity interaction: the cuing effect (faster RTs to validly-cued trials) was only present for disgusted faces, and not for happy faces. These results suggest that participants were forming cue/target contingencies based on the context created by pairing emotional faces with motivationally relevant cues. Thus, expectancies created by experimental context are an important determinant of gaze and expression interactions and gaze-triggered orienting.

## F10

### VISUAL ATTENTION TO A VIDEO-CLASS INCREASES FOLLOWING AUDITORY DISTRACTORS WHEN STUDENTS ENJOY THE CLASS: AN EYE-TRACKING STUDY

Luana Righi[1], Hamilton Haddad[1], Gilberto Fernando Xavier[1]; [1]University of São Paulo — Aim: This study investigated the effect of auditory distractors on orientation of visual attention during a video-class on physiology and its interaction with participant's enjoyment. Methods: Twelve participants watched a video-class on physiology during which 6 auditory distractors lasting about 710 ms each were individually and unpredictably presented. The participants were strongly encouraged to attend to the video-class and were informed that there would be an exam after the video. At the end of the presentation, the participants rated how much they enjoyed the video-class using a visual scale. Based on this scale, the participants were divided into two groups: low rates group (rate=6.9±1.15 mean±s.d; n=6) and high rates group (rate=9.15±0.62 mean±sd; n=6). Eye movements were recorded during the video-class. Average fixation durations (FD) along areas of interest (AOIs), defined as the entire area of the video-class projection, lasting 1000 ms each before and after distractors presentations was evaluated. Results: Groups' FD in AOI before distractor presentation did not differ among each other (P=0.80). In contrast, FD after distractor presentation was longer for high rate group as compared to low rate group (P=0.03). Finally, only high rate group exhibited an increase in FD after distractor presentation as compared to before (P=0.01). Conclusion: Unpredictable auditory distractors presentations lead to an increase in the fixation duration shortly after their presentation when participants enjoyed the video-class. It suggests the occurrence of an increased orientation of attention towards information considered relevant when internal motivation is high.

## F11

### TRACKING THE LOCUS OF LEARNED SELECTIVE ATTENTION DURING RULE LEARNING WITH MULTI-VOXEL PATTERN ANALYSIS

Dmitrii Paniukov[1], Tyler Davis[1]; [1]Texas Tech University — Attention plays a critical role in category learning by enhancing processing of stimulus features that are diagnostic of category membership. Recently, multivoxel pattern analysis (MVPA) methods have been used to decode the locus of attention in basic cuing paradigms and naturalistic target detection tasks (e.g., movies). In the present study, we examined whether MVPA could be used to measure the changes in selective attention that are theorized to occur during rule-based category learning. To study the temporal dynamics of learned selective attention, we utilized two independent rule-based category learning tasks. In the matching task, participants learned a rule via trial-and-error by selecting one of four target stimuli that matched a reference stimulus on a single feature. In the categorization task, participants learned a rule via trial-and-error by categorizing one stimulus at a time into one of two categories. In both tasks, when the rule was learned, it was switched to another rule. Using fMRI data from the matching task as a training set, we found significant increases in MVPA classifier output for diagnostic features as subjects solved rules in the categorization task. These results suggest that MVPA may be useful for testing theories of learned selective attention in category learning.

## F12

### LEVERAGING OBJECT SELECTIVITY TO MODEL THE ROLE OF LEARNED SELECTIVE ATTENTION IN BASE-RATE NEGLECT

Sean O'Bryan[1], Tyler Davis[1]; [1]Texas Tech University — Selective attention is a critical component of learning that allows people to distinguish between useful and irrelevant information. In this experiment, we investigated the neural basis of selective attention in cue learning and how it contributes to base-rate neglect. Subjects learned to predict four hypothetical diseases based on a combination of face, object, and scene cues. Objects and scenes were diagnostic cues, and predicted either a common or rare disease. Prior to the task, we collected independent localizer scans that were used to train a classifier to distinguish between activation patterns for the different object classes. This classifier was then used to predict attention to cues during learning and test. During learning, classifier output was significantly higher for diagnostic cues than non-predictive cues. During test, ambiguous trials were presented in which a cue for the rare disease was paired with a cue for the common disease. Consistent with previous behavioral results, participants ignored the disease base rates and selected the rare disease more often. Accordingly, classifier output was significantly higher for the rare cue than common cue. These results support attentional models of base-rate neglect and suggest that multi-voxel analyses can be used to test theories of learned selective attention.

## F13

### SEMANTIC CATEGORIZATION IN INHIBITORY PROCESSING FOR MEDICATION-NAIVE ATTENTION-DEFICIT HYPERACTIVITY DISORDER ADOLESCENTS

Demi Krieger[1], Neena K. Rao[1], Bambi Delarosa[1], Michael A. Kraut[3], John Hart, Jr.[1,2]; [1]University of Texas at Dallas, Center for Brain Health School of Behavioral Brain Sciences, [2]University of Texas at Southwestern Medical Center, Department of Neurology, [3]Johns Hopkins University, Department of Radiology — The primary goal of this study was to investigate how semantic complexity influences inhibition in children with ADHD. While EEG was recorded, six male medicine-naive adolescents diagnosed with ADHD and six male neurotypical adolescents completed three versions of a response inhibition task in which the complexity of semantic processing was manipulated. The lowest level of semantic processing required only simple feature-based discrimination (i.e, respond to a picture of a single car [80% Go] but not a single dog [20% No-Go]; the next level required more complex feature-based discrimination (i.e, respond to multiple types of cars but not multiple types of dogs); and the highest level required conceptual-based discrimination (i.e, respond to objects but not animals). The difference in mean evoked potential amplitudes for No-Go compared to Go responses at 300 ms (P3) in frontal regions (Fz) decreased as each task increased in semantic complexity for ADHD adolescents. The control group only showed a difference in mean evoked potential amplitudes at 300 ms in frontal electrodes for the most semantically complex condition. The pattern of frontal-mediated inhibition effects for the ADHD group compared to the control group suggests that successful inhibition for adolescents with ADHD requires greater involvement of frontal-mediated semantic resources.

## F14

### NOT ALL MIND WANDERING IS CREATED EQUAL

Paul Seli[1], Tanya Jonker[1], Daniel Smilek[1], Jonathan Smallwood[2]; [1]University of Waterloo, [2]University of York — The available evidence suggests that mind wandering can occur either spontaneously (unintentionally) or deliberately (unintentionally). In the present study, we related individual differences in spontaneous and deliberate mind wandering to resting-state functional connectivity maps, using the default mode network (DMN) hubs as seed regions (PCC, mPFC, and hippocampal formation). Critically, although the DMN is commonly believed to reflect increases in mind wandering, we found stronger functional connectivity between the DMN and the hippocampal formation for individuals who self-reported less spontaneous mind wandering. These results suggest that the relationship between the functional activity of the DMN and experiences such as mind-wandering is more complex than typically assumed, and demonstrate the value of understanding the heterogeneous nature of self-generated experiences as a lens through which to understand intrinsic neural processes.

# EMOTION & SOCIAL: Emotion-cognition interactions

## F15

### AN ELECTROPHYSIOLOGICAL STUDY ON THE INFLUENCE OF EMOTION ON INTERFERENCE CONTROL IN CHILDREN

Aishah Abdul Rahman[1], Sarah Elke[1], Sandra Wiebe[1]; [1]University of Alberta — Early childhood is marked by rapid development in children's cognitive and emotion regulation abilities. In this study, we examined how emotion influenced children's ability to resist distractor interference at the behavioural and neural levels. Two groups of children, in early childhood (n = 19; mean age = 5;1) and middle childhood (n = 18; mean age = 7;5), completed a face flanker paradigm while scalp EEG was recorded. Children were asked to press a button indicating the colour of the border around the central target face, ignoring the flanking distractor faces bordered by the same (congruent) or different (incongruent) colour. The target face was happy, angry, or neutral. Dependent measures included accuracy, speed, and event-related potential (ERP) measures (N2 amplitude and latency). Children responded slower on incongruent trials. Trials with happy and angry targets had differing effects on children's performance: happy targets facilitated task accuracy, whereas angry targets slowed responding. The effect of emotion on resisting distractor interference varied with age: in older children only, N2 latency was earlier for angry targets than happy targets. Our findings, in keeping with the dual competition framework (Pessoa, 2009), highlight that cognitive performance may be enhanced or impaired by emotion. The contrasting manner in which happy (low level of threat) and angry (high level of threat) targets influenced children's performance suggests that the level of threat in the emotional information is crucial in determining its effect on cognitive performance.

## F16

### DIFFERENTIAL AMYGDALA SUB-NUCLEI FUNCTIONAL CONNECTIVITY SUPPORTS AFFECTIVE PROCESSING IN BIPOLAR AND UNIPOLAR MOOD DISORDERS

Vincent Man[1], June Gruber[2], David C. Glahn[3], William A. Cunningham[1]; [1]University of Toronto, [2]University of Colorado Boulder, [3]Yale University — There has been increased recent attention to understanding the unique functions of the sub-nuclei within the amygdaloid complex (Roy et al., 2010), which can be distinguished in cytoarchitecture and connectivity (Sah et al., 2003), and their role in affective processing. In light of these insights, we examined functional connectivity (FC) across sub-regions of the amygdala in bipolar disorder (BD). BD is characterized by fluctuations between manic, depressive, and euthymic mood states, and we propose that FC disruptions between the amygdala and prefrontal cortex regions (Anticevic et al., 2013) may distinguish bipolar disorder from other affective disorders. We explored differential FC patterns to valenced stimuli among currently manic bipolar (BD-manic; n=9), depressed bipolar (BD-depressed; n=11), and depressed unipolar (MDD-depressed; n=15) adults. All participants viewed blocks of positive, negative, and neutral images (IAPS; Lang et al., 2008) during fMRI. We found that FC between the whole amygdala and a supragenual cingulate cluster when processing affective information can differentiate between current mood state across disorders. The BD-depressed group showed stronger negative connectivity for negative, compared to positive or neutral, stimuli. The BD-manic group exhibited the reverse effect. Further, decreased FC was found for MDD-depressed participants regardless of stimuli valence. Exploring the sub-nuclei separately demonstrated that whole-amygdala results are predominantly explained by the laterobasal nuclei. These findings are consistent with the idea that the supragenual cingulate may play a regulatory role in its interaction with the specific regions of the amygdala, and a reduced regulatory process may account for current symptoms in affective disorders.

## F17

### EEG CORRELATES OF ENGAGEMENT IN AN ASSESSMENT CONTEXT

Laura Halderman[1], Bridgid Finn[1], Nicole Long[2], Isaac Pedisich[2], Patrick Crutchley[2], Michael Kahana[2]; [1]Educational Testing Service, [2]University of Pennsylvania — Low engagement is problematic when tests are low-stakes for students but have significant consequences for teachers or schools. Low engagement results in scores that underestimate actual abilities which jeopardizes test validity and leaves institutions drawing questionable conclusions about the efficacy of their programs. Online measurement of engagement using EEG provides an objective view into the test-taker's experience and potentially yields stronger evidence of engagement than self-report measures. The current study sought to establish EEG correlates of engagement to be used in future studies to investigate improvements in assessment designs that foster engagement during the test. Forty university students participated in a simulated GRE session while EEG was recorded from 128 channels. Participants completed two verbal and two quantitative GRE test blocks for a total of 40 items each and after half of the items rated their engagement on a scale of 1-6. Power in 7 frequency bands (delta, theta, alpha, beta, low, medium and high gamma) was computed for 6 ROIs on the scalp (left/right frontal, left/right temporal and left/right parietal). Correlations between engagement ratings and power in each frequency band revealed positive correlations for gamma in right frontal, left temporal and left/right parietal ROIs and beta in left temporal and right parietal ROIs. Negative correlations were found for alpha and beta in left frontal and right temporal ROIs. An ANOVA contrasting high (ratings of 4-6) and low (1-3) engagement confirmed these results. Additional analyses will investigate how item type (verbal vs. quantitative) and session length modulate levels of engagement.

## F18

### DECREASES IN CORTISOL ARE POSITIVELY ASSOCIATED WITH IMPROVEMENTS IN EXECUTIVE CONTROL

Arryn Robbins[1], Laura Thompson[1]; [1]New Mexico State University — Research in stress reactivity in the hypothalamic-pituitary-adrenal axis (HPA Axis) has uncovered influences on memory systems (e.g. de Quervain, Roozendaal, & McGaugh, 2013; Wolf, 2003), but has yet to disentangle effects on attentional processes. This study examined the influence of cortisol and acute psychosocial stress on attention network performance. In one session, male participants completed the Attention Network Test (ANT; Fan et al., 2002) before (T1) and after (T2) participating in a psychosocial stressor (the Trier Social Stress Test; TSST) or the placebo version of the TSST. Salivary cortisol samples were collected at baseline (20 mins post-lab entry;T1) and (20 mins post-stressor;T2) points throughout the study. Participation in the placebo TSST condition yielded less efficient performance in the alerting measure (though marginally significant) and better efficiency in the executive control measure of the ANT. The stress (TSST) condition did not yield a change in the performance of any attention measure. Cortisol reactivity (T2-T1) was a significant predictor of executive control performance at T2. The results of the study indicate that decreases in cortisol yield better performance in executive control and increases in cortisol reactivity prevent improvement over time. This study also adds to research demonstrating that glucocorticoid receptors in the prefrontal cortex (associated with executive control; Fan et al., 2005) could contribute to known impairments in executive functioning during stress (e.g. Arnsten, 2009 for a review; Butts, Weinberg, Young & Phillips, 2011).

## F19

### EFFECTS OF SHORT-TERM ENVIRONMENTAL ENRICHMENT AND PHYSICAL EXERCISE ON BEHAVIOUR, MEMORY AND COGNITION

Gaurav Singhal[1], Emily Jaehne[1], Frances Corrigan[2], Bernhard Baune[1]; [1]Psychiatric Neuroscience Lab, School of Medicine, Discipline of Psychiatry, The University of Adelaide, Adelaide, Australia, [2]Discipline of Anatomy and Pathology, School of Medical Sciences, The University of Adelaide, Adelaide, Australia — Background: The beneficial effect of environmental enrichment (EE) with toys and novel objects and/or physical exercise (Ex) in improving cognition and other behaviors has been well established. However, little is known about the distinct effects of short-term EE when used alone and in combination with Ex on behavior in young and middle aged mice. Methods: C57BL/6 mice aged either 3 or 8 months old, were housed for one month in cages with toys and novel objects to act as EE, an exercise wheel for voluntary exercise, a combination of the two, or with standard housing as a control. At the end of this period (at either 4 or 9 months), a behavioral battery was undertaken to assess cognition and depressive like behavior. Results: Ex mice showed an increase in depressive-like behavior at 4 months, with increased immobility time on the FST ($p=0.0038$), and impaired cognition, with higher latencies to find the escape box in the Barnes Maze ($p<0.05$) compared to control mice. EE significantly reduced depressive-like behavior on the

FST at 9 months (p=0.022) but not at 4 months compared to control mice. Conclusion: Short-term exercise in mice appears to impair cognition and increase depression-like behavior at 4 months of age, while EE appears to reduce depressive-like behavior at 9 months of age. Further experiments on 14 month old mice and with a longer duration of EE are being conducted to fully elucidate the effects of EE and Ex on behavior.

## F20

### GREAT EXPECTATIONS: THE ROLE OF SOCIAL RULES IN GUIDING PRO-SOCIAL BEHAVIOUR IN GROUPS WITH HIGH VERSUS LOW AUTISTIC TRAITS

Leila Jameel[1], Karishma Vyas[1], Giulia Bellesi[1], Shelley Channon[1]; [1]University College London — Autism spectrum disorder (ASD) is a neurodevelopmental condition characterised by social difficulties. A continuum approach that measures autistic traits in the general population has proven sensitive for investigating links to cognition, but little work has explored the relationship with social behaviour. A recent study examining pro-social behaviour in those high versus low in autistic traits found that when presented with scenarios depicting characters in need, the high autistic trait group was less pro-social and reported reduced personal reward for engaging in pro-social behaviour, compared to the low autistic trait group (Jameel et al., 2014). The present study followed up this work by investigating understanding of the social rules that influence expectations to help others, and subsequent pro-social behaviour. A novel scenario-based task, 'Social Expectations', describing characters in need of help, was administered to students scoring high versus low on the Autism-Spectrum Quotient. Scenarios had two variants, underpinned by either a 'clear-cut' or an 'ambiguous' social rule. Participants high in autistic traits were less pro-social and sympathetic overall towards the characters than those low in autistic traits. The high trait group gave similar ratings of the characters' expectations of help, but provided more simplistic and rigid rule-based explanations. The groups were not differentially affected by the strength of the social rule. This pattern of relatively intact knowledge of societal rules, but impaired social/emotional processing, in the context of reduced pro-social behaviour has implications for informing social skill training programmes.

## F21

### "HOW CAN I PUT THIS?" RAISING EVERYDAY AWKWARD ISSUES IN SOCIAL SITUATIONS IN PEOPLE WITH AUTISM SPECTRUM DISORDER

Giulia Bellesi[1], Karishma Vyas[1], Leila Jameel[1], Shelley Channon[1]; [1]University College London — Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by marked deficits in social interaction. It has been associated with abnormalities in a range of brain areas involved in social and emotional processing. Whilst previous work has explored the social difficulties encountered by those with ASD, little research has examined their understanding of the rules underpinning social interactions, and ability to apply these rules. In the present study, neurotypical participants and those with ASD were presented with a series of scenarios describing everyday social interactions between two fictional characters. There were two versions of each scenario, one with two characters familiar to one another and one with two strangers. In each scenario, the participant had to decide whether the main character should raise an awkward issue, and to say how they should phrase this. Participants then made a series of judgements about the appropriateness of the situations. The results suggested that the participants with ASD were less skilled than the neurotypical group in phrasing their responses, but were similar in their judgments of the situations. These findings are explained in relation to recent cognitive and neural accounts of ASD. The implications for developing interventions to tackle the everyday difficulties experienced by those with ASD are discussed.

## F22

### PREDICTIVE NEURAL CODES ENHANCE THE PERCEPTION OF THREATENING STIMULI

Tamara Sussman[1], Jingwen Jin[1], Akos Szekely[1], Aprajita Mohanty[1]; [1]Stony Brook Univeristy — Threatening stimuli exist in a complex visual environment and require fast, adaptive responses. The perceptual prioritization of threatening stimuli is attributed to bottom-up stimulus driven factors. However, expectation of threat due to implicit or explicit cues enhances perception. According to the predictive coding hypothesis, the brain anticipates the forthcoming sensory environment, generating a template against which observed sensory evidence is matched. Here we test the hypothesis that the expectation of an emotional stimulus, rather than a physical encounter with it, is a key factor in improved threat detection. Participants were cued to detect perceptually degraded fearful and neutral faces presented at pre-determined ideographic thresholds in a two-alternative forced-choice perceptual discrimination task while functional resonance imaging (fMRI) data was recorded. Signal detection and multivariate pattern analyses (MVPA) of fMRI data was conducted. Compared to neutral cues, threatening cues enhanced perceptual sensitivity (d-prime; $t = 2.10$, $p = .05$) and speed ($t = 5.80$, $p < .001$) of detection of upcoming targets. Multivariate pattern analysis of fMRI data show pre-(cue-related) and post-stimulus representations of fearful faces are more positively correlated than pre- and post-stimulus representations of neutral faces in both the amygdala ($t = 6.07$, $p < .001$) and fusiform face area ($t = 7.69$, $p < .001$), suggesting that more effective pre-stimulus templates for threatening faces are instantiated in limbic and face-sensitive sensory cortex. These findings support the predictive coding theory and establish the importance of top-down, endogenous factors in the perceptual prioritization of threatening stimuli.

## F23

### RAPID INVOLVEMENT OF THE PREFRONTAL CORTEX DURING ATTENTIONAL BIAS TO FEARFUL FACES: A NEAR-INFRARED SPECTROSCOPY STUDY

Robert Torrence[1], Keara Kangas[1], Joshua Carlson[1]; [1]Northern Michigan University — Orienting attention towards threating or emotionally valanced stimuli is evolutionarily important for survival. Previous research has used fearful faces to capture visuospatial attention in the dot-probe task while measuring brain activity with fMRI. This research has identified an amygdala – prefrontal network for the orienting of visuospatial attention to emotionally valanced stimuli. However, little is known about the temporal dynamics of prefrontal cortical activity in attentional capture by threat. Here, we examined PFC activity using near-infrared spectroscopy (NIRS)—which has excellent temporal resolution compared to fMRI—during the dot-probe task with three trial types: baseline (two neutral faces), congruent (dot appears behind the fearful face), and incongruent (dot appears behind the neutral face). This study had three hypotheses: 1) reaction time (RT) for congruent trials would be significantly faster than incongruent trials, 2) RT for baseline would be slower than congruent, but faster than incongruent, and 3) PFC activity would have greater during congruent and incongruent trials compared to baseline. Congruent trial were faster than incongruent with baseline falling in between. The NIRS data indicated that there was a relative increase in oxygenated hemoglobin (HbO) in the left PFC during congruent and incongruent trials compared to baseline trials. The data suggests that the left PFC is involved in the engagement and disengagement of visuospatial attention to fearful faces.

## F24

### FRONTAL THETA PHASE SYNCHRONY AFTER FEEDBACK PRESENTATION PREDICTS BEHAVIORAL ENGAGEMENT

Kyle Curham[1], Andrew Bismark[2], John Allen[1]; [1]University of Arizona, [2]VISN-22 Mental Illness, Research, Education and Clinical Center (MIRECC), VA San Diego Healthcare System — The Feedback Related Negativity (FRN) is a medial-frontal event-related potential (ERP) in the theta (4-7 Hz) range that occurs in response to worse-than-expected feedback. A previous study using the current dataset showed a diminished FRN when participants passively observed the task, not participating in choice-selection [1]. It has previously been shown that theta synchrony between medial and lateral frontal sites predicts theta power, which in turn predicts behavioral adaptation [2,3]. This study compared inter-trial phase synchrony when participants actively participated or passively observed a 4-choice gambling task. Participants were presented with win/loss feedback after each choice. Participants only behaviorally engaged the task during the self-choice condition. During the first observation condition, participants watched as choices were made by the computer. In a third condition, participants again passively observed, but the time between choice and feedback was varied. Forty-six participants completed the task with 64 channel EEG data available. Single-trial data were convolved with complex Morlet wavelets to extract instantaneous power and phase. Inter-trial phase locking and power Z-scores were computed by permutation t-tests, and compared between win and loss conditions. Dif-

ference scores were entered into a one-way repeated measures ANOVA to compare between self-choice and observation conditions. Increased phase locking was observed on loss relative to win trials, only in the self-choice condition. This suggests that medial frontal inter-trial phase synchrony is a marker of behavioral engagement.

## F25

### "YOU SCRATCH MY BACK, AND I MIGHT SCRATCH YOURS" – RECIPROCITY IN GROUPS HIGH AND LOW IN PSYCHOPATHIC TRAITS

Karishma Vyas[1], Leila Jameel[1], Giulia Bellesi[1], Shelley Channon[1]; [1]University College London — Psychopathy is a disorder characterised by impaired affective processing, interpersonal difficulties, and behavioural problems. A substantial body of work has examined cognitive and emotional functioning in psychopathy; this has typically been carried out using abstract laboratory tasks within the prison population. However, very little work has investigated how psychopathic traits in the general population influence everyday social behaviour. The present study examined how individuals high versus low in self-reported psychopathic personality traits performed on a novel measure of reciprocity in social interactions. Participants were presented with a series of scenarios in which they chose whether to reciprocate a social favour. Each scenario had two variants in order to manipulate the value of the social favour, such that reciprocal actions were advantageous to the participant in one variant, and disadvantageous in the other. Participants were asked to decide the extent to which they would reciprocate by selecting amongst alternative courses of action, and to rate how satisfied they would feel with each alternative. As predicted, the high psychopathic trait group was significantly less reciprocal than the low psychopathic trait group, and reported significantly less satisfaction with reciprocal courses of action. However, the groups were not differentially influenced by the type of variant (advantageous or disadvantageous). All participants were more likely to reciprocate in the advantageous condition, and also reported greater satisfaction with reciprocal actions in this condition. The potential long-term implications of the findings for increasing prosocial behaviour in individuals with psychopathic traits are discussed.

## F26

### CONTEXTUAL LEARNING AND THREAT DETECTION

Akos Szekely[1], Suparna Rajaram[1], Aprajita Mohanty[1]; [1]SUNY Stony Brook University — It is hypothesized that threatening stimuli are detected better than neutral stimuli due to bottom-up stimulus-related factors. However, stimuli are not perceived in isolation; they exist embedded in a rich global context consisting of other stimuli. Robust memory of regularities within these visual contexts guides faster detection of embedded targets, as demonstrated by the contextual cuing effect (Chun & Jiang, 1998; Chun & Phelps, 1999). Using variants of the contextual cuing task in which a threatening schematic face appeared in spatial configurations of faces that were either novel or repeated, the present study tests whether contexts can be learned to more effectively guide detection of threatening than neutral targets. Participants (N=24) detected threatening faces faster (no speed-accuracy tradeoffs) across trial blocks in repeated versus novel contexts, $F(2, 21) = 7.40$, $p = 0.01$, establishing that contextual learning guides detection of threatening stimuli. In the next experiment, we limited display exposure time and compared threat versus neutral detection times. Participants (N=33) detected threatening faces faster (again, no speed-accuracy tradeoffs) than neutral faces across trial blocks more in repeated versus novel contexts, $F(3, 84) = 3.67$, $p < 0.05$, with steeper learning slopes in repeated contexts for threatening targets than for neutral targets, $t(3) = -10.73$, $p < 0.01$ or for threatening targets in novel contexts, $t(3) = 4.89$, $p < 0.05$. Present findings indicate that contextual learning occurs more effectively when threatening stimuli are present, and demonstrate how memory and attention interact to optimize visual processing of threatening stimuli.

## F27

### NEURAL AND PSYCHOLOGICAL CORRELATES OF EMOTIONAL FACE PERCEPTION IN PSYCHOTIC DISORDERS

Amri Sabharwal[1], Prerona Mukherjee[1], Akos Szekely[1], Roman Kotov[1], Aprajita Mohanty[1]; [1]Stony Brook University — Deficits in emotional face perception are prominent impairments in schizophrenia, and their biological correlates have been recommended as viable candidates for biomarker development by the cognitive neuroscience treatment research to improve cognition in schizophrenia (CNTRICS) initiative. Emotional face perception has also been found to be a strong predictor of quality of life and functioning in schizophrenia. However, it is unclear whether emotion perception-related deficits and imaging biomarkers are specific to schizophrenia or present generally in psychosis, and whether they predict real-world functioning. In the present study, behavioural and fMRI data were recorded while patients with schizophrenia (SZ; N=24), other psychoses (OP; N=26), and controls (NP; N=29) performed a task matching faces based either on emotion or on identity. A 3x2 repeated measures ANOVA showed a significant interaction effect between diagnostic group and matching condition. Compared to NP and OP, SZ showed worse accuracy for matching emotions than matching identity. This deficit correlated with higher negative symptoms and worse social functioning and global assessment of functioning (GAF) scores. Preliminary neuroimaging results show that, in SZ, during emotion face matching there is greater activity in fusiform gyrus and inferior occipital gyrus, regions involved in processing identity of faces. Coupled with worse emotion matching performance in SZ and correlation with symptom-related and real-world functioning measures, present findings establish the importance of emotion perception measures in SZ and highlight the value of imaging biomarkers in informing clinical applications.

## F28

### INTEGRATION OF EXPECTED STIMULUS SALIENCY AND PROBABILITY ENHANCES PERCEPTION: EVIDENCE FROM PERCEPTUAL PSYCHOPHYSICS AND MULTIVARIATE PATTERN ANALYSES (MVPA)

Jingwen Jin[1], Tamara Sussman[1], Aprajita Mohanty[1]; [1]SUNY-Stony Brook University — Studies show that expectation of threatening stimuli results in faster and more accurate detection of upcoming stimuli. These studies manipulated expectation by selectively biasing processing of threatening or neutral stimuli. In the present study we manipulated the probability of occurrence of upcoming stimuli. In a two-alternative forced-choice perceptual discrimination task, participants used 25%, 50%, and 75% likelihood cues to detect perceptually degraded threatening or neutral faces presented at their pre-determined perceptual threshold, while functional magnetic resonance imaging (fMRI) data were recorded. Behavioral pilot results (N=29) showed greater perceptual sensitivity (d-prime) for threatening versus neutral, $F(1, 28)=18.24$, $p<0.001$ and high versus low probability, $F(2,56)=5.26$, $p<0.005$) cues. An interaction in RT, $F(2,56)=5.55$, $p<0.005$ indicates faster detection of faces following high probability threatening but not neutral cues. Preliminary searchlight MVPA of fMRI data (N=3) indicates that local pattern representations of threatening and neutral cues are more distinguishable at higher (75%) than lower probability (25%) conditions ($p<0.001$, uncorrected, 100-voxel cluster extension) in superior occipital and inferior parietal lobes indicating these regions integrate salience and probability-related information. Future analyses will examine whether, compared to neutral cues, ensemble codes for high probability threatening cues better predict upcoming threatening stimuli than low probability cues, further clarifying the neural mechanisms by which the brain integrates prior saliency and probability information to enhance perception.

## F29

### CHRONIC VIOLENT VIDEO GAMERS: AVOIDANT, BUT IN CONTROL

Robert T. Palumbo[1], Laura Stockdale[2], Kavita Patel[3], Rebecca L. Silton[4], Robert G. Morrison[5]; [1]Loyola University Chicago — Media violence research has shown an association between media violence exposure and increased aggression, and decreased prosocial behavior. Participants who played a violent video game for 20 minutes more quickly and accurately identified angry faces as opposed to happy faces (Kirsh & Mounts, 2007). Researchers have shown that abnormal facial processing and poor behavioral regulation abilities are related to aggression; however, no known research has examined the influence of chronic exposure to violent video games on the neural correlates of emotional face processing and inhibitory control. 31 chronic violent video gamers (CVVG; 30+ hours/week playing violent video games) and 31 non-chronic gamers (control; <5 hours/week playing non-violent action games) male undergraduate students completed a stop-signal task using equally arousing fearful and happy faces while brain activity was recorded using scalp electroencephalography (EEG). Participants were asked to identify the gender of the faces with no explicit mention of emotion, and to inhibit their response when a stop-signal appeared. No behavioral differences were observed across groups in gender discrimination or stopping accu-

racy or reaction time (RT). However, CVVGs displayed reduced occipital P100 amplitude relative to controls. CVVGs also displayed reduced central P300 amplitude on stop trials compared to controls. We believe in this context the reduction in the P100 amplitude suggests that the CVVGs have reduced early attention for emotional faces while the reduced P300 amplitude is reflective of less resources recruited to inhibit behavior (Ramautar et al., 2004). These results illustrate the potential risks and benefits of violent video gaming.

### F30

### LISTENING TO THE BIG PICTURE: THE EFFECTS OF MUSIC-INDUCED AROUSAL ON CREATIVITY AND PERCEPTUAL SCOPE

Michael Coffel[1], Renee Schapiro[1], Denise Evert[1]; [1]Skidmore College — The present set of experiments was designed to test the effects of music-induced arousal on creative performance and the underlying cognitive mechanisms mediating the observed effects. Experiment 1 identified musical selections that were sufficiently high and low on arousal as well as an appropriate control condition. In Experiment 2, participants were exposed to a music condition while completing a battery of creativity assessments and the Navon task. We hypothesized that 1) participants exposed to high arousal music would have faster response times to the global than local targets because arousal engenders a broader attentional scope and 2) have enhanced performance on divergent thinking creativity tests (Alternative Uses and Abbreviated Torrance Test) and impaired performance on convergent thinking creativity tests (Remote Associates Test) because a broader perceptual scope engenders a broader conceptual scope, facilitating novel, but appropriate solutions. Conversely, we hypothesised that participants exposed to low arousal music would exhibit the opposite pattern of results due to a narrowed attentional scope. We found support for our hypotheses only when arousal was included in the analysis, suggesting that arousal mediates the observed effects of music on creative performance.

### F31

### MOXIFLOXACIN INDUCED PSYCHOSIS

Arman Fesharaki[1], Ramotse Saunders; [1]SUNY Downstate Medical Center — Fluoroquinolones, a broad spectrum antibiotic frequently used in medical units for upper respiratory infections and urinary tract infections, have been demonstrated to cause drug induced mental status changes (Farrington et al. 1995). These changes, though reportedto be less than 0.1%, could potentially manifest themselves as delusional thought process and hallucinations ( Blondeau et al. 1999, Perry etal. 1999). One theory proposed to explain this rare phenomena is the blockage of GABA receptor-binding, in turn causing secondary excitatory changes as per measured EEG recordings (Segev et al. 1988) The reported patient is a 91 year old woman with prior medical history of chronic obstructive pulmonary disease (COPD), hypertension, hyperlipidemia , coronary artery disease, peripheral artery disease and without prior psychiatric history. The patient was admitted to the inpatient medical unit for management of COPD exacerbation, for which she was started on oxygen therapy, prednisone 40mg tab PO daily (the patient was on long term prednisone regimen), montelukast 10mg tab PO every evening at 7pm, as well as Moxifloxacin 400mg tab PO dailyOn the following evening after her admission, the patient became acutely agitated, displaying paranoid delusions comprised of patient believing that the inpatient nurses and staff members were trying to steal her belonging and kill her along with another neighboring patient. Despite multiple behavioral interventions from the inpatient staff members, the patient remained acutely agitated.

### F32

### AMBIVALENT VERSUS UNIFORM ATTITUDES TOWARD PRC CHINESE: NEURAL IMAGING EVIDENCES INDUCED BY CONTEXTUAL CUES

I-Ching Lee[1], Yu-Hsuan Sun[1]; [1]Department of Psychology, National Chengchi University — Ambivalence is the coexistence of positive and negative attitudes towards the same target. Due to the intricate relationship Taiwan has with PRC China, the Taiwanese may hold ambivalent attitudes towards PRC China. Few studies had examined neural activities of ambivalence induced by contextual cues. We conducted this research to address such a question. We hypothesized that when a war concept was primed by contextual cues, people with ambivalent attitudes towards PRC China (the ambivalent group) should show different neutral activities from those with uniform attitudes towards PRC China (the uniform groups). The current study used the fMRI technique to examine brain activities of the two groups. All participants were asked to first indicate the country of the pictures (to establish the baseline brain activities), and then to indicate their preferences towards pictures (i.e., a preference task) mixed with three countries (i.e., UK, PRC China, & Taiwan). In the preference task, pictures of countries were showed in two conditions (mixed with pictures of wars or of natural disaster). We found that when a war concept was primed, the ambivalent group showed more activities in right inferior occipital gyrus (BA 18) when indicating their preference towards PRC China, suggesting more visual processing on affective information. Conversely, when a war concept was primed, the uniform group showed more activities in left superior temporal gyrus (BA 39) when indicating their preference towards UK and Taiwan, suggesting more cognitive processing on integrating information. Further implications regarding affective and cognitive information processing and ambivalence were offered.

## EMOTION & SOCIAL: Self perception

### F33

### CAN YOU RECOGNIZE YOUR OWN FINGER SNAPPING SOUND? – ERP CORRELATES OF PRE-REFLECTIVE (EARLY) AUDITORY SELF-PERCEPTION

Christoph Justen[1], Cornelia Herbert[2]; [1]German Sport University Cologne, Institute of Psychology, Department of Performance Psychology, Cologne, Germany, [2]University of Tübingen, Department of Psychiatry and Department of Biomedical Magnetic Resonance Imaging, Tübingen, Germany — Every day we are interacting with our environment and thereby differentiate between self- and other-generated information. Especially the processing of self-generated movement information plays a major role in our daily lives as we are often engaged in social physical activities requiring hand- and finger movements with characteristic sounds (e.g. finger snapping or clapping). Until now, studies on this topic have mainly focused on investigating reflective (late) self-related processing of movement-related unimodal visual or multimodal stimuli. The present study used self- versus other-generated movement sounds (finger snapping sounds) and electroencephalography (EEG) to study the temporal and neural dynamics of pre-reflective self-related processing based on complex (movement-related) auditory information. Event-related potentials (ERPs) were recorded from 64 electrode sites while healthy participants (N=12, 6 males, 6 females) listened to self or other-generated finger snapping sounds. Stimuli were presented during a passive standard oddball paradigm consisting of 2 blocks ("self" as standard, "other" as deviant stimulus and vice versa). Block order was counterbalanced across subjects. Preliminary data analysis revealed that ERPs elicited by the subject's self-generated finger snapping sounds were significantly different from those evoked by other-generated finger snapping sounds. In particular, ERP grand average plots show differences between the processing of self- and other-related movement sounds, starting already in the time-window of endogenous ERP components (P100, mismatch negativity [MMN] and N200). Our findings provide first evidence for an early, bottom-up driven differentiation mechanism in the processing of complex self- and other-related auditory information based on sensory memory processes.

## EMOTION & SOCIAL: Emotion-cognition interactions

### F34

### DEVELOPMENTAL DIFFERENCES IN PREFRONTAL AND SUBCORTICAL ACTIVITY DURING AN EMOTIONAL WORKING MEMORY TASK

Sofie Cromheeke[1], Sven Mueller[1]; [1]Ghent University — Theories of adolescent behaviour attribute increases in risk-taking and sensation seeking in this age group to a heightened sensitivity to emotional stimuli (due to increased ventral striatal and amygdala activation) on the one hand and a relatively immature cognitive control system (decreased prefrontal activation) on the other hand. The goal of the current study was to outline to what extent relevant and irrelevant emotional stimuli bias the imbalance between affective processing and cognitive control. Twenty-four adolescents (16 females, aged 12-16) and 28 adults (14 females, aged 25-35) com-

pleted two attentional conditions of an emotional face working memory 0-back/2-back task while undergoing fMRI. Participants were asked to attend to the emotional facial expression in the 'relevant' emotion condition, and to the gender of the face in the 'irrelevant' condition. Analyses focused on regions-of-interest supporting cognitive control - especially working memory - (dorsolateral prefrontal cortex (DLPFC) and ventrolateral prefrontal cortex (VLPFC)) and emotion processing (amygdala and ventral striatum). Both adults and adolescents showed greater right VLPFC activation in response to angry compared to happy and neutral faces. A similar pattern was observed in the right DLPFC in adults, but not adolescents. This finding might represent adolescents' immaturity in mobilizing additional cognitive resources in the face of emotional information. Furthermore, adolescents exhibited less left amygdala deactivation for angry compared to happy and neutral faces in the 'irrelevant' condition. In sum, these findings indicate developmental differences in the functioning of fronto-limbic systems as proposed by neurobiological theories of adolescent behaviour.

### F35

### COGNITIVE CONTROL AND EMOTION REGULATION: COMMON NEURAL SUBSTRATES AMONG RESPONSE INHIBITION, IMPLICIT, AND INTENTIONAL DOWN-REGULATION OF EMOTION FMRI PARADIGMS

Jennifer Townsend[1], Vizueta Nathalie[1], Bookheimer Susan[1], Altshuler Lori[1]; [1]University of California, Los Angeles — Emotion regulation studies consistently show ventrolateral prefrontal cortex (vlPFC) activation and suggest an essential role of this region in "controlling" emotion via modifying limbic activity. Few studies explore common neural substrates underlying intentional vs implicit emotion down-regulation. Furthermore, response inhibition studies show vlPFC recruitment during cognitive control via modifying striatal activity. Little is known about shared and distinct activation patterns in different emotion regulation and cognitive control strategies. This study sought to directly compare cognitive and emotion regulation in the same subjects. fMRI data was collected during 3 paradigms: response inhibition using GoNoGo, implicit emotion regulation using the Faces task and conscious emotion regulation using cognitive reappraisal of negative stimuli from the International Affective Picture System (IAPS). 17 healthy participants completed all 3 tasks (mean age=32.8±9.6; 9M/8F). A repeated-measures 3-level analysis was performed with regulatory contrasts (Nogo-Go; Identify Emotion-Match Shape; Decrease Negative- Look Negative) entered as the within-subject factor. This analysis generated across-task contrasts, which were then entered in a random effects model. Results revealed extensive overlap in activation of bilateral vlPFC (BA44/45/47), as well as other frontal regions, including bilateral inferior frontal gyri, middle and superior frontal gyri and medial prefrontal cortex. Significant activation was seen also in bilateral parietal lobules, occipital cortices and throughout the striatum. These findings suggest the vlPFC's central role in adaptive responses across cognitive and emotional domains. This provides a framework for understanding internal and external regulatory processes and may help discern factors contributing to psychopathology and its treatment.

## EXECUTIVE PROCESSES: Development & aging

### F36

### DIFFERENTIAL RELATIONSHIPS OF FITNESS, EXECUTIVE FUNCTION AND BRAIN FUNCTION IN MALE AND FEMALE PREADOLESCENTS

Rachel Clark[1], Laura Chaddock-Heyman[2], Charles H. Hillman[2], Arthur F. Kramer[2], Michelle W. Voss[1]; [1]University of Iowa, [2]University of Illinois at Urbana-Champaign — Fitness is consistently associated with better executive function performance across the lifespan, but the neural mechanism for this relationship has not been fully characterized. Brain networks derived from resting BOLD signal may provide a link for further understanding this relationship. Based on differing developmental trajectories, the relationship between fitness and executive functions in preadolescents may also differ by sex. This study examined average functional connectivity (FC) within two networks associated with executive function in relation to task-switching performance. Forty-eight 8-9 year old preadolescents (28 female; Age = 8.66 years, SD=0.57) completed demographic assessments, a graded exercise test to assess cardiorespiratory fitness (CRF), cognitive tests and structural and functional MRI. Fronto-executive (FE) and frontal parietal (FP) network FC was calculated by averaging pair-wise FC between regions of interest in each network. Variability of the BOLD signal was measured by calculating both the mean squared successive difference (MSSD) and the standard deviation of the squared successive difference (SSSD) within each network region to better characterize signal fluctuation patterns. Results support an interaction with sex. Females demonstrated negative associations between fitness and FC (FE: r=-.500,p=.008;FP:r=-.442,p=.021) and fitness and FP SSSD (r=-.387,p=.046), as well as positive associations between accuracy switch cost (higher=poorer switch ability) and FP FC (r=.408,p=.035). Males did not have significant relationships between fitness and FC or SSSD in either network or switching cost and FC or SSSD in either network (all p-values >.05). Results suggest sex-specific trends in how fitness relates to brain function and executive function performance in preadolescents.

### F37

### TEMPORAL ORDER MEMORY ABILITIES IN YOUNG, MIDDLE-AGED, AND OLDER ADULTS MAY DEPEND ON LEVEL OF INTERFERENCE

Lindsay J. Rotblatt[1], Catherine A. Sumida[1], Emily J. Van Etten[1], Jacob D. Hileman[1], Gabrielle M. Wagner[1], Eva Pirogovsky Turk[2,3], Jerlyn C. Tolentino[1], Paul E. Gilbert[1,4]; [1]Department of Psychology, San Diego State University, San Diego, CA, [2]Department of Psychiatry, University of California San Diego, San Diego, CA, [3]Veterans Affairs, San Diego Health Care System, San Diego, CA, [4]San Diego State University - University of California San Diego Joint Doctoral Program in Clinical Psychology, San Diego, CA — Memory for the temporal order of items or events in a sequence has been shown to be impaired in older adults compared to young adults. However, less is known about temporal order memory abilities in middle age. The present study sought to examine the effects of temporal interference on memory for sequences of visuospatial stimuli across the adult lifespan. Young adults (18-25 years; n=60), middle aged adults (40-55 years; n=43), and older adults (65+ years; n=43) completed a visuospatial temporal order memory test involving high and low levels of temporal interference. Results demonstrated that at low levels of temporal interference both the young and middle-aged adults significantly outperformed the older adults ($p < .05$). However at high levels of interference, the young adults significantly outperformed middle-aged adults, and middle-aged adults significantly outperformed older adults ($p < .05$). Thus during middle age, temporal order memory for sequences of stimuli may remain relatively stable in situations when interference is low. However, temporal order memory may begin to decline as early as middle age in situations when interference is high. The findings suggest that tests of temporal order memory may be useful in detecting cognitive change in middle age and older adulthood. Given the importance of temporal order memory in activities of daily living, the present findings also may have important everyday implications.

### F38

### DEVELOPMENT OF FLUID REASONING ABILITIES IN SCHOOL AGE CHILDREN

Isabelle Soulières[1], Eliane Danis[1], Nelly Nedeltcheva[1]; [1]University of Quebec at Montreal (Canada) — Fluid reasoning, inferring logical solutions to novel problems, is considered one of the main pillars of human learning and cognition. Solving analogies, such as a fireman is to a fire truck what an astronaut is to ____, is a type of fluid reasoning requiring the ability to jointly consider different relations between the items in order to solve the problem. There are individual and developmental differences in preferential use of visuospatial representations versus the use of rules and propositions when solving reasoning problems. The goal of our study was to investigate the development of fluid reasoning in school-aged children (n=34, data collection still undergoing, 6-13 years). Children completed an intellectual evaluation (Raven's Progressive Matrices; RPM) computerized task of relational reasoning involving visuospatial versus semantic content (e.g. geometric figures versus drawings of known objects). Problems were presented as 2x2 matrices with the last entry missing and varied in complexity (0-relation, 1-relation, and 2-relations to jointly consider) and in content (visuospatial or semantic analogies). Preliminary results confirm that 2-rel. problems were less successfully completed than the 1-rel. and

0-rel. problems, more so in younger children. The ability to solve complex visuospatial versus semantic problems did not develop at the same rate. Also, the correlation between children's performance on the RPM and their performance on the relational task was stronger for complex problems than simpler problems. These results suggest developmental shifts in the abilities to solve semantic versus visuospatial analogies, and individual differences in abilities for these two types of reasoning.

## F39

### CHANGE IN CEREBRAL BLOOD FLOW IN THE VISUAL CORTEX TO A FLASHING CHECKERBOARD CORRELATES WITH MEASURES OF EXECUTIVE FUNCTION IN OLDER ADULTS

Benjamin Zimmerman[1], Bradley P. Sutton[1], Kathy A. Low[1], Chin Hong Tan[1], Mark A. Fletcher[1], Nils Schneider-Garces[1], Edward L. Maclin[1], Gabriele Gratton[1], Monica Fabiani[1]; [1]University of Illinois at Urbana-Champaign — Cognitive declines, especially in tasks that require executive function, are associated with normal aging, and are likely to be linked to age-related changes in cerebrovascular health. In order to gain a better understanding of the relationships between age, cardiorespiratory fitness (CRF), cerebral blood flow (CBF), and cognition, arterial spin labelling (ASL), a functional magnetic resonance technique, was used to study the CBF in healthy older adults ranging in age from 56-88. Previous research in our lab using the same method found that estimated CRF fully mediated the age effects on the mean CBF over frontal and parietal cortices, but was unable to demonstrate a relationship between mean CBF and cognitive function. Here we present an extension of this analysis to the visual cortex, using data collected on a subset of those participants one year later. We expanded our previous findings, showing that CRF fully mediated the effects of age on mean CBF in the gray matter of the visual cortex. In addition, we found that the change in CBF associated with activation to a flashing checkerboard, but not the mean CBF, was associated with neuropsychological measures of executive function. These results indicate that the impact of CRF on age-related declines in blood flow is relevant across the brain, even in areas that are thought to be less affected by normal aging, such as the visual cortex. However, measures of cognitive function seem to be related more strongly to measures of activation CBF rather than the baseline CBF.

## F40

### INCREASED GLOBAL EFFICIENCY AND RESTING STATE FUNCTIONAL CONNECTIVITY IN DEFAULT MODE, FRONTO-PARIETAL AND SALIENCE NETWORKS ASSOCIATED WITH INCREASED HARM AVOIDANCE IN RISK-TAKING ADOLESCENTS

Samuel J. DeWitt[1], Micaela Y. Chan[1], Francesca M. Filbey[1]; [1]The University of Texas at Dallas — Hyperconnectivity between PFC-amygdala/ventral striatum were found for risk-taking adolescents, which may indicate inefficient network connectivity (DeWitt, Aslan & Filbey, 2014). The present study takes a graph-based approach (Bullmore & Sporns 2009) to investigate how brain network organization is associated with risk-taking behaviors among adolescents. We hypothesized that increased global efficiency (GE) will be observed in non risk-taking compared to risk-taking adolescents in 3 networks: default mode network (DMN), fronto-parietal network (FPN; cognitive control) and salience network (SN; directed attention). Methods: Thirty-three adolescents (Mage=14,15 males) underwent a resting-state fMRI scan (risk-taking N=17). Using 264 nodes and network labels from Power et al. (2011), a node-by-node correlation matrix was computed for each participant. GE was calculated for each participant using BCT Toolbox (Rubinov & Sporns, 2010). Results: GE and mean network connectivity did not differ between risk-taking and non risk-taking adolescents. However, within the risk-taking group, harm avoidance was correlated with all three networks in terms of GE (rDMN=.47, rFPN=.63, rSN=.61, all $p < .05$ and mean network connectivity (rDMN=.54, rFPN=.64, rSN=.59, all $p < .05$). In the non-risk-taking group, connectivity and GE in the DMN was negatively correlated with novelty-seeking ($r=-.60$, $p <.01$). Discussion: Contrary to our prediction, increased GE and heightened connectivity was associated with increased harm avoidance only in the risk-taking adolescents. This suggests that better organization of these networks is associated with active harm avoidance in risk-taking adolescents. Such information provides a useful neurocognitive profile of potential protective factors against more serious risk-taking behavior in vulnerable adolescents.

## F41

### NEURAL, DEMOGRAPHIC AND LIFESTYLE CORRELATES OF AGGREGATE COGNITIVE PERFORMANCE AND SUCCESSFUL COGNITIVE AGEING

David Samu[1], Rik Henson[2], . Cam-CAN[3], Lorraine K Tyler[1]; [1]University of Cambridge, [2]MRC Cognition and Brain Sciences Unit, Cambridge, [3]Cambridge Centre for Ageing and Neuroscience (Cam-CAN), University of Cambridge — Although age-related differences in performance in most cognitive domains have been frequently reported, there have only been limited attempts to integrate these differences across domains into a single estimate of cognitive ageing and identify its demographic, lifestyle and neural correlates. In the present study, we characterise cognitive health index (CHI) as the common factor underlying performance across a diverse set of behavioural measures, including reasoning, memory, motor function and language. The basis of our analysis is a large, population-derived sample (N = 452, aged 25-85) from the Cambridge Centre for Ageing and Neuroscience (www.cam-can.org), that allows for testing both age-independent and age-related factors of cognitive health. Validating our approach, we found the obtained CHI to correlate with widely-used medical diagnostic measures of dementia and cognitive impairment (ACER and MMSE). Key demographic, lifestyle and mental health variables, such as education level, reading, smoking, depression and anxiety, were also significantly correlated with CHI across the entire age range. In contrast, a composite measure of social connectedness exhibited increasing correlation with CHI only for participants older than 65, highlighting its importance in successful ageing. Voxel-based morphometry analysis of grey matter volume showed a significant correlation between bilateral frontal regions and CHI. Furthermore, we found that CHI is highly related to integrity of white-matter tracts connecting the frontal lobe to posterior cortical areas (superior longitudinal fasciculus) and to the thalamus (anterior internal capsule). These findings represent a step toward an integrated, multi-level explanation of healthy cognitive functioning and successful cognitive ageing.

## F42

### COGNITIVE FLEXIBILITY, WHITE MATTER AND HEALTHY AGING: A DTI STUDY OF 168 PARTICIPANTS.

Daniel Rinker[1], Talia M. Nir[1], Neda Jahanshad[1], Derrek P. Hibar[1], The ADNI[2], Artemis Zavaliangos-Petropulu[1], Paul M. Thompson[1]; [1]Imaging Genetics Center, Institute for Neuroimaging & Informatics, Dept. of Neurology, USC Keck School of Medicine, Los Angeles, United States, [2]The Alzheimer's Disease Neuroimaging Initiative, San Francisco, United States — Cognitive flexibility—the ability to rapidly switch between cognitive sets—is a fundamental indicator of neurological health, and is important in neurological aging. It is often operationally measured as "set-shifting," with the Trail-Making Test (TMT). Poor performance on this task is associated with cognitive impairments, decline and brain disease. fMRI studies of the TMT implicate different brain regions important for various subcomponents of the task, such as processing speed, motor tasks and visual scanning. These different regions may work in concert, forming a functional neural circuit. Communication between these regions—facilitated by white matter (WM) association tracts—is crucial. Using diffusion tensor imaging, we related individual differences in white matter status to task performance, to investigate (1) the cognitive construct of set-shifting and (2) how it relates to brain aging. As part of the Alzheimer's Disease Neuroimaging Initiative, Diffusion tensor imaging data, along with neuropsychological testing data, was acquired from 168 participants (mean age 73.5 ± 7.4; 120 M 91 F; 55 Control, 113 Mild Cognitive Impairment). We looked at how corrected time to completion on parts A and B of the TMT was associated with fractional anisotropy and mean diffusivity in WM tracts. In ROI-based regression analyses, FA and MD were correlated ($P<0.05$, FDR corrected $q<0.003$) with task performance in several tracts selected a priori: L Superior longitudinal fasiculus, L&R Fornix, Corpus Callosum, and L Cingulum, in controls and MCI patients. These results are consistent with the neural circuit hypothesis and support set-shifting as a neural correlate of healthy neurological aging.

## F43

### EXTENDED TRAINING ALLEVIATES SPATIAL LEARNING AND MEMORY DEFICITS IN A MODEL OF FETAL ALCOHOL SPECTRUM DISORDER

Katherine Yanagi[1], Thuy Hua[1], Kerry Thompson[1]; [1]Occidental College — Fetal alcohol spectrum disorder (FASD) is an umbrella term used to

describe neurodevelopmental deficits associated with exposure to ethanol in utero. Using a rat model of FASD, we examined the deficits caused by cell death within the hippocampus during the critical period of hippocampal synaptogenesis. Intraperitoneal injection of diazepam (30 mg/kg), a drug that mimics some of the effects of ethanol, at postnatal day 7 (P7) has been shown to induce cell loss in the hippocampus. We evaluated cell death in the limbic structures using a hematoxylin and eosin stain, and found evidence of degeneration in the hippocampus, entorhinal cortex, and subiculum using a semi-quantitative scale. Since the hippocampus plays a role in spatial navigation, we examined spatial learning and memory with the Morris water maze behavioral task. We observed that rats exposed to diazepam (n=5) at P7 and tested 2 months later showed deficits when compared to the controls (n=3). When tested with probe trials after five days of training, rats exposed to diazepam spent significantly less time moving towards the platform zone (control 30.47±0.93, diazepam 28.34±0.23, $p<0.05$). These deficits were not observed after a ten-day training period. When retested in the probe trial after ten days of training, no difference was observed between control and diazepam animals (control 30.67±1.09, diazepam 29.32±0.93, $p>0.05$). The results of this study suggest that overtraining alleviates the deficits associated with FASD and merits further investigation into extended training period protocols. These data, may suggest potential prophylactic strategies for learning deficits associated with FASD.

# EXECUTIVE PROCESSES: Working memory

## F44

### INDIVIDUAL DIFFERENCES IN VISUAL WORKING MEMORY CAPACITY: AN INTERPLAY OF GATING AND ENCODING

Nina Hiebel[1,2], Hubert D. Zimmer[1,2]; [1]Saarland University, [2]The International Research Training Group "Adaptive Minds" — The capacity of visual working memory (WM) is highly limited making it considerably important to select only the most relevant objects. Consequentially, individual differences in visual WM are partially due to attention-memory interactions which can happen at multiple stages of processing. It was already shown that low-capacity individuals are poorer in controlling which information accesses WM. We report data providing evidence that people differing in WM capacity already differ in early gating mechanisms enabling the selection of relevant items (N1). Participants performed a visual change detection task in which it was necessary to remember the orientation of either two or five rectangles in either the left or right hemifield, as indicated by a cue, while we recorded event-related potentials. After a brief delay memory was tested. On one third of the trials (=filtering), participants were required to select only the relevant rectangles indicated by a certain color presented among distractors. We compared the N1 elicited in the filtering condition with trials that did not require discriminating between relevant target features. Specifically, we expected lower amplitude in the filtering condition than set size five if early selection processes already boost the gating of task relevant stimuli. This N1 effect of the selection process was found for high- but not low-WM capacity individuals. Additionally, the decrement in amplitude in the filtering condition to set size five was larger for high- than low-WM capacity individuals and it correlated negatively with the unnecessary storage of task irrelevant information.

## F45

### THE SOMATOTOPY OF MENTAL TACTILE IMAGES

Timo T Schmidt[1,2], Felix Blankenburg[1,2]; [1]Neurocomputation and Neuroimaging Unit (NNU), Freie Universität Berlin, Germany, [2]Bernstein Center for Computational Neuroscience, Berlin, Germany — The role of prefrontal cortices in mental imagery and working memory is often referred to as 'cognitive control' while sensory cortices are considered as 'mental sketchpads'. Representation of mental content is considered as interaction of abstract/conceptual aspects (prefrontal) and analog/depictive properties in sensory regions. Here we utilize cortical somatotopy in a mental imagery task to depict lateralization principles in both, prefrontal and sensory regions. Subjects perceived or imagined vibrotactile stimuli on a 2x4-pin Braille-like display (QuaeroSys) at four different body locations: left/right thumbs and left/right big toes (2x4 design). 19 subjects were scanned on a 3T Siemens Trio (TR = 2s, whole brain) for three runs (á 11min) comprising blocks of 8s duration (ISI=12s) of perception or imagery, supplemented with null-events. After every run subjects rated the vividness/clearness of their mental images/percepts for all eight conditions. To test if tactile imagery relies on somatotopic sensory cortices we computed GLM contrasts and conjunction analyses between corresponding imagery and perception conditions. Next, we tested for lateralized processes by contrasting imagery of left and right body parts. Finally, we present connectivity changes related to the construction and maintenance of the mental image. Our analyses indicate somatotopic recruitment of primary somatosensory cortex during imagery while rather BA2 than BA1 or BA3a/b was activated. Together with previous reports (i.e. Schmidt et al., Neuroimage 2014) this is in line with the view that the 'finer grained' a mental images is, hierarchically lower cortices are recruited to augment fine sensory details to an abstract mental representation.

## F46

### CAUSAL ROLE OF THE PREFRONTAL CORTEX IN THE TOP-DOWN MODULATION OF SENSORY PROCESSING AND WORKING MEMORY

Neda Perwez[1], Tsukasa Kamigaki[1], Yang Dan[1,2]; [1]University of California, Berkeley, [2]Howard Hughes Medical Institute — Prefrontal cortex plays a critical role in higher cognitive functions such as selective attention, object recognition, stimulus processing, and retention of information. The objective of this project is to determine the causal role of the pre-frontal cortex (PFC) in the top-down control of sensory processing and working memory (WM). To test the causal role of PFC-mediated top-down modulation, mice were trained on visual and an auditory delayed response tasks. Laser stimulation of PFC during visual and auditory delay response tasks developed an association between sensory processing and working memory by dissociating the performance into: expectation, encoding, maintenance, and retrieval. To quantify the relationship between PFC and sensory processing, we calculated d-prime as a measure of retrieval accuracy by subtracting standardized false alarm rates from standardized hit rates. Stimulation of PFC led to an improvement in d-prime value. This suggests that sensory processing of stimulus improves as a result of increased activity in PFC during working memory dependent tasks.

## F48

### THE INFLUENCE OF OBJECT ARRANGEMENT IN VISUAL WORKING MEMORY: EFFECTS ON POSTERIOR BRAIN AREAS

Michel Quak[1], Durk Talsma[1]; [1]Ghent University — In a series of experiments we examined whether object arrangement in visual working memory (WM) can influence WM capacity, performance, and the activation of posterior brain areas. We used a change detection paradigm and simultaneous EEG recording to examine the Contralateral Negative Slow Wave (CNSW), a neural correlate of visual WM capacity. Four abstract objects were presented in each visual hemifield. Participants were prompted to remember one object worth of visual information in one hemifield for 1000 milliseconds. The complexity of the arrangement of visual information that needed to be remembered could relate to either a single object, a single half of two separate objects, or one quarter of four separate objects (for a total of one entire object in each case). All objects had the same surface area and consisted of the same visual features, keeping basic visual information equal across conditions. Behavioral results indicate that performance decreased with increased complexity of arrangement. ERP results show increased negativity over parietal and occipital recording sites during memorization, contralateral to the location of the memorized item. The CNSW was significantly more negative for the half and quarter conditions, compared to the whole object condition, suggesting that the more complex arrangements increased memory load. Since the actual amount of visual information was kept equal for all conditions, these results suggest that activation in posterior brain areas is not only due to processing of visual information; it might, at least partially, reflect the interaction between contextual and visual information processing.

## F49

### LOAD-DEPENDENT NEURAL PATTERNS WITHIN SUPERIOR INTRAPARIETAL CORTEX REFLECT THE DETERIORATION OF PRECISION IN VISUAL WORKING MEMORY

Elena Galeano Weber[1,2], Benjamin Peters[3], Tim Hahn[1], Christoph Bledowski[3], Christian J. Fiebach[1,2]; [1]Department of Psychology, Goethe University Frankfurt, Germany, [2]IDeA Center

for Individual Development and Adaptive Education, Frankfurt, Germany, [3]Institute of Medical Psychology, Goethe University Frankfurt, Germany — Recent work has established that working memory (WM) capacity limitations depend on the number of items that can be stored and the precision with which they can be stored. Further, it was suggested that performance impairments under high WM load may result from a decrease in WM precision as well as an increased variability of precision across trials. We used fMRI (n = 22, color WM, continuous response format) to explore the neural mechanisms underlying individual differences in WM precision and variability. Precision, variability, and guessing rate (variable precision model) were estimated separately for each subject and load (1,3,5). Across participants, precision declined with increasing load, while guess rate and between-trial variability of precision increased. A load-related activation increase was found in a broad bilateral frontoparietal network, including visual areas V3 and V4. Participants with more stable WM performance (i.e., lower load-dependent increase of the variability parameter) showed stronger load-related activation increase in left superior intraparietal sulcus (sIPS), suggesting that sIPS involvement helps to stabilize WM representations in the face of higher load. WM contents could be decoded from activity patterns in visual and parietal regions using multivariate pattern classification. Here, decreasing classifier accuracy under higher load in sIPS was identified as neural correlate of reduced precision and higher variability (but not guess rate) under increased load. We suggest that the quality of WM representations depends on representational precision in sIPS while the same region controls the stability with which such representations can be kept active under WM demands.

## F50

### MAINTENANCE OF NON-CONSCIOUSLY PERCEIVED INFORMATION ENGAGES TASK- AND STIMULUS-RELATED CORTICAL REGIONS

Fredrik Bergström[1,2], Lars Nyberg[1,2], Greger Orädd[1,2], Johan Eriksson[1,2]; [1]Umeå center for Functional Brain Imaging (UFBI), [2]Umeå University — Working memory is traditionally assumed to only operate on conscious information. However, recent findings have shown that non-consciously perceived information can be maintained for up to 15 s, despite irrelevant distracters, while engaging the prefrontal cortex. Here we used continuous flash suppression (CFS) to non-consciously present stimuli, and a delayed match-to-sample task (DMS) to investigate non-conscious working memory. Specifically, maintenance of combined spatial and object information was required to solve the task successfully. In two behavioral experiments, DMS performance for unseen stimuli was above chance level after a 5 s delay. During functional magnetic resonance imaging, DMS performance was at chance level across the whole group (n=27) after a variable 5-15 s delay. For participants with a positive d' (n=13), BOLD signal changes in prefrontal, parietal, and temporal regions were specifically associated with the delay period. BOLD amplitude in prefrontal, parietal, temporal, and occipital regions correlated with individual DMS d' scores for the sub-group with positive d'. Thus, for individuals with successful non-conscious retention, task- and stimulus-related regions were engaged and could predict task performance. We therefore conclude that non-consciously perceived information can be maintained during a working memory task.

## F51

### THE ROLE OF THE INTRAPARIETAL SULCUS IN SETTING CAPACITY LIMITS IN VISUAL WORKING MEMORY

Amanda van Lamsweerde[1,2], Jeffrey S. Johnson[1,2]; [1]North Dakota State University, [2]Center for Visual and Cognitive Neuroscience — Several lines of evidence suggest a role for the intraparietal sulcus (IPS) in the storage capacity of working memory (WM). For example, IPS activity has been found to increase with memory load, with the extent of the increase predicting individual differences in capacity (Todd & Marois, 2004, 2005). Other research, however, has revealed that the IPS is insensitive to the complexity of the stored information (Xu, 2006), prompting the proposal that the IPS may contribute to capacity by indexing the locations of a fixed number of objects, rather than storing WM representations. To test this hypothesis, continuous theta burst TMS (cTBS) was applied to either the IPS or a control area prior to the performance of a color recall WM task, and cTBS-related changes in the capacity and precision of WM representations, and the likelihood of mis-binding objects to locations (swap errors), were analyzed. If the IPS indexes a fixed number of locations, rather than representing item information, cTBS should influence the capacity of WM, but not the quality of the representations (precision). Supporting this possibility IPS stimulation decreased capacity, but had no effect on either precision or swap errors. Preliminary analysis of data from a follow-up experiment (n=7), revealed decreased capacity and swap errors, but no change in precision, when arrhythmic trains of high-frequency rTMS were applied to the IPS during the maintenance, but not the encoding, phase of the recall task. This suggests that the IPS contributes to WM capacity, but likely does not directly represent stimulus information.

## F52

### EPISODIC MEMORY INTERFERES WITH HIGH-RESOLUTION VISUAL WORKING MEMORY

Matthew Sazma[1], Andy Yonelinas[1]; [1]UC Davis — In a model proposed by Yonelinas (2013), the hippocampus is involved not only in long-term memory, but also in complex high-resolution bindings in working memory and perception. In order to test this model, participants performed a high-resolution working memory task while being distracted. Three colored squares flashed for 400ms, then during the two second retention interval, one of two distractors was given: either a semantic compound word judgment (do these two words form a compound word or not), or an episodic memory judgment (participants had to identify if word pairs studied at the beginning of the experiment were intact or rearranged). Participants then had to select the precise color of a square using a graded high-resolution color wheel. Performance on the two distractor tasks was matched in a pilot study for both accuracy and reaction time. Results show when the distractor was the episodic judgment, performance is worse for the memory judgment, and worse for selecting the precise color from the color wheel. This mutual interference when hippocampal resources were used during the retention interval (episodic memory judgment) compared to an equally difficult semantic compound word judgment supports the idea that there is hippocampal involvement in complex high-resolution visual working memory.

## F53

### INDIVIDUAL DIFFERENCES IN MATERIAL-SPECIFIC ENCODING.

Katherine L Alfred[1], Rachel G Pizzie[1], Daniel S Harris[1], David J M Kraemer[1]; [1]Dartmouth College — Neuroimaging investigations generally pool variance on the group level, treating individual differences as unaccountable noise. This approach eschews the potentially important detail that each participant contributes unique variance to any group analysis due to idiosyncratic cognitive functioning. Indeed, several studies (Hsu et al., 2011; Kraemer et al., 2009; Miller et al., 2002; 2011) have demonstrated that measurable individual differences (e.g., encoding strategies) account for significant variance that is not explained by task manipulations alone. Here we extend this research by comparing the separate influences of individual differences in verbal and visual modalities, including intelligence, working memory, cognitive styles, and encoding strategies. Using an intentional encoding task during fMRI scanning, we manipulated stimuli in a 2[modality: words, images] x 2[semantic relevance: meaningful, nonsense] design, to obtain two separate measures of task performance: stimulus repeat detection during encoding, and subsequent recognition memory. Results demonstrate that some individual difference measures exhibit different correlations with neural versus with behavioral measures. For example, in a functionally-defined verbal region-of-interest (words>images), a positive correlation was observed between verbal cognitive style and relative activity during meaningful images > non-meaningful images. This is consistent with the hypothesis that these individuals have a tendency to activate verbal labels when available. However, verbal cognitive style predicted verbal - but not visual - recognition performance. The overall pattern of results reveals interacting influences of these individual differences by examining their relative effects across semantic versus perceptual processes, verbal versus visual modalities, and behavioral versus neural levels of analysis.

## F54

### INFLUENCE OF COLOUR AND LUMINANCE ON VISUAL WORKING MEMORY - A STUDY USING EEG.

Maciej Kosilo[1], Jasna Martinovic[2], Corinna Haenschel[1]; [1]City University London, [2]University of Aberdeen — Early encoding processes in working memory (WM) have been shown to have significant impact on performance (Haenschel et al., 2007). Although current reports point to the interplay between perception and WM (Pasternak & Greenle, 2005), the role of perceptual factors in WM is not clear.

Separate visual channels process chromatic and achromatic (luminance) information. In line with accounts of everyday vision benefitting from fast luminance projections transmitted through magnocellular pathway (Bar, 2003), we expected that luminance will benefit performance on WM task more than chromatic information. In a delayed discrimination task participants had to remember up to 3 abstract shapes. The stimuli were defined along different directions in cardinal colour space (Derrington et al., 1984), creating luminance-defined stimuli, two classes of chromatic-only stimuli, and a mixed-signals stimuli. The stimuli were equated in terms of salience through an initial psychophysical same/different threshold task. Luminance-defined shapes led to higher accuracy and faster reaction times. Event-related potentials time locked to the last item in encoding array revealed that early visual component P1 was characterised by a greater amplitude in response to luminance stimuli. Component N1 peaked at parietal and frontal sites earlier for luminance-defined stimuli, reflecting the luminance speed advantage. The results point to the differential contribution of different cone signals to WM performance, highlighting the importance of early encoding in these tasks. In line with previous studies (Kveraga et al., 2007) we hypothesise that fast luminance projections may serve as an early trigger for top-down processing, affecting the efficiency of WM encoding.

# LANGUAGE: Lexicon

## F55

### EVENT RELATED POTENTIALS REVEALED EARLY (150 MS) RHYMING EFFECTS FOR SINGLE LETTERS

Sewon Bann[1], Anthony Herdman[1]; [1]University of British Columbia — Previous event related potential (ERP) studies using rhyme-related letter or word stimuli have reported a rhyme effect in which nonrhyming stimuli elicit a larger negativity at 450 ms (i.e. N450) than rhyming stimuli. This N450 effect has been attributed to phonological processing; however, previous ERP studies suggest that basic phonological processing can begin as early as 150ms. This study provides support for this claim. We investigated whether ERPs could detect early (<300 ms) phonological processing using three different paradigms: a letter rhyming paradigm (letter names rhyme with the sound /i/, e.g. "D", "T"), a paired-stimulus rhyming paradigm (first letter name rhymes with second letter name), and a letter/pseudoletter detection paradigm. ERPs from the two rhyming paradigms revealed an early rhyme effect around 150 ms (i.e. N150) along with the later expected N450 rhyme effect. These results, along with consideration of known models of word reading and recognition, led us to suggest that the N150 rhyme effect might be the beginning of phonological retrieval. Therefore, the N450 rhyme effect is most likely associated with subsequent phonological awareness. We also found that pseudoletters evoked a larger and more delayed N170, which has been previously suggested to reflect orthographic processing. However, given that our results showed a rhyme effect as early as 150 ms, this N170 letter vs. pseudoletter effect might reflect phonological processing in addition to orthographic processing. These results indicate that existing models of letter and word recognition might need adjustments with regards to the timing of orthographic and phonological processing.

## F56

### PROCESSING SPECIFIC TO LETTER STRINGS AND LETTERS UNDER A RESTRICTION ON THE AVAILABILITY OF ATTENTION BY THE PRESENTATION RATE OF LETTER STRINGS IN JAPANESE HIRAGANA

Tomoki Uno[1], Yasuko Okumura[1,2], Tetsuko Kasai[3]; [1]Graduate School of Education, Hokkaido University, [2]Department of Developmental Disorders, National Institute of Mental Health, National Center of Neurology and Psychiatry, [3]Faculty of Education, Hokkaido University — Extensive experience in reading develops specialized neural activities for letter string perception, which is reflected in N170 component of event-related potentials (ERPs). To examine the automaticity of print-tuned processing in Japanese Hiragana, we previously examined ERPs in response to letter and non-letter stimuli when linguistic processing was restricted by rapid stimulus presentation (100 ms duration with 300-600 ms interstimulus interval) and the task that leads attention away from stimuli themselves (discrimination of fixation color), and we observed bilateral N170 for letter strings without typical left lateralization (Okumura et al., 2014, NeuroReport). The present study examined whether the bilateral N170 was due to the difference in proportion of letter- to non-letter stimuli within experimental blocks (i.e., 2:1). ERPs were recorded from 11 native Japanese speakers under the same experimental conditions as those in Okumura et al. (2014), except that each block contained two types of equiprobable stimuli out of three (words, nonwords, and symbols). As a result, during 150-200 ms poststimulus, words and nonwords elicited left-lateralized N170 at occipito-temporal scalp sites, along with a greater negative enhancement for nonwords against words at parietal sites. The results suggest that the number of stimulus types that constitute a sequence affects the amount of attention allocated to two task-irrelevant processes: phonological processing in terms of letter strings and processing specific to individual letters in transparent language.

## F57

### INFERENTIAL PROCESSING IN NATURAL READING: A FIXATION-RELATED POTENTIALS (FRPS) STUDY

Jonas Diekmann[1], Dietmar Roehm[1]; [1]University of Salzburg, Salzburg, Austria — This Fixation-related potential (FRP) study investigated the online processing of inferences in natural reading by means of co-registering subject's eye-movements and electrophysiological activity. It previously has been shown that the processing of varyingly strong inferential relationships elicits a centro-parietal negativity (N400) and a posterior positivity (P600). In addition, recent eye-movement (EM) studies reported that the parameters fixation duration and gaze duration are sensitive to inferential processing. Here, we extend previous work by the manipulation of inferable entities' discourse prominence. Two diverging context types were utilized in which the inferable entity was either acting as agent or instrument within the preceding context. With respect to the participant's EMs we found increased total reading times for discourses including difficult inferences. In contrast, the context manipulation led to reduced total reading times and amount of fixations for inferable entities acting as an agent in comparison to an instrument. With respect to the electrophysiological measurements FRPs related to the first fixation on a critical noun revealed a N400 effect for more difficult inferences versus less difficult inferences which was distributed over anterior-left and –right electrode sites. Additionally, the inferential processing of entities associated with the thematic role of an instrument elicited a posterior distributed P600 effect in comparison to the inferential processing of entities acting as an agent. Furthermore, our results suggest that inferential processing in natural reading might be executed in a delayed manner as compared to a rapid serial visual paradigm (RSVP).

## F58

### INTRA- AND INTER-HEMISPHERIC WORD PROCESSING IN YOUNG ADULTS WITH AUTISM SPECTRUM DISORDER

Kareem Al-Khalil[1], Michael O'Boyle[1], Adam Brewer[2], NaHe Jeon[3]; [1]Texas Tech University, [2]Florida Institute of Technology, [3]Stanford University — Weak Coherence Theory suggests that hypo-connectivity between brain regions may underlie several of the cognitive deficits observed in Autism Spectrum Disorder (ASD, Happe & Frith, 2006). And, some current research has reported decreased inter-hemispheric connectivity in those with ASD (Anderson et al., 2011). Visual-half field experiments provide a useful methodology to assess intra-hemispheric functioning, as well as evaluating inter-hemispheric communication. In the present study, 11 ASD (6 males, 5 females, 18-23 years) and 18 neuro-typical (NT; 8 males,10 females, 18-23 years) made same/different judgments about word pairs flashed briefly to the left visual-field/right hemisphere (LVF-RH), the right visual-field/left hemisphere (RVF-LH), or one word presented simultaneously to each visual field (Cross Hemisphere). In the latter, participants must exchange information between the hemispheres to successfully perform the task. The ASD committed significantly more errors than NT participants regardless of visual field of presentation. And, the ASD produced significantly longer reaction times (RT) than the NT when processing word pairs presented in each of the three visual-fields, with the differences between groups being most pronounced for LVF-RH and Cross Hemisphere trials. This pattern suggests a deficit in inter-hemispheric transfer of information in those with ASD. Possible explanations for the obtained deficit include particularly impaired word processing by the right hemisphere in the ASD (e.g., insufficient encoding) and/or inefficient transfer of information between the hemispheres via the Corpus Callosum.

### F59

**NEURAL CHANGES UNDERLYING SUCCESSFUL SECOND LANGUAGE WORD LEARNING: AN FMRI STUDY** Jing Yang[1], Kathleen Gates[2], Peter Molenaar[2], Ping Li[3]; [1]Bilingual Cognition and Education Lab, and National Key Research Center for Linguistics and Applied Linguistics, Guangdong University of Foreign Studies, Guangzhou, China, [2]Department of Human Development and Family Studies, Pennsylvania State University, University Park, PA, USA, [3]Center for Brain, Behavior, and Cognition and Department of Psychology, Pennsylvania State University, University Park, PA, USA — A great deal of research has examined behavioral performance changes associated with second language learning. But what changes are taking place in the brain as learning progresses? How can we identify differences in brain changes that reflect successes of learning? To answer these questions, we conducted a functional magnetic resonance imaging (fMRI) study to examine the neural activities associated with second language word learning. Participants were 39 native English speakers without prior knowledge of Chinese or other tonal language, and were trained to learn a novel tonal vocabulary in a six-week training session. Functional MRI scans as well as behavioral performances were obtained from these learners at two different times. We performed region of interest (ROI) and connectivity analyses to identify effective connectivity changes associated with success in second language word learning. We compared a learner group with a control group, and also examined the differences between successful learners and less successful learners across the two time points. Our results indicated that (1) after training, learners and non-learners rely on different patterns of brain networks to process tonal and lexical information of target L2 words; (2) within the learner group, successful learners compared to less successful learners showed significant differences in language-related regions; and (3) successful learners compared to less successful learners showed a more coherent and integrated multi-path brain network. These results suggest that second language experience shapes neural changes in short-term training, and that analyses of these neural changes also reflect individual differences in learning success.

### F60

**SPATIO-TEMPORAL DYNAMICS OF THE LEXICAL SELECTION NETWORK IN SPEECH PRODUCTION: INSIGHTS FROM ELECTROCORTICOGRAPHY** Stephanie Ries[1], Rummit Dhillon[1], Alex Clarke[2], Kenneth Laxer[3,4], Peter Weber[3], Rachel Kuperman[5], Kurtis Auguste[4,5], Gerwin Schalk[6], Josef Parvizi[7], Nathan Crone[8], Nina Dronkers[9], Robert Knight[1]; [1]University of California, Berkeley, CA, USA., [2]Centre for Speech, Language and the Brain, Department of Experimental Psychology, University of Cambridge, [3]California Pacific Medical Center, [4]University of California San Francisco, [5]Children's Hospital and Research Center, Oakland, CA, [6]New York State Department of Health, Wadsworth Center, and Department of Neurology, Albany Medical College, [7]Stanford Human Intracranial Cognitive Electrophysiology Program (SHICEP), Stanford University, [8]Department of Neurology, The Johns Hopkins University School of Medicine, [9]VA Northern California Health Care System and University of California, Davis. — Lexical selection is the process of selecting the words necessary for language production. Different regions of the prefrontal cortex (PFC) and of the left temporal cortex (LTC) are associated with lexical selection but their role and how they interact remain underspecified. We recorded electrocorticography (ECoG) in 8 neurosurgical patients to examine where and when subregions of the PFC and the LTC were engaged in lexical selection (6 with left, 2 with right hemisphere coverage, spanning the areas of interest). Patients performed picture naming wherein semantic context was manipulated to affect lexical selection difficulty: pictures of objects were presented within semantically-homogeneous (difficult) or heterogeneous blocks (easy). Subjects' performance was worse in homogeneous vs. heterogeneous blocks. High-gamma (HG) activity, indexing cortical activation magnitude, was sensitive to semantic interference at several cortical sites (greater in homogeneous vs. heterogenous blocks). Early effects were seen in HG activity starting between 180 and 260 ms post-stimulus at posterior inferior LTC sites. Subsequent left PFC effects were observed at middle (starting around 310 ms post-stimulus) and inferior frontal sites (around vocal-onset). Response-locked effects were also observed at superior and middle LTC sites. Finally, across trials, HG power co-varied between involved left PFC and LTC recording sites. Our results suggest that posterior inferior LTC engages in lexical access as semantic concepts become available. Left PFC activity may provide top-down control over LTC regions to help solve competition between semantically-related alternatives trial-by-trial. Finally, response-locked LTC activity may reflect a speech monitoring mechanism sensitive to lexical selection difficulty.

### F61

**THE LEFT POSTERIOR VENTRAL OCCIPITOTEMPORAL CORTEX IS INVOLVED IN (LEXICAL) ORTHOGRAPHIC BUT NOT SEMANTIC PROCESSING OF AUDITORY WORDS** Philipp Ludersdorfer[1], Martin Kronbichler[1,2], Heinz Wimmer[1]; [1]University of Salzburg, [2]Paracelsus Medical University Salzburg — Dual-route theories of reading have posited the existence of a neuronal representation coding for whole written words (i.e., an orthographic lexicon). However, neuroimaging evidence for such a representation is sparse since it has proved difficult to disentangle lexical orthographic from semantic processes in reading. The present fMRI study tried to accomplish this by contrasting orthographic and semantic processing of auditory words. Twenty-nine participants performed three tasks in the scanner. In the orthographic task participants had to decide whether the spelling of an auditorily presented word consisted of three or four letters. Lexical orthographic processing was assured by an opaque phoneme-grapheme relation. While all words consisted of three phonemes, they could either have three or four letters. Thus, sublexical processing (i.e., serial phoneme-grapheme conversions) was discouraged. The orthographic task was compared to a semantic task in which participants were presented with the same auditory words but had to decide whether the words referred to a living or nonliving entity. An additional auditory control task presented pure tones and participants had to evaluate their pitch. We observed more activation for the orthographic compared to the semantic task only in a single cluster located in left posterior ventral occipitemporal cortex (LpvOT). Additionally, LpvOT activation for the semantic task did not differ from the auditory control task. These results suggest that LpvOT is involved in lexical orthographic but not semantic processing. This is in line with the hypothesis that LpvOT may be the neuronal equivalent of the cognitive orthographic lexicon.

## LANGUAGE: Other

### F62

**EFFECT OF AGE OF ACQUISITION ON VISUAL WORD RECOGNITION; AN EVENT-RELATED POTENTIAL MEASURE IN PERSIAN ORTHOGRAPHY** Mehdi Bakhtiar[1], Hyun Kyung Lee[1], I-fan Su[1], Brendan Weekes[1]; [1]Laboratory for Communication Science, The University of Hong Kong — Detecting an effect of age of acquisition (AoA) in expert visual word recognition is a controversial issue. One issue is whether AoA has a truly unique effect in word naming and another concern is whether this effect is lexical, semantic or phonological in nature. In this study the unique nature of AoA in visual word recognition across different words in Persian were inspected using an ERP experiment. 23 native Persian speakers were asked to perform lexical decision with 120 early-acquired and late-acquired transparent and opaque words whilst controlling word frequency. The ERP analysis revealed a significantly greater N400 negativity for the late versus early-acquired words across the central electrodes i.e. FZ, CZ and PZ ($p < .01$). Moreover, there was greater N170 negativity for early versus late acquired words (PO5-PO8) but the difference was significant in the right hemispheric i.e. PO6 and PO8 electrodes ($p < .05$) only. Finding greater N400 negativity (i.e. greater lexical-semantic retrieval) from the long-term memory store for late acquired words compared to early words is in agreement with semantic accounts of the AoA effect. A greater negativity of N170 component for early versus late acquired words especially in the right parietal-occipital hemisphere indicates more efficient orthographical processing for words learnt earlier in life. Finding more efficient orthographic and semantic processing for early versus late words is also consistent with the neural plasticity hypothesis indicating that early learning can take advantage of a more flexible neural system and may induce multiple neural representations in the brain.

## F63

### THE BEAT GOES ON: THE EFFECT OF RHYTHM ON READING

Layla Gould[1], Eric Lorentz[1], Chelsea Ekstrand[1], Marla Mickleborough[1], Ron Borowsky; [1]University of Saskatchewan — Speech and music involve organized acoustic sequences and complex cognitive and motor processes. Although speech does not possess the same degree of temporal regularity as music, there is recent evidence to suggest that temporal regularity (i.e., a beat) enhances speech processing (Cason & Schön, 2012). Furthermore, phonetic decoding activates the putamen (Oberhuber et al., 2013), which is a key region involved in rhythm processing (e.g., Grahn, 2009). The aim of this experiment was to explore the connection between reading and rhythm processing by examining whether reading is affected by the presentation of a rhythmic prime (loud-soft or soft-loud) that was either 'on-beat' or 'off-beat' with the syllabic stress of the bisyllabic target letter string. We developed a novel paradigm using targets that place the stress on either the first or second syllable (practice vs. police), as well as their corresponding pseudohomophones (praktis vs. polees). We predicted that naming reaction times would be faster when the rhythmic prime was 'on-beat' with the syllabic stress, and slower when the rhythmic prime was 'off-beat'. Furthermore, we predicted that the pseudohomophones would show a larger effect given that they must be phonetically decoded. The results supported these hypotheses, and suggest that a rhythmic prime matched to the syllabic stress of a letter string can enhance reading processes. This study also guided our development of a functional magnetic resonance imaging study to identify the brain networks that underlie the cross-domain effect of rhythm on speech, and our exploration of the putamen's involvement in phonetic decoding.

## F64

### HEMISPHERIC DOMINANCE FOR LANGUAGE IN PRIMARY PROGRESSIVE APHASIA

Megan Thompson[1,2], Zachary A. Miller[1], Leighton B. Hinkley[1], Danielle Mizuiri[1], Maya Henry[1], Maria Luisa Mandelli[1], Miranda Babiak[1], Gil Rabinovici[1], Howard Rosen[1], Bruce L. Miller[1], Maria Luisa Gorno-Tempini[1], Srikantan S. Nagarajan[1]; [1]University of California, San Francisco, [2]University of California, Berkeley — Primary progressive aphasias (PPA), specifically semantic variant (svPPA), are asymmetric language neurodegenerative conditions typically affecting the left side with increased rates of non-right handedness. Previous cases of left-handed svPPA individuals with right-sided atrophy have illustrated atypical language lateralization, raising the possibility that disease vulnerability associates with language dominance. Here, we use magnetoencephalographic (MEG) imaging to describe the lateralization of functional language activity in PPA. MEG data was collected from both healthy controls and PPA patients during an auditory noun-verb generation task using a 275-channel biomagnetometer (CTF). Data was reconstructed in source space using an adaptive spatial filtering technique in Nutmeg (bil.ucsf.edu/nutmeg). In the healthy controls, changes in beta (12-30Hz) power were largely confined to frontal, temporal and parietal regions of the left hemisphere, with only 5% of individuals showing right hemisphere dominance for language. In contrast, 29% of svPPA patients were clearly right hemisphere dominant. In a group contrast between control and svPPA groups, robust differences in beta suppression were only significant ($p<0.001$) for right frontal regions, with increased suppression over the middle frontal and pre-central gyri in svPPA patients. Atypical language lateralization is more common in non-right handed individuals than right-handed individuals. In the context of prior findings of increased non-right-handedness in svPPA, these imaging data are more consistent with a theory of anomalous language lateralization as a risk factor associated with development of svPPA rather than svPPA being directly associated with language dominance.

## F65

### MISMATCH NEGATIVITY RESPONSES TO WITHIN-CATEGORY CHANGES IN THE SWEDISH VOWEL /I/

Ellen Marklund[1], Iris-Corinna Schwarz[1], Francisco Lacerda[1]; [1]Stockholm University — The amplitude of MMN-responses to non-speech stimuli varies with the degree of acoustic difference between the standard stimulus and the deviant stimulus [H. Tiitinen, et al., Nature 372, 90-92, (1994)]. When stimuli are speech-sounds, the MMN-amplitude also depends on the phonemic categories of the participant's language. For example, the same deviant elicits a greater MMN-amplitude in listeners if it belongs to a different phonemic category in their language compared to in listeners in whose language it belongs to the same category as the standard [R. Näätänen, et al., Nature 385, 432-434, (1997)]. Additionally, changes of equivalent spectral difference result in greater MMN-amplitudes if they cross a phoneme boundary than if they do not [A. Sharma and M. F. Dorman, Journal of the Acoustical Society of America 106, 1078-1083, (1999)]. However, little is known about how the MMN-amplitude varies with different kinds of acoustic variations of speech-sounds within the same phonemic category. The present study investigates MMN-responses to within-category changes of the Swedish vowel /i/, varied in terms of fundamental frequency (f0), the first formant (F1), or the second formant (F2). Twelve right-handed native speakers of Swedish participated in the study. A first analysis shows that an MMN response was found in response to the f0-deviants, but not in response to either the F1-deviants or the F2-deviants. This is attributed to the fact that variations in f0 are generally more perceptually salient than variations in F1 or F2, especially in within a single speech-sound category.

## F66

### CHANGES TO NEURAL SENSITIVITY BEFORE AND AFTER OVERNIGHT CONSOLIDATION OF PHONETIC TRAINING IS ABSENT IN ADULTS WITH LANGUAGE-BASED DISORDERS

F. Sayako Earle[1], Emily B. Myers[1,2], Nina Gumkowski[2], Nicole Landi[1,2]; [1]University of Connecticut, [2]Haskins Laboratories — Phonological instability is observed in individuals with language-based disorders (primary language impairment and/or dyslexia [LI]; Snowling, 1998; Joanisse & Seidenberg, 1998). Memory encoding during sleep is thought to be critical in building phonological categories (Earle & Myers, 2014); for example, sleep has been observed to facilitate improved discrimination (Earle & Myers, 2013) and generalization of identification to unfamiliar talkers (Earle & Myers, under review), following training on a nonnative contrast. However, individuals with LI have atypical sleep patterns (e.g. O'Bruni et al., 2009); therefore, overnight consolidation of phonetic information may be compromised. To test this, we trained adults with and without LI to identify nonnative (dental-retroflex) speech sounds at 8PM on day 1, and assessed their discrimination performance immediately before and after training, and again at 8AM on the following day (day 2). We obtained mismatch negativity (MMN) responses to the nonnative contrasts, before training on day 1 and after retest on day 2, as neural correlates to the changes observed in behavior. Groups demonstrated comparable learning during training. In typical adults, we replicated the finding (Earle & Myers, 2013) that discrimination performance improved overnight. Consistent with our behavioral measure, the amplitude of the MMN response in typical adults was significantly higher on day 2 than day 1. In contrast, adults with LI did not improve in performance across the overnight interval; furthermore, there was no significant difference in their MMN response between sessions. Results suggest that the role of sleep in encoding novel phonetic information differs in language impairment.

## F67

### NEURAL CORRELATES OF ORTHOGRAPHIC CONSISTENCY IN READERS WITH AND WITHOUT DYSLEXIA

Myriam Oliver[1], Pedro M. Paz-Alonso[1], Ileana Quiñones[1], Cesar Caballero[1], Maria P. Suarez-Coalla[2], Jon A. Duñabeitia[1], Fernando Cuetos[2], Manuel Carreras[1,3,4]; [1]Basque Center on Cognition, Brain and Language, (BCBL) Donostia-San Sebastián, Spain, [2]Departamento de Psicología, Universidad de Oviedo, Spain, [3]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain, [4]Departmento de Lengua Vasca y Comunicación, UPV/EHU, Bilbao, Spain — Readers with dyslexia exhibit less stable orthography-phonology mappings. Reading in transparent orthographies relies more on small grain size linguistic units (grapheme-phoneme). Thus, variations in orthographic consistency of small-unit patterns may compromise phonological decoding in transparent orthographies and present an additional difficulty for dyslexic readers. The present fMRI study aimed at investigating the neural correlates of orthographic consistency in Spanish readers with dyslexia (21) and matched controls (20) using a naming task. At the scanner participants had to name four different types of stimuli: 1) consistent words (words, porteria); 2) inconsistent words (words with specific pronunciation rules, ingeniero); 3) non-words/pseudowords (cinguda); and, 4) homophones (non-words derived from misspells in words with specific pronunciation rules, ajencia). Regional patterns of activation

in left perisylvian regions, including inferior frontal gyrus and superior parietal lobe, showed group by condition interactions. Controls, but not dyslexics, recruited more strongly these areas for pseudowords and homophones relative to words. Group effects were observed across conditions in the middle temporal gyrus and ventral occipital-temporal cortex, with dyslexic readers showing hipoactivation in these regions relative to controls. Also, phonological fluency was predicted by pars opercularis activation in controls and by pars triangularis in dyslexics, suggesting higher reliance on semantic regions to solve phonologic processes in dyslexic readers. Our results revealed a less refined neural patterns of orthographic consistency and phonology in dyslexic readers, which may determine their reading difficulties.

### F68

### EVIDENCE FOR THE DUAL ROUTE MODEL OF LANGUAGE PROCESSING USING DYNAMIC CAUSAL MODELING

Marcela Perrone-Bertolotti[1], Cédric Pichat[2], Louise Kauffmann[3], Juan R Vidal[4], Monica Baciu[5]; [1]CNRS, LPNC UMR 5105, F-38040 Grenoble, [2]CNRS, LPNC UMR 5105, F-38040 Grenoble, [3]CNRS, LPNC UMR 5105, F-38040 Grenoble, [4]CNRS, LPNC UMR 5105, F-38040 Grenoble, [5]CNRS, LPNC UMR 5105, F-38040 Grenoble — Functional MRI results suggest that visual word recognition depends on a dual-route model including a dorsal grapho-phonological (dGP) and a ventral lexico-semantic (vLS) stream. Here, we combined fMRI and dynamic causal modeling (DCM) analysis to investigate word and pseudo-word processing according to the dual-route model. Based on the group-level analysis, we first defined five ROIs (vOT, STG, SMA, dIFG and vIFG) and specified nine alternative models with equivalent level of complexity, similar endogenous connectivity between the ROIs and two modulated streams (ventral modulation by dGP and dorsal modulation by vLS). Both pathways started with vOT and ended with vIFG. We used DCM12 to estimate how experimental conditions (dGP, vLS) influenced connectivity between ROIs. Bayesian model selection was applied to define the most plausible Family (F) of models grouped according to the connections modulated by dGP and vLS. Results indicated that the Model 6 (Figure 1) was the most plausible for processing words and pseudo-words. Furthermore, F analysis for dGP stream indicated that F1 (modulation of vOT==> SMA ==> dIFG ==> vIFG connectivity) and F2 (modulation of vOT==> STG ==> SMA ==> dIFG ==> vIFG connectivity) were the most plausible to explain pseudo-word processing. F analysis for the vLS stream indicated that F3 (including two co-existent sub-streams, with modulation of vVOT ==> vIFG and vOT==>STG ==> vIFG connectivity). Overall, these results are in agreement with the dual route model of word recognition, suggesting that the two pathways, one dorsal and another one ventral can be selectively recruited according to lexical properties.

# LANGUAGE: Semantic

### F69

### MEASURING INCIDENTAL WORD LEARNING IN FIRST AND SECOND LANGUAGES USING ERPS

Ben Seipel[1]; [1]California State University, Chico — The objective of this study was to examine the behavioral and neurocognitive (ERPs) differences in reading known words, recently learned words, and incidentally learned words for native and non-native English speakers. Twenty-nine native English speakers (21 females, mean age = 19.44 years) and 43 English Language Learners (30 females, mean age = 21.49 years, mean number of year of speaking English = 9.4 years, sd = 5.4 years) participated in the study. Students completed six tasks in this order: common English word pretest, rare English word pretest, Gates-MacGinitie Reading Test (modified 12th grade edition), 20 min. rare word study period, EEG data collection while reading, and posttest of the rare words. During EEG data collection, students were instructed to read for comprehension. Although behavioral gain scores indicated that native and non-English speakers do not differ in their ability to explicitly learn new vocabulary ($F = .79$, $p = .38$) , the two groups did differ in their ability to incidentally learn new vocabulary from context ($F = 7.56$, $p < .01$). In addition, neurocognitive data indicated that ERPs indicated that native and non-native English speakers process incidentally learned words differently. Specifically, on only words learned incidentally, native English speakers exhibit greater central negativity (Cz) 400 ms after stimulus onset ($F = 4.58$, $p = .04$), and greater right parietal negatively (P4) 400 ms after stimulus onset ($F = 5.98$, $p = .02$) than do non-native English speakers. Conversely, non-native English speakers exhibit greater negativity in the occipital lobe at the same time.

### F70

### INVESTIGATING PRAGMATIC CONSTRAINTS IN COUNTERFACTUAL ANTECEDENTS: EVIDENCE FROM THE N400

Eugenia Kulakova[1], Mante Nieuwland[2]; [1]University of Salzburg, [2]University of Edinburgh — Counterfactual antecedents (e.g. "If words were made out of sugar, …") express states which are factually false but which are treated as true for the sake of the argument ( "… then letters would taste sweet."). Counterfactuality is marked by subjunctive mood which pragmatically signals that the speaker is deliberately saying something false. On the other hand, a factually true statement embedded in a subjunctive antecedent (e.g. "If sweets were made out of sugar, …") constitutes a pragmatic violation. The present EEG/ERP study investigated the effects of pragmatic constraints regarding the truth-value of counterfactual antecedents on N400 amplitude. The N400 indexes semantic processing costs and is sensitive to contextual fit. Thirty participants read conditional sentences presented in rapid serial presentation. In a 2 x 2 design we manipulated phrasing (counterfactual vs. indicative) and propositional truth-value (false vs. true) of the antecedents: Counterfactual-false ("If words were made out of sugar"), indicative-false ("If words are made out of sugar"), counterfactual-true ("If sweets were made out of sugar"), indicative-true ("If sweets are made out of sugar"). Our results show higher N400 amplitude for false compared to true propositions at the critical word ('sugar'). Furthermore, despite identical semantic association (sweets – sugar) counterfactual-true antecedents showed higher N400 amplitude compared to indicative-true antecedents. In contrast, N400 amplitude did not differ between both false conditions. These results speak for an immediate impact of pragmatic constraints during the processing of counterfactual antecedents. Participants experience true counterfactual antecedents as contextually inappropriate.

### F71

### DESCRIBING AND GESTURING CAUSAL EVENTS: EVIDENCE FROM FOCAL BRAIN-INJURED PATIENTS

Demet Özer[1], İdil Bostan[1], Anjan Chatterjee[2], Tilbe Göksun[1]; [1]Koç University, [2]University of Pennsylvania — In describing cause-effect relation in events, people use causal verbs (e.g., push, pull) and may gesture accordingly. Little is known about the neural correlates of causal language and their accompanying spontaneous gestures. In a sentence "the man pushes the box with the stick," pushing is the casual verb;the stick is the instrument. In this study, we investigated how focal brain-injured patients describe causal events, involving the components of causal verb and instrument and whether gestures compensate for impaired verbalization of those components. Patients with left (LHD, n=16) or right (RHD, n=16) hemisphere damage and elderly controls (n=14) were asked to describe causal events depicted in 22 video clips (11 of them depict causal actions with an instrument). The correct use of the verb and the instrument of the causal action and subjects' spontaneous iconic gestures were coded. Patients with LHD were less accurate in using both the verb ($p<.01$) and instrument ($p<.02$) in speech compared to RHD and controls. There were no differences in the number of iconic gesture use (dynamic or static)among three groups. Yet, LHD patients as a group were more likely to use causal language neither in speech nor in gesture compared to RHD and control ($p<.02$). Patients with damage to the left superior inferior frontal gyrus and left middle frontal gyrusdid not produce verbs in either modality (case statistics, Crawford &Gartwaite, 2007). We suggest that frontal lesions may lead to conceptual deficits of causality that appear both in speech and gesture.

### F72

### SEMANTIC FEATURE DISTINCTIVENESS: A FUNCTIONAL MAGNETIC RESONANCE IMAGING (FMRI) STUDY.

Megan Reilly[1], Natalya Machado[1], Sheila Blumstein[1,2]; [1]Brown University, [2]Brown Institute for Brain Science — Recent models of semantic memory propose that the semantic representation of concepts is based, in part, on a network of features. In this view, a feature that is distinctive for an object (a zebra has stripes) is processed differently from a feature that is shared across many objects (a zebra has four legs). Indeed, dementia patients with damage to the anterior temporal lobe (ATL) have shown selective impairment in the pro-

cessing of distinctive features. Nonetheless, the neural basis of processing differences between distinctive and shared features in healthy adults has not been tested directly. In an fMRI experiment, participants responded 'yes' or 'no' by button press to visually presented words paired with either shared or distinctive features. A region of interest analysis focused on four bilateral regions proposed to be involved in semantic processing: the ATL, identified in patient and TMS research (Pobric et al. 2007), and three areas involved in processing semantic relatedness and feature selection: the inferior frontal gyrus, posterior middle temporal gyrus, and inferior parietal lobe (IPL) (Whitney et al., 2012). In a preliminary analysis (n=8), only the left IPL showed a significant difference in activation with greater activation for shared compared to distinctive feature trials. Although patient research has suggested that the ATL is involved in distinguishing between shared and distinctive features, these results suggest that a broader network, at least including the IPL, is sensitive to feature distinctiveness.

## F73

### LANGUAGE AND CULTURE DETERMINE ONLINE SEMANTIC ACCESS

Ceri Ellis[1], Jan Kuipers[2], Guillaume Thierry[1], Victoria Lovett[3], Oliver Turnbull[1], Manon Jones[1]; [1]Bangor University, [2]University of Stirling, [3]Swansea University — Linguistic relativity effects have been found in brain processes such as colour perception, early object categorization, and motion event perception. Here, we show that language also modulates higher processing levels, such as access to semantic knowledge. Welsh-English bilinguals with native-like proficiency in both their languages read sentences containing a premise that they were subsequently asked to rate as true or false, whilst event related potentials were recorded on the sentence-final word. Half of the sentences contained information that was culturally relevant to Wales (In Wales, Snowdon is the highest mountain), whilst the other half contained information culturally non-specific to these participants (Everest is the highest mountain). Sentences were presented in Welsh or English, which was counterbalanced across participants. Analysis of the N400 time window (340-450ms) yielded a significantly reduced amplitude for true sentences containing culturally relevant information when it was presented in Welsh. In other words, Welsh-English speakers were better able to integrate high-level semantic information (truisms) when the content and the language of presentation were aligned. Crucially, sentences containing exactly the same information but presented in English did not show the same level of semantic integration. Our findings show that even in highly proficient bilinguals, language interacts with factors associated with personal identity, such as culture, to modulate online semantic access.

## F74

### ACTION IS THE KEY TO OBSERVE THE CONTINUUM AMONG CONCRETE AND ABSTRACT WORDS

Felipe Munoz-Rubke[1,2], Karen Kafadar[4], Karin H. James[1,2,3]; [1]Cognitive Science Program, Indiana University, [2]Program in Neuroscience, Indiana University, [3]Psychological and Brain Sciences, Indiana University, [4]Department of Statistics, University of Virginia — Words are often classified in terms of the degree to which their meaning refers to observable objects or actions: if this is high, they are classified as concrete; if it is low, the word is considered to be abstract. This concrete/abstract dichotomy has been extensively used in both behavioral and fMRI studies. However, classifying words into these categories fails to take into consideration how words are originally learned: through direct experience. Furthermore, the concrete/abstract dichotomy has provided an impoverished account of the representation of word meaning in the brain. We propose that words fall along a continuum that refers to our interactions with our environments and that previously used scales have fostered the concrete/abstract dichotomy. To investigate these hypotheses, we created two scales emphasizing the sensorimotor experience underlying word meaning - one based on multisensory information and another based on action. Sixty-eight nouns and verbs were selected and rated by 80 participants on four scales: the well-known concreteness and imageability scales, and the two new scales. A word-by-word analysis conducted by means of a median polish – a robust exploratory technique – showed that both new scales were successful in identifying a continuum for both nouns and verbs, while both imageability and concreteness scales strongly dichotomized the nouns, and to a lesser extent, the verbs. These results suggest that word meaning should be considered in light of how words are initially learned and provide a novel way to understand meaning.

## F75

### DOWNSTREAM PROCESSING CONSEQUENCES OF SENTENTIAL CONCRETENESS

Cybelle Smith[1], Kara Federmeier[1]; [1]University of Illinois, Urbana-Champaign — Processing advantages for concrete over abstract language are seen in a variety of behavioral tasks, and differential brain responses to frequency-matched concrete and abstract words have been observed using a variety of methods, including Event Related Potentials (ERPs). In particular, concreteness has been found to modulate the amplitude of the N400 component, indexing semantic access, and to elicit a sustained anterior negativity, which has been linked to mental imagery (e.g., West & Holcomb 2000). Whereas concreteness effects are well-documented for individual words, the question of how concrete versus abstract words are used to build message-level representations has not been much examined. In the current ERP study (32 subjects), we manipulated the concreteness of sentence-medial nouns, and examined the processing consequences of this concreteness manipulation both at the target noun and further downstream, where a pronoun referred back to the target. Participants read sentences for comprehension such as: "The beer (concrete) / joke (abstract) did not go over well, since it didn't suite the guests' taste." N400 concreteness effects were apparent at the target noun. However, the sustained anterior negativity was elicited several words later, prior to and including the pronoun. This suggests that under ordinary reading conditions, participants may engage in mental imagery preferentially to augment message-level comprehension, such as when establishing co-reference.

## F76

### WHEN A HIT SOUNDS LIKE A KISS: AN ELECTROPHYSIOLOGICAL EXPLORATION OF SEMANTIC PROCESSING IN VISUAL NARRATIVE

Mirella Manfredi[1], Neil Cohn[2], Marta Kutas[2]; [1]University of Milano-Bicocca, Milan, Italy, [2]University of California, San Diego, La Jolla, CA, USA — We investigated the understanding of language embedded in comics - a type of visual. In comics, audiovisual information is often presented visually by means of written onomatopoeia. The onomatopoeia often accompany "action stars," a conventionalized star-shaped "flash" that indicates the culmination of an event. We thus used action stars to introduce different types of written information from which inferences could be drawn. Specifically, we presented 100 4-6 panel Peanuts comic strips without words to 28 University students and recorded ERPs to the critical panel which had been replaced by an action star containing one of four different types of words: (1) an onomatopoeic word (e.g., pow!) coherent with the context, (2) a descriptive word (e.g., hit!) referring to a hidden action, (2) an anomalous onomatopoeic word (e.g., smooch!) incoherent with the context, and a so-called "Grawlix" containing a string of symbols (e.g., @$*%?!) that could be construed as a swear word. All but the Grawlix panel elicited a large N400, larger to Anomalous onomatopoeia and Descriptive words and smallest to the congruent Onomatopoeic word, presumably because the latter were easier to interpret; the Grawlix ERP was positive in this window, much like a physical violation. Post-N400, only the Descriptive panel elicited a fronto-central late positivity, suggesting continued processing of the word and its relation to the visual narrative. In sum, the results demonstrate that lexical information, carrying different event meaning, can be incrementally incorporated into the representation of a visual narrative by ~ 300 ms.

## F77

### PROCESSING PRONOMINAL REFERENCE RESOLUTION: AN ERP STUDY

James Monette[1], John Drury[1]; [1]Stony Brook University — Previous ERP studies of anaphor processing have reported sustained anterior negativities (Nrefs) following anaphors in contexts with more than one potential antecedent (e.g., ''Bruce told Al that HE…"; Nieuwland & Van Berkum 2006). More recently it has become clear that these situations of referential ambiguity may also give rise to P600-type effects, with the observed pattern (i.e., Nref, P600, or both) depending on both presence/absence and type of behavioral task as well as individual differences in working memory span (Nieuwland & van Berkum 2008; Nieuwland 2014). The present ERP reading/judgment study examined responses to pronouns in contexts with 2, 1, or 0 available antecedents. Additionally, we divided the cases with only one available referent [1Ref] based on whether the first or second NP served as the antecedent. For example: [2Ref] "Mary told Jane that SHE…" [1Ref-NP1] "Mary told John that SHE…" [1Ref-NP2] "John told Mary that

SHE…" [0Ref] "Mike told John that SHE…". Included also in this study were a range of violation types targeting, e.g., morpho-syntax ("could *walks…") and logical-semantics/pragmatics ("There wasn't *John in the room"). Here we discuss only the pronominal reference conditions. Preliminary data (N=8) suggest both Nref and P600 effects for both [2Ref] and [0Ref] compared to the [1Ref-NP1] cases (consistent with Nieuwland 2014). Interestingly, the [1Ref-NP2] cases demonstrate the most negative going effect of the four conditions. We situate these findings in the context of a discussion of reference resolution, biases that influence it, and our understanding the etiology of Nref and P600-type effects.

# LONG-TERM MEMORY: Episodic

## F78

### BRAIN RESPONSES FOR EMOTIONAL MEMORY WHEN EMOTIONAL MEMORY IS AT CHANCE

Erik A. Wing[1], Ilana T. Z. Dew[1], Roberto Cabeza[1]; [1]Duke University — The finding of enhanced memory for emotional information has been linked to amygdalar contributions during encoding. Studies of emotional source memory suggest that the amygdala and other MTL structures are involved in the encoding and retrieval of affective information, even when retrieval cues are neutral, while separate work has found that the amygdala is sensitive to emotional stimuli that are processed only subliminally. Such findings raise the possibility that this region might track successful emotional memory encoding even when memory is at chance. To explore this question, we conducted an fMRI study in which participants initially studied faces with either angry or happy expressions. At test, initially-studied faces appeared in a neutral format, along with completely novel faces. Participants decided whether each face was previously angry, previously happy, or new. These responses were used to sort repeated stimuli into three conditions: Source Correct (SC, correct emotional expression), Source Incorrect (SI, incorrect emotional expression) and Miss (M, repeated faces called "new"). Although memory scores for old items were at chance, encoding activity in the amygdala/anterior hippocampus increased with subsequent memory accuracy (SC>SI>M). Furthermore, representational similarity analyses revealed greater encoding-retrieval similarity in frontal and MTL regions during successful face memory. These findings indicate that in cases where little behavioral evidence for explicit memory exists, neural signatures may still discriminate between correct and incorrect memory responses. Further exploration in this area may help clarify the relationship between implicit and explicit measures, and reveal dissociations between brain-related and overt memory responses.

## F79

### CUED REACTIVATION DURING AWAKE STATE ENHANCES NEXT-DAY MEMORY AND IS RELATED TO INDIVIDUAL DIFFERENCES IN LEARNING

Arielle Tambini[1], Alice Berners-Lee[2], Lila Davachi[3]; [1]University of California, Berkeley, [2]Johns Hopkins School of Medicine, [3]New York University — Long-term memory retention is thought to supported by the reactivation of neural activity representative of prior experience during post-encoding states such as sleep and awake rest. Previous work has sought to externally cue reactivation by presenting stimuli that were elements of prior learned associations during post-encoding time periods (e.g. Rudoy et al., 2009). Cueing during sleep has been shown to benefit memory, as compared to cueing during the awake state while subjects perform an attention-demanding task. Only one prior study, to date, has shown a memory benefit for awake cueing. Additionally, it is unclear whether memory benefits of cueing persist into extended time periods, and what potential factors are related to cueing success. Here, we asked whether cueing during the awake state while subjects perform an easy, non-vigilant task benefits next-day memory. To this end, subjects were trained to criterion on object-location associations. After learning, a subset of these objects was briefly presented (50ms) while subjects performed an unrelated lexical decision task. A benefit in next-day memory (decreased spatial error) was found for cued versus uncued associations. Individual differences in learning were related to cueing benefits, such that poorer learners benefited most from cueing. Additionally, we found cueing benefits were inversely related to explicit knowledge of which objects were cued, suggesting that explicit retrieval and rehearsal are not driving cueing benefits. These results suggest that cued reactivation during post-encoding awake restful periods may benefit memory and that cueing benefits may be related to individual differences in learning.

## F80

### HIPPOCAMPAL STRUCTURE IS ASSOCIATED WITH ABILITY TO REACTIVATE RELATED STIMULI

John Walker[1,2], Kathy Low[2], Nirav Patel[2], Neal Cohen[1,2], Gabriele Gratton[1,2], Monica Fabiani[1,2]; [1]Department of Psychology, University of Illinois at Urbana-Champaign, [2]Beckman Institute, University of Illinois at Urbana-Champaign — Previously we had shown that presenting an item from a studied pair prior to the test display elicits reactivation of the related cortical representation, that is, cortical activity based on the retrieval of relational memory (Walker et al., 2014). The ability to relationally reactivate the various processers of a representation in the cortex has been theorized to be tied to hippocampal function (Eichenbaum & Cohen, 2001). Here, using the event-related optical signal (EROS; a neuroimaging technique with high spatial and temporal resolution), we investigated the functional connectivity and the structural properties of the brain and how they are associated with the ability to reactivate representations in the cortex. Participants were presented with face-scene pairs to study and were later tested using yes-no recognition, with a presentation of the scene as a preview prior to every test display. We found that hippocampal volume is strongly correlated with the ability to reactive face areas in the left superior temporal sulcus (STS), and also that white matter health (as measured by mean FA) in the right hippocampus is correlated with the ability to reactivate, which was predictive of behavioral performance. Finally, we found a similar relationship between dorsolateral prefrontal cortex (an area that shows functional connectivity with the STS both immediately prior and following reactivation), FA, and the ability to reactivate. These data demonstrate the association the hippocampus, and to some extent the DLPFC), has with the ability to reactivate related items in the cortex.

## F81

### DAMAGE TO THE MEDIAL TEMPORAL LOBES IMPAIRS SPATIAL PRECISION AND SPATIOTEMPORAL BINDING WHILE SPARING ALLOCENTRIC MEMORY

Branden Kolarik[1], Alyssa Borders[1], Andrew Yonelinas[1], Arne Ekstrom[1]; [1]University of California, Davis — Separate lines of research suggest roles for the human hippocampus in both spatial navigation and the binding of item and context information in episodic memory. Reconciling these two accounts has proven difficult. Here, we tested a novel model of hippocampal function termed the perception and binding model (PBM) (Yonelinas, 2013), which postulates roles for the hippocampus in complex, high-resolution binding as part of a larger role in both perception and memory. Using a virtual analogue of the Morris Water Maze (vMWM), we tested a patient with damage to the medial temporal lobes (MTL) on multiple probe locations over different delay intervals. We analyzed search patterns on probe trials using a sliding window centered on the hidden target rather than employing spatial quadrants, as done in past work, because this method might be better poised to reveal deficits in spatial precision. Analysis of patient search patterns during probe trials revealed a tendency to search the area of the hidden platform although with less spatial precision than controls. These data suggest that in a patient with MTL damage, some allocentric spatial memory is spared but the precision of this memory is reduced relative to controls. Additionally, using a modified version of our task, we show that memory and precision impairments become more severe when required to remember more than one location. These second set of finding suggest deficits in spatiotemporal binding. Together, our findings suggest a role for the hippocampus in spatial precision and spatiotemporal binding, consistent with the PBM model.

## F82

### NEURAL DYNAMICS UNDERLYING RETRIEVAL-PRACTICE EFFECTS

Pedro M. Paz-Alonso[1], Manuel Carreiras[1,2,3]; [1]BCBL. Basque Center on Cognition, Brain and Language, [2]IKERBASQUE, Basque Foundation for Science, Bilbao, Spain, [3]Departmento de Lengua Vasca y Comunicación, UPV/EHU, Bilbao, Spain. — Retrieval practice is highly beneficial for long-term memory. Compared to repeated study, repeated retrieval enhances performance on tested information and facilitates learning from subsequent encounters with that information. Despite a deluge of recent behavioral studies exam-

ining the retrieval-practice effect and the factors modulating it, there is limited neuroimaging data examining the neural mechanisms underlying this effect. Here, we conducted an fMRI study with young adults (N=38) aimed at investigating the functional dynamics between regions typically involved in retrieval success, including the medial temporal lobe (MTL), parietal cortex and prefrontal cortex (PFC), during the retrieval of information encoded 48 hours earlier. Participants studied 100 Swahili-Spanish word pairs (rafiki-friend) under repeated retrieval or repeated study conditions. Two days after learning these items participants underwent MRI scanning and performed a final memory test. Behavioral results confirmed long-term memory benefits of repeated retrieval as opposed to repeated study. Neuroimaging data revealed stronger MTL engagement for successfully remembered items studied under repeated study versus repeated retrieval. In contrast, participants exhibited stronger lateral PFC recruitment for remembered items learned under repeated retrieval versus repeated study. Functional connectivity analyses for anatomically-defined hippocampal regions and structures involved in retrieval success revealed tighter coupling among distributed hippocampal-PFC regions for items studied under repeated retrieval versus repeated study, as well as stronger connectivity among hippocampal regions for items studied under repeated study versus repeated retrieval. Our results suggest that retrieval practice facilitates the creation of additional routes to trace back information from long-term memory, making this information less hippocampal dependent.

## F83

### ATTENTIONAL FOCUS DISSOCIATES FUNCTIONAL BRAIN NETWORKS ENGAGED BY MUSIC-EVOKED AUTOBIOGRAPHICAL MEMORIES

Benjamin Kubit[1], Petr Janata[1]; [1]University of California, Davis — Neuroimaging studies on autobiographical (AB) memory retrieval have implicated a heterogeneous mix of cortical brain regions encompassing parietal, prefrontal, and default mode network (DMN) regions. Studies on top-down attention have demonstrated negative correlations between DMN and the same parietal and prefrontal regions. The relationships between these regions during memory retrieval remain unclear, in part, due to limitations inherent in traditional memory paradigms. We used functional magnetic resonance imaging (fMRI) to compare brain networks engaged by autobiographically salient music as a function of attentional focus. Before each song, participants were instructed to either attend memories by focusing on the retrieval and content of memories associated with the song, or to attend music by focusing on the structure of the music, ignoring any music-evoked memories. The strength of memory recollection, vividness of mental imagery, and familiarity ratings was higher for AB trials. In addition, during attend-memory trials, AB memories were rated as having greater strength and vividness compared to memories during attend music trials. fMRI results indicate that attending to song structure was associated with activity in parietal and lateral prefrontal regions while focusing on the music-evoked memory was associated with activity in DMN and lateral prefrontal regions. Both attention conditions activated the medial temporal lobe, whereas DMN and parietal regions demonstrated negatively correlated time-series across conditions. This dissociation between functional networks suggests that both retrieval-related activity and phenomenological dimensions associated with a memory vary according to attentional focus.

## F84

### ALPHA, BUT NOT THETA, OSCILLATIONS COVARY WITH INDIVIDUAL DIFFERENCES IN RECOGNITION-MEMORY

Yvonne Chen[1], Jeremy B Caplan[1]; [1]University of Alberta, Edmonton, AB, Canada — Desynchronization of alpha (8-12 Hz) and synchronization of theta (4-8 Hz) oscillations is found during hit-trials compared to miss-trials of recognition-memory tasks (Klimesch, 1997). We tested the hypothesis that theta and alpha are different modes of a single generator-network (Klimesch et al., 2010) that drives effective memory. Taking an individual-differences approach, we do predicted recognition-memory-related alpha and theta oscillations would covary over a large participant sample. We predicted 1) a strong negative correlation between posterior-alpha and anterior-theta rhythms across participants at both encoding and retrieval, indicating they are mutually exclusive; and 2) a strong correlation between the two oscillations and accuracy and response speed, indicating relevance to memory-outcome. First, alpha- and theta-oscillation durations (ignoring memory-performance) and were significantly positively correlated (encoding: $r(55)=0.26$; retrieval: $r(55)=0.49$, $p<0.05$), inconsistent with our first prediction. Also inconsistent with alpha-theta mutual exclusivity, that portion of the rhythmic signals that differentiated memory success (hits-misses) were not significantly correlated across participants. Testing our second set of predictions the alpha measure correlated significantly with accuracy and negatively with latency across participants, but the theta measure, apart from differentiating hits from misses, did not significantly explain individual variability in memory. Our findings challenge the hypothesis that alpha and theta oscillations share a generator, or are in fact mutually exclusive, and also problematize the idea that theta oscillations play a major role in item-recognition memory.

## F85

### DYNAMICS OF MEMORY ENCODING: LARGE-SCALE BRAIN NETWORK FLUCTUATIONS DURING PRESTIMULUS TIME WINDOWS

Christine A. Godwin[1], Joshua K. Grooms[1,2], Derek M. Smith[1], Shella D. Keilholz[1,2], Eric H. Schumacher[1]; [1]Georgia Institute of Technology, [2]Emory University — Previous research has demonstrated that fluctuations in large-scale brain networks such as the default mode network (DMN) and task-positive network (TPN) can predict performance on an attention task several seconds before a stimulus appears (Thompson et al., 2013). Here we build on these findings to examine if similar prestimulus network dynamics predict successful memory encoding. We used an fMRI incidental subsequent memory effect procedure and a multiband pulse sequence with a repetition time (TR) of 700 ms to effectively capture rapid changes in networks. Participants viewed images of faces and scenes and rated the pleasantness of each image. Importantly, each image was preceded by an extended fixation period ranging between 15-20 seconds. After scanning, participants completed a recognition memory test consisting of old and new images. We employed a sliding window correlation analysis to examine fluctuations in the relationship between the DMN and TPN during 12-second prestimulus windows. Results indicate that prestimulus anticorrelation between the DMN and TPN distinguishes between remembered and forgotten items. This finding replicates Thompson and colleagues and suggests that large-scale brain networks play an important role in regulating neural processing underlying memory encoding before events are experienced. In addition, pairwise sliding window correlations between memory encoding-related regions (hippocampus, fusiform cortex, and inferior frontal gyrus) indicate increased prestimulus functional connectivity between encoding-related regions for subsequently remembered images. Our findings build on the prestimulus memory encoding literature (e.g., Park & Rugg, 2010) and illustrate the role of dynamic prestimulus neural processes in cognitive performance.

## F86

### HOW ACUTE STRESS DURING CONSOLIDATION AFFECTS MEMORY FOR NEGATIVE MATERIALS WITH DIFFERENT AROUSAL LEVELS.

Lisa Weinberg[1], Audrey Duarte[1]; [1]Georgia Institute of Technology — Both human and animal research has demonstrated that acute stress affects memory, and the nature of this effect depends on when the stress occurs. Stress during consolidation consistently enhances memory, but there is disagreement as to whether memory for emotional or neutral information is improved. One reason for this could be that only highly arousing emotional material is differentially affected by acute stress. We manipulated the arousal level of our stimuli to determine if memory for the most arousing material will be enhanced as a result of acute psychological stress during consolidation. We tested recognition memory for neutral, high arousal negative, and low arousal negative images. During encoding, participants gave a visual detail rating after seeing each image. During retrieval, participants rated their confidence in each response. We used the Montreal Imaging Stress Task (MIST) as a psychological stressor during consolidation, and measured salivary cortisol before and after the MIST. Overall, recognition memory performance was better in the stress group than in the control group. Participants in the stress group were also more confident in their correct responses than participants in the control group. Participants in the stress group were more likely to remember images that they gave a high visual detail rating to at encoding than participants in the control

group. Effects of arousal on memory accuracy and confidence were minimal. These preliminary results indicate that stress during consolidation improves memory accuracy and increases confidence.

## F87

## UNCONSCIOUS REACTIVATION OF EPISODIC INFORMATION DURING MEMORY RETRIEVAL: A FAILURE TO REPLICATE

Mason Price[1], Jeffrey Johnson; [1]University of Missouri — Several neurocomputational models of memory predict that episodic retrieval should be accompanied by reactivation of the cortical representations that were active during encoding. Consistent with the idea that reactivation is hippocampally-dependent, several fMRI and EEG studies have shown that these effects are strongly related to conscious retrieval (recollection). Yet, the involvement of reactivation during weak, and even unconscious, retrieval remains relatively unexplored. One exception is an EEG study by Wimber, Maa□, Staudigl, Richardson-Klavehn, and Hanslmayr (2012) in which words were encoded in the context of background visual flicker (6 and 10 Hz) and then presented at retrieval in the absence of flicker. Phase-locking (inter-trial coherence) was observed at the corresponding encoding frequencies during retrieval, consistent with the reactivation of encoding representations. Given the important implications of such unconscious reactivation, the current study (n = 18) attempted to replicate these results with a design that closely followed the previous study. In addition to original retrieval phase, we included a final memory test in which EEG was recorded while subjects were explicitly asked to make judgments about the frequency of flicker previously associated with each word. Whereas, robust phase-locking to the presented flicker was observed at encoding, no evidence of flicker reactivation was observed during either of the retrieval phases. The failure to replicate unconscious reactivation effects during memory retrieval, which is particularly surprising given the ideal conditions of the final test that was explicitly focused on the salient information, are discussed in relation to potential limiting conditions of neural reactivation.

## F88

## A DUAL-TASK INVESTIGATION OF THE COMPONENT PROCESSES SUPPORTING EPISODIC FUTURE THINKING

Paul F. Hill[1], Samantha T. Boothe[1], Rachel A. Diana; [1]Virginia Tech — Accumulating research demonstrates extensive functional overlap between episodic recall and imagining novel future events, or episodic future thinking (EFT). Despite this overlap, converging behavioral and neuroimaging evidence suggests that constructing future events places increased demands on executive processes necessary to selectively retrieve and bind episodic and contextual details into a coherent and plausible future event representation. Likewise, the initial construction of episodic past and future events is characterized by considerable neural differentiation, with EFT evoking a greater neural response in medial and lateral prefrontal cortex (PFC) and right hippocampus. Working memory (WM) is suggested to provide the cognitive workspace necessary to temporarily maintain and organize disparate episodic details into a coherent future event; however, this hypothesis has not been systematically tested. In the current study, we experimentally manipulated cognitive load in order to isolate component neurocognitive processes supporting the construction of temporally and contextually specific future events. Participants were cued to imagine future episodic events while simultaneously performing one of two cognitively engaging tasks – maintaining information in short-term memory (maintenance condition) or mentally organizing items based on their relative weights (manipulation condition). Similar paradigms have been used to elicit dissociable responses in ventrolateral and dorsolateral PFC, respectively. Events imagined during the maintenance and manipulation conditions were less temporally and contextually specific than those imagined during comparable control trials. These novel results provide additional evidence for WM's hypothesized role supporting EFT construction and offer a useful framework for investigating the neural correlates of component EFT mechanisms.

## F89

## EPISODIC FUTURE THINKING AND SCENE CONSTRUCTION AFTER VENTROMEDIAL PREFRONTAL DAMAGE

Elisa Ciaramelli[1], Elena Bertossi[1], Fabio Aleo[2], Davide Braghittoni[2]; [1]Department of Psychology, University of Bologna, Italy, [2]Centre for studies and research in Cognitive Neuroscience — There is increasing interest in revealing the cognitive and neural bases of episodic future thinking (EFT), the ability to imagine specific events relevant to one's own future. Functional neuroimaging studies have shown that EFT engages a set of regions including medial prefrontal cortex, frontal pole, and medial temporal lobes (MTLs). Converging neuropsychological evidence confirms that the MTLs are crucial for EFT. We hypothesize that the ventromedial prefrontal cortex (vmPFC) is another crucial neural substrate of EFT. vmPFC, indeed, is typically activated while imagining the future, and vmPFC patients show steep temporal discounting of future rewards. vmPFC, however, is also strongly activated during imagination of fictitious (atemporal) experiences, suggesting that this region may support processes enabling, yet not uniquely related to, EFT, such as scene construction. Here, vmPFC patients, control patients with lesion to the posterior cortices, and healthy controls underwent a scene construction task requiring to imagine future and fictitious experiences. vmPFC patients were impaired at constructing both future and fictitious experiences compared to the control groups, but they were relatively more impaired at imagining future compared to fictitious experiences. Lesion volume in BA 11 of vmPFC correlated with performance in both future and fictitious scenarios, whereas lesion volume in BA 32 and BA 10 only correlated with performance in future scenarios. These results suggest that vmPFC is crucial to imagine novel experiences, and that different regions within vmPFC mediate core construction processes, needed to simulate any complex events, and processes uniquely related to EFT.

## F90

## THE IMPACT OF OBJECT-LEVEL STATISTICS ON SUBSEQUENT MEMORY EFFECTS: AN EVENT-RELATED POTENTIAL STUDY

Benjamin Geib[1], Simon Davis[1], Berry van den Berg[1,2], Roberto Cabeza[1], Marty Woldorff[1]; [1]Duke University, [2]BCN Neuroimaging Center, University of Groningen, Groningen, Netherlands — Unfamiliar events may be remembered because they are more distinctive, whereas familiar events may be remembered because they fit with a pre-existent semantic schema. We investigated these different encoding mechanisms by comparing the event related potentials (ERPs) evoked by items that were subsequently remembered vs. forgotten (subsequent memory effect—SME). Specifically, we examined neural evoked responses with respect to conceptual familiarity and subsequent memory in an incidental encoding task. In the task, subjects engaged in the covert naming of images. Images consisted of a broad range of natural and man-made objects. Object names varied in frequency; high frequency items were deemed familiar, and low frequency items were deemed unfamiliar. In a second session, one day later, old and new object words were presented in a semantic recognition test. Immediately afterwards, subjects' perceptual memory of previously seen objects, as compared to matched exemplars, was tested. Unfamiliar object words were associated with higher semantic memorability, an effect that was absent with respect to perceptual memorability, suggesting that conceptual frequency impacts semantic, but not perceptual memorability. Preliminary ERP results, with respect to semantic SMEs, support prior findings of a late positive complex (LPC), but also suggest a stronger, earlier-onsetting, long-lasting, prefrontal negativity. This effect appears to be selectively driven by successfully remembered familiar concepts, suggesting that it may be attributable to facilitated semantic access. These results help to clarify the nature of encoding operations with respect to conceptual familiarity.

## F91

## AGE DIFFERENCES IN HIPPOCAMPAL ACTIVATION DURING FALSE RECOGNITION OF OBJECTS

Laura E. Paige[1], Brittany S. Cassidy[1,2], Angela H. Gutchess[1]; [1]Brandeis University, [2]Indiana University — Research shows age-related increases in gist-based processes that lead to greater false recognition. An open question regards what brain regions are involved in these age differences, responding as a function of gist. Gist, memory processes driven by general concept or perceptual similarity shared across exemplars (e.g. different chairs) within a category, contributes to false memory, particularly for older adults. Extant work revealed that false recognition in younger adults is associated with increased hippocampal activation, but in aging the role of the hippocampus may differ since there is reduced associative memory, important for recombining correct features at retrieval. We explored how varying degrees of gist differently engaged neural regions, including the hippocampus, across age groups. Specifically, participants

encoded different set sizes (small, medium, large) of exemplars to vary the amount of gist. They later made recognition memory judgments for studied (e.g., "old" chairs) and related images (e.g., "new" chair exemplars) using functional magnetic resonance imaging. Comparing neural age differences across 16 younger and 16 older adults while committing memory errors (false alarms) for the large versus small set size revealed more hippocampal activity among older adults at the small set size compared to young. This suggests that reconstructing erroneous memories evokes hippocampal activity for older more than younger adults at small set sizes. Exploratory parametric modulation analyses revealed that younger adults had increased anterior cingulate activity relative to older adults as set size decreased, suggesting younger adults potentially utilize monitoring more than older adults when there is less gist information.

# LONG-TERM MEMORY: Skill learning

## F92

### SHIFTS IN CONNECTIVITY DURING PROCEDURAL LEARNING AFTER MOTOR CORTEX INHIBITION

Leonora Wilkinson[1], Adam Steel[1], Sunbin Song[2], Devin Bageac[1], Kris Knutson[1], Ziad S. Saad[3], Steven J. Gotts[4], Eric M. Wassermann[1]; [1]Behavioral Neurology Unit, National Institute of Neurological Disorders and Stroke, [2]Human Cortical Physiology Section, National Institute of Neurological Disorders and Stroke, [3]Scientific and Statistical Computing Core, National Institute of Mental Health, National Institutes of Health, [4]Laboratory of Brain and Cognition, National Institute of Mental Health, National Institutes of Health — Inhibitory transcranial magnetic stimulation has been widely used to inactivate cortical areas selectively. One method, continuous theta burst stimulation, applied over the primary motor cortex depresses motor output excitability via a local effect and also impairs subsequent procedural learning. This could be related to response changes in the stimulated area and/or a local effect or a changes in its the connectivity to other regions in itsof a distributed network. To investigate this question, we used functional magnetic resonance imaging to examine changes in brain activation and connectivity during motor sequence learning after application of real and sham continuous theta burst stimulation over the motor cortex. Compared to sham, real stimulation reduced learning-related functional connectivity between motor (primary motor cortex, dorsal premotor & supplementary motor areas) and visual (superior & inferior occipital gyri) areas, while increasing connectivity between frontal associative (superior & inferior frontal gyri), cingulate (dorsal & middle cingulate), and temporal areas. There were no local effects on learning-related activations. Inhibitory stimulation of primary motor cortex reduces learning-related coupling in a motor-based learning network and shifts it to another associative learning network in a potentially compensatory way. This finding suggests that the inhibitory transcranial magnetic stimulation can alter network dynamics and change the distributed network underlying learning.

## F93

### NOCTURNAL SLEEP SPINDLE EEG FREQUENCIES ARE ASSOCIATED WITH NORMALIZED MOTOR SKILL ACCURACY IN ATTENTION-DEFICIT-HYPERACTIVITY DISORDER.

Jared M. Saletin[1], William G. Coon[2], Mary A. Carskadon[1,3]; [1]Brown University, [2]National Center for Adaptive Neurotechnologies, Albany, NY, [3]University of South Australia, Adelaide, SA, Australia — Pediatric attention-deficit-hyperactivity-disorder (ADHD) is associated with motor learning deficits and sleep abnormalities. In adults, NREM stage 2 sleep spindles predict improvements in motor learning following sleep. This association is poorly characterized in children, or in pediatric ADHD. Laboratory sleep was monitored (~10hr) in seven children with ADHD (2F, 11.9±0.9 years, abstaining from medication) and 14 typically-developing controls (4F, 11.7±0.9 years). Participants trained on a validated motor sequence task (MST) in the evening and were retested the following morning; analyses focused on MST accuracy (correct sequences as a proportion of all keystrokes). Linear mixed-effects modeling of the final two evening and first 2 morning trials confirmed a main-effect of sleep showing increased accuracy overnight (Wald-$\chi2$=17.56, p<0.001). A significant condition-x-group interaction (Wald-$\chi2$=6.08, p<0.014) indicated that accuracy improved overnight in ADHD (Wald-$\chi2$=16.61, p<0.001) but not in controls (Wald-$\chi2$=2.23, p=0.135). Although evening accuracy was lower in ADHD (Wald-$\chi2$=3.90, p=0.048), morning accuracy did not differentiate groups (Wald-$\chi2$=2.23, p=0.135), suggesting an overnight normalization of performance. NREM Stage 2 EEG power spectra were examined to explore a possible mechanism underlying this motor skill improvement. ADHD-status moderated the association between slow spindle activity (12-13.5 Hz) and overnight accuracy improvement ($\beta$=1.289, p=0.023). Thus, spindle-frequency EEG activity positively predicted improvements in ADHD ($\beta$=0.792, p=0.021) but not in controls ($\beta$=0.056, p=0.817). These data indicate that motor skill learning in children with ADHD, as previously shown in adults, benefits from nocturnal sleep spindle frequency EEG activity. Sleep disturbance in ADHD, therefore, may in part underlie cognitive deficits commonly observed in this population.

## F94

### DISCRETE TO CONTINUOUS: ROBUST AND RELIABLE IMPLICIT LEARNING ACROSS MOTOR RESPONSE TYPES

Daniel J. Sanchez[1], Maneesh K. Yadav[1], Tim McCarthy[1], Nicolas Ehrhardt[2], John Murray[1]; [1]SRI International, [2]Stanford University — Motor sequence learning research distinguishes between discrete-event tasks (e.g., serial reaction time) and continuous-performance tasks (e.g., line tracking). Although these tasks have different operating characteristics, suggesting that the knowledge representation may contain different perceptual and motor components, the fundamental process of sequence learning underlies them both. To examine the hypothesis that these task characteristics do not alter the general process of sequence learning, we implemented the Serial Interception Sequence Learning (SISL) task with both discrete- and continuous-performance versions. In the standard SISL task, participants intercept scrolling cues on a computer screen by making precisely-timed keyboard responses as the cues pass a target zone. For the present study, we developed SISL variants for a mobile phone that allowed for discrete (tapping locations with thumbs) and continuous (sliding a single finger to move a cursor) interception response conditions with identical stimulus presentations. After 192 repetitions of training on a 12-item sequence, knowledge was assessed as the difference in percentage correct between trained and novel sequences at test. Controlling for trial lists across conditions, knowledge expression was robust in both conditions, ps<.01, although slightly higher for the discrete condition, M=7.4%, SE=2.5%, compared to the continuous condition, M=6.1%, SE=1.9%. Note that the continuous response condition produced learning despite featuring discrete stimulus events. These results support the theory that sequence knowledge is based on a goal-oriented representation of information that will be learned as long as there are repeating consistencies in perceptual and motor components, and also opens sequence-learning research to novel interaction methodologies.

## F95

### POSTTRAUMATIC STRESS DISORDER (PTSD) AS A POSSIBLE MEDIATOR BETWEEN EDUCATION AND CAUDATE VOLUME IN VETERANS

Dana Waltzman[1,2], Salil Soman[1,2,3], J. Kaci Fairchild[1,2], Nathan Hantke[1,2], Lisa M. Kinoshita[1,2], J. Wesson Ashford[1,2], Jerry Yesavage[1,2], Helena C. Kraemer[2,4], Maheen Adamson[1,2], Ansgar J. Furst[1,2]; [1]War Related Illness and Injury Study Center, VA Palo Alto Healthcare System, [2]Department of Psychiatry and Behavioral Sciences, Stanford University, [3]Department of Radiology, Harvard University, [4]University of Pittsburgh — Evidence suggests that patients with PTSD exhibit enhanced and impaired memory of the traumatic event. This concept may be explained by a multiple memory systems framework, in which stressful situations activate the dorsal-striatal habit memory system when the hippocampal declarative memory system becomes inactive and fails to encode features of the stressful event. We investigated volumetric differences controlling for estimated total intracranial volume (eTIV) in the hippocampus and striatum in Veterans with PTSD (N=32) and without PTSD (N=22), and whether education has an effect on these brain structures. While the groups were matched on age (PTSD M=49.31, SD=10.69; non-PTSD M=46.32, SD=10.56) and gender (PTSD=4F/28M; non-PTSD=1F/21M), Veterans with PTSD had less education than Veterans without PTSD overall (p=0.017). There were non-significant trends for hippocampal and striatal regions to be smaller in Veterans with PTSD. There was a negative correlation between education and PTSD status (p=0.017) and PTSD symptom severity (p=0.040), suggesting higher education is associated with reduced PTSD symptoms. However, separate analyses revealed only

in patients without PTSD a significant correlation between education and the left caudate ($p<0.001$) and right caudate ($p=0.032$), whereas no such correlations were found for patients with PTSD ($p > 0.864$). Analogous analyses for the hippocampus did not reveal any effects. In completing a mediator analysis, these findings suggest that PTSD may mediate the effects of education on striatal brain volume and may attenuate its protective effects on certain brain structures involved in PTSD pathology.

## F96

### OSCILLATORY CORTICAL DYNAMICS OF IMPLICIT LEARNING IN PATIENTS WITH SCHIZOPHRENIA

Leighton Hinkley[1], Sophia Vinogradov[2], Melissa Fisher[2], Danielle Mizuiri[1], Bruno Biagianti[2], Srikantan Nagarajan[1]; [1]Department of Radiology and Biomedical Imaging, UCSF, [2]Department of Psychiatry, UCSF — An emerging hypothesis in the neuropathology of schizophrenia is that alterations in oscillatory activity contribute to cognitive and behavioral symptoms prevalent in the disorder. Here, we use magnetoencephalographic imaging (MEGI) to test the hypothesis that impoverished oscillatory activity over frontal cortices impedes implicit skill learning in schizophrenia. MEG data was collected using a 275-channel biomagnetometer (VSM MedTech) during a modified serial reaction time task (SRTT) using manual or vocal movements. Individuals were instructed to respond to a short vowel presented in the auditory domain at the beginning of each trial. Subjects either responded by speaking the vowel they have heard (vocal), or pressing a button (manual) corresponding to one of four spatial locations. Whole-brain oscillatory power changes were examined in the beta (12-30Hz), gamma (30-55Hz) and high gamma (65-115Hz) bands. Patients with schizophrenia either failed to show learning effects (learners) or performed at a pace similar to healthy controls (non-learners). Neurophysiologically, a decrease in beta and an increase in high-gamma power localized to bilateral frontal cortex in healthy controls around movement onset. Schizophrenia learners, while performing like healthy controls, showed increased gamma suppression following movement onset over motor cortices in the frontal lobe ($p<0.005$) suggesting a compensatory mechanism, while schizophrenia non-learners failed to recruit sufficient high-gamma activation over the ipsilateral hemisphere compared to both controls and learner counterparts ($p<0.005$). This data indicates that impairments in recruiting high-frequency neural synchrony translates into a deficit in rapid cognitive learning. These neuroimaging-based markers have the potential to track recovery following cognitive-based rehabilitation.

## F97

### THERE IS A BENEFIT OF TESTING WITHOUT FEEDBACK ON THE ABILITY OF ALPHABETIC (BUT NOT WORD LEARNERS) TO READ MADE-UP NAMES FOR CRITTER OBJECTS IN A NOVEL ORTHOGRAPHY.

Jackie Liederman[1], Allyson Alfonso[1]; [1]Boston University — Six words were created in a novel orthography consisting of five hieroglyphics associated with five sounds. The meaning of these words was presented in Critter stories wherein participants (N= 105) were trained to criterion to match the sound of two different words to a picture of a make-believe category of toys, pets, or instruments. Word Learners were trained to match a pair of hieroglyphics to the sound of a Critter word; Alphabetic Learners matched one hieroglyphic with one letter name. The groups were matched for IQ and reading ability. Half of each group was tested on a Categorization task before a Word Recognition task; half in the reverse order. Despite the absence of feedback, Alphabetic Learners benefited from being first tested on Categorization tasks before they undertook a word recognition task as follows: they were better at rejecting several kinds of foils, and responded more rapidly when the word was located in the first than second position. Even in terms of Categorization itself (e.g., choosing which of two written Critter words was a Pet), Alphabetic Learners were better when Categorization testing occurred first. None of these differences were significant in Alphabetic Learners when they performed the Critter Word Recognition task before Categorization testing. In contrast, Word Learners, irrespective of task order, did not improve their performance across testing of these two tasks. Therefore testing in the absence of feedback can powerfully improve learning new words in a new orthography only in those trained by means of an Alphabetic system.

## F98

### THE EFFECT OF REINFORCEMENT LEARNING ON NEURAL SYNCHRONY IN THE STRIATUM

Pierson Fleischer[1], Sebastien Helie[1]; [1]Purdue University — Past research has shown that the basal ganglia (BG) are critical in supporting skill learning (e.g., Helie et al., 2012a, 2012b). However, Helie et al. (2013) argue that one problem with many computational cognitive neuroscience (CCN) models of skill learning is that they are often small-scale simulations that do not exploit the brain's internal dynamics to account for the modeled cognitive function. The present work aims to innovate on current CCN modeling efforts by accurately modeling the BG's internal dynamics and exploring the relationship between these dynamics (e.g. brain oscillations) and cognitive function. Specifically, we simulated a sparsely interconnected striatum (Ponzi & Wickens, 2010) using the INa,p + Ik cell model (Izhikevich, 2007) and connected the model to a simulated visual cortex. We used this model to simulate a perceptual category learning task with two categories. We measured the periodicity of the striatal neurons and the synchrony between neurons. After learning the model showed increased periodic spiking in neurons and decreased synchrony between neurons associated with the same category. This suggests that reinforcement learning may be accompanied by a rhythmic de-synchronization of neural firing in the BG, which is consistent with some deficits being associated with abnormal synchrony in some neuropsychological populations. Future work should explore the question of whether these changes are essential for learning or merely a byproduct thereof. A possible future experiment could involve disrupting the patterns found in the model, either during learning or after learning has occurred, then observing the effect on the model's performance.

## F99

### STRENGTHENED BRAIN FUNCTIONAL CONNECTIVITY DETECTED BY INDEPENDENT COMPONENT ANALYSIS IS ASSOCIATED WITH CONTEXTUAL INTERFERENCE EFFECT IN MOTOR LEARNING

Ho-Ching Yang[1], Chien-Ho Janice Lin[1,2], Allan D Wu[3], Barbara J Knowlton[3], Ming-Chang Chiang[1]; [1]National Yang-Ming University, Taiwan, [2]Yeong-An Orthopedic and Physical Therapy Clinic, Taiwan, [3]University of California, Los Angeles — INTRODUCTION: Increasing contextual interference (CI) during practice by arranging motor sequences in an interleaved order generally induces superior motor learning than arranging sequences repetitively. To identify functional brain pathways underlying the CI effect in motor learning, group independent component analysis (gICA) was applied to analyze fMRI data. METHODS: On 2 consecutive days, 16 young adults practiced serial reaction time tasks consisting of three distinct 4-element sequences either in an interleaved or repetitive order 2-4 weeks apart. Retention was evaluated on Day 5 in an MR scanner. We applied gICA to participants' fMRI data to identify 35 statistically independent components as our ROIs whose time series data were best correlated with the temporal profile the experimental model (each 18-second task block was followed by an 18-second rest block). Functional connectivity was gauged by the time-lagged correlation coefficient between the time series data of the components. We then compared the differences in functional connectivity across the 35 ROIs between the interleaved and repetitive conditions. RESULTS: Functional connectivity during retention was stronger following the interleaved than the repetitive practice, especially between the left precentral gyrus and the cerebellar vermis, and between bilateral calcarine cortices and the left middle temporal cortex. CONCLUSION: The results suggest that motor learning following interleaved practice leads to stronger recruitment of the corticomotor system and the visuospatial circuit that connects the temporal and occipital cortices. These neural pathways may support the CI benefits of motor learning following interleaved training.

## F100

### INVESTIGATING THE NEURAL CORRELATES OF EXECUTIVE FUNCTIONS DURING FOOTBALL GAMEPLAY

Kyle Morgan[1,2], Phan Luu[2], Nicholas Price[2], Don Tucker[1,2]; [1]University of Oregon Department of Psychology, [2]Electrical Geodesics, Inc. — Results from animal studies suggest frontal corticolimbic systems are involved in the early stages of learning, whereas brain activity shifts to the hippocampus and posterior cingulate during the later stages. However, recent human studies using dense-array

EEG (dEEG) have shown an increase in frontal corticolimbic involvement throughout the learning stages as they report an increase in Medial Frontal Negativity (MFN) amplitude across a multi-session Go/No-Go learning task. The goal of the present study was to further investigate this finding, and determine if we can replicate it within a realistic context of football players going through simulated pre-season cognitive training. We tracked the neural mechanisms of learning and decision making as former high school football players were subjected to a multi-day, modified Go/No-Go task which taught them how to recognize and make informed decisions about an opposing team's defensive formations. Dense-array EEG was used to record the MFN and P300 ERP components. We report on the changes in these ERP components as our subjects become proficient in the task, and propose an alteration to the heuristic commonly used to describe the brain processes associated with visuomotor skill acquisition.

# PERCEPTION & ACTION: Audition

## F101

### MUSICAL BEAT PERCEPTION AND PRODUCTION IN CONGENITALLY BLIND ADULTS

Laureline Arnaud[1,2], Lucie Ménard[2,3], Vincent Gracco[1,2]; [1]McGill University, [2]Center for Research on Brain, Language and Music, [3]Université du Québec à Montréal — The brain has a remarkable ability to adapt when problems occur early in development. In congenitally blind adults (CB), brain reorganization occurs and brain areas devoted to vision are taken over for other senses. Apparently as a result, CB adults often exhibit better performance for auditory processing tasks including pitch processing tasks. Few studies have investigated rhythm perception or production in CB adults. The purpose of this study was to test musical beat perception and production abilities in CB adults. Here, an adaption of the Beat Alignment Test was used. Fourteen CB adults and fourteen controls (matched for age, gender, education and formal musical training) participated in the study. Perception: participants had to decide if a beep track presented simultaneously along with musical excerpts was on or off the musical beat. There was no significant difference between the perception score of the blind group and the control group (t(26)=1.39, p=.175). Production: participants tapped along with 14 musical excerpts. The blind group showed a significantly better ability to match the music tempo than controls (t(26)=2.16 , p=.0399). The variability of tapping was not significantly different between the groups (t(26)=-1.21, p=.238). Interestingly, significant correlations were found between perception and production scores for the controls only (rcc-control=0.69, p=.006; rcv-control= -0.72, p= .003; rcc-blind=0.19, p=.51; rcv-blind=-0.04, p=.88). In conclusion, blind participants showed a significantly better ability to tap the beat in synchronization with the musical beat. These results echo back to previous results obtained in speech production in congenitally blind adults.

## F102

### RAPIDLY-LEARNED IDENTIFICATION OF SEIZURES FROM SONIFIED EEG

Matan Koplin-Green[1], Michael Massone[1], Mark Frick[1], Psyche Loui[1]; [1]Wesleyan University — Sonification refers to a process by which data are converted into sound, providing an auditory alternative to visual display. Currently, the prevalent method for diagnosing seizures in epilepsy is by visually reading a patient's electroencephalogram (EEG). However, sonification of EEG data provides inherent advantages due to the frequency-sensitive nature of human auditory perception. We developed a novel EEG sonification algorithm in Max/MSP, whereby voltage values from the seizure and non-seizure EEG files were assigned notes in a musical scale and played by a software synthesizer in Logic Pro. We hypothesized that human listeners would be able to identify seizures simply relying on the sonified EEGs, and that accuracy of seizure identification would increase after minimal training. Ten-second sound clips were generated from seizure and non-seizure EEG recordings and presented to subjects (N=52) in two-alternative forced-choice tests before and after a one-minute training session. Results showed that before training, subjects performed at chance level in differentiating seizures from non-seizures (M=53.1%, SD=0.17), but there was a significant improvement of accuracy after the training session (p<.05). After training, subjects successfully distinguished seizures from non-seizures using the auditory modality alone (M=63.4% correct, SD=0.13). Signal detection theory analyses demonstrated improvement in sensitivity and reduction in response bias as a result of training (d'=0.751, SD=0.75 post-training). This study demonstrates the potential of sonifying EEGs for the detection of seizures. Ongoing work involves making EEG sonifications in real-time, directly from an EEG recording device, and investigating the therapeutic potential of audible neurofeedback in the treatment of epilepsy.

## F103

### LIMITATIONS IN FINE-GRAINED WITHIN-CATEGORY SEMANTIC AUDITORY DISCRIMINATION: INSIGHTS FROM SPATIO-TEMPORAL ANALYSES.

Rosanna De Meo[1,2], Pawel J. Mastusz[1,2], Jean-François Knebel[1,2], Micah M. Murray[1,2,3], W. Reid Thompson[4], Stephanie Clarke[1,2]; [1]Vaudois University Hospital Center, [2]University of Lausanne, [3]Vanderbilt University Medical Center, [4]Johns Hopkins University School of Medicine — Correct recognition of individual sound objects within a semantic category (e.g., bird songs) involves cortical regions along a left lateralized temporo-fronto-parietal network. Here, we investigated how representations of other environmental sounds, i.e. heartbeats, differ when sounds have been correctly versus incorrectly categorized. Thirteen medical students, of which 2 were excluded due to poor performance during the training session, participated in this study. EEG and behavioural data were recorded from eleven participants who completed: 1) an audio-visual training session requiring recognition of 4 categories of real patients' heartbeat sounds (the training session ended when participants reached 70% accuracy); and 2) a testing session requiring discrimination of the 4 previously learned categories on recordings of new heartbeat sounds. Accuracy data showed a significant decrease in performance from the training session to the EEG session, but which still remained significantly above chance level. EEG analyses compared correctly vs. incorrectly recognized items with a paired t-test of source estimations calculated for each participant. The results identified a time-window showing different topographies, and by extension different brain generators. Source estimations revealed several clusters in left frontal and parietal areas, frontal and temporal areas, as well as the cingulate and the thalamus, bilaterally. Differences were mainly driven by a higher activity for the Miss condition. Correct and incorrect categorization demonstrates that errors in discrimination of objects within a semantic category can be driven more by incorrect labeling, rather than by limitations at a lower, i.e. perceptual, processing level.

## F104

### MOTOR REPRESENTATIONS OF SPEECH SPECIFICALLY CONTRIBUTE TO PERCEPTION OF DISTORTED SPEECH SOUNDS

Helen Nuttall[1], Daniel Kennedy-Higgins[1], John Hogan[2], Joseph Devlin[2], Patti Adank[1]; [1]Speech, Hearing and Phonetic Sciences, University College London (UCL), London, UK, [2]Experimental Psychology, University College London (UCL), London, UK — Past studies have shown that activity in speech motor cortex is essential for speech perception, but the precise role of motor cortex in speech perception is unclear. There are two views on how the motor system is involved in perception. Both posit that listeners mentally imitate/simulate others' actions during speech perception to aid understanding. However, the views differ in their predictions on which conditions maximally recruit motor cortex. One asserts that there is greater recruitment when speech perception is challenging, such as when speech is distorted or heard in background noise. The other predicts that motor recruitment is greatest when perception is easiest. We aimed to disambiguate between these predictions. We measured Motor Evoked Potentials (MEPs) to probe excitability of the primary motor cortex (M1) representation of the lip muscle, with M1 hand as a control area, to test if MEPs were greater when listening to clear versus distorted VCV (vowel-consonant-vowel) stimuli. We also used a place-of-articulation contrast to confirm if the effect was modulated in an articulator-specific manner. Finally, we compared individual differences in MEPs to a behavioral measure (identification) of speech perception. MEPs for lip, but not hand, were larger for distorted stimuli than for clear stimuli and MEPs for distorted VCVs were bigger for stimuli produced using the lips. Also, we found a positive link between identification of the distorted VCV sounds and MEP size. Our findings indicate that activity of motor cortex during speech perception serves to support and facilitate challenging speech perception.

### F105

**THETA-BAND PHASE TRACKING IN INTERRUPTED SPEECH** Shweta Soni[1], Dillon A. Hambrook[1], Matthew S. Tata[1]; [1]University of Lethbridge — When speech is interrupted by intermittent gaps of silence it becomes quite difficult to understand. When those gaps are filled with broad-band noise, speech becomes more intelligible. This Phonemic Restoration or "Picket Fence" effect has been interpreted in the context of perceptual "filling in" - a kind of temporal interpolation of the signal. Recent work has shown that successful perception of normal fluent speech is accompanied by strong phase-locking between theta-band EEG oscillations and the acoustic envelope. We tested the theory that degrading speech with gaps of silence impairs perception because it breaks this phase-tracking effect. We further tested whether filling the silent gaps with noise restores perception by restoring phase tracking to the original envelope. We found that inserting gaps of silence into fluent speech reduces intelligibility, strongly degrades the dynamics of the speech envelope, and breaks EEG theta-phase tracking. However, filling silent gaps with noise does not restore theta-phase tracking, despite improving intelligibility. We conclude that disruption of theta-phase tracking may be a cause of degraded speech perception, but that other mechanism are likely responsible for the "filling in" phenomenon observed in Phonemic Restoration.

### F106

**ENCODING POLYPHONIC MUSICAL MOTIVES: EFFECTS OF VOICE SEPARATION AND TEMPORAL OVERLAP ON MISMATCH NEGATIVITY (MMN)** Madeline Huberth[1], Takako Fujioka[1]; [1]Stanford University — In music, a motif often repeats in different melodic lines. Previous event-related potential (ERP) studies have shown that the mismatch negativity (MMN) reflects simultaneous encoding of different melodic lines. However, occasionally motif entrances occur before the conclusion of the previous motif. Here we specifically investigated whether repeated motif presentation across two separate voices is encoded as a single entity or two separate entities, and whether motives overlapping in time impede or enhance the strength of encoding. We recorded the electroencephalogram (EEG) from 15 musicians, using a repeating 5-note motif with varied entry pitch level and number of overlapping notes. For 18% of trials, the 5th note was a contour changing deviant. The 'one-voice' arrangement used a half-octave range for motif entry pitch, while in the 'two-voice' arrangement, alternating motives were moved one octave lower. In both cases, the entrances overlapped by two notes, or none (e.g., silence in between). With zero-note overlap, MMN in frontal electrodes was larger in the one-voice compared to the two-voice condition. This suggests that even if the same motif repeats, presenting them across the two voices makes its encoding specific to each voice. In contrast, with motives overlapping by two notes, no significant MMN was observed, while differences between standard and deviant ERP were significant in the centro-parietal electrodes for both voice conditions. Moreover, the N1 peaks were significantly delayed compared to those in zero-overlap conditions. These observations suggest that different memory processes in the auditory cortex are active when melodies are temporally concurrent.

### F107

**NEURONAL ENTRAINMENT TO AUDITORY STIMULI AT MULTIPLE TIMESCALES** Gabriel A Nespoli[1], Paolo Ammirante[1], Frank A Russo[1]; [1]Ryerson University — Tracking pitch and beat are important objectives when engaging with music. Representation of these dimensions in the brain takes the form of synchronization, or entrainment. Using electroencephalography (EEG), subcortical neurons in the inferior colliculus have been found to synchronize their firing rates with the periodicities in tones, called the frequency-following response (FFR). Neuronal synchronization has also been seen at the beat level as a steady-state evoked potential (SSEP), presumably of cortical origin. However, how these forms of synchronization might be related across timescales is largely unknown. Participants listened to an isochronous train of tones while FFRs and SSEPs were measured simultaneously. The stimulus contained both short (tones) and long (beat) periodicities. It was found that the spectrum of EEG activity closely matched the spectrum of the stimulus at both timescales. In addition, the extent of synchronization to short timescale periodicities was correlated with (a) behavioral measures of musical engagement, and (b) with extent of synchronization to long timescale periodicities. These findings indicate that the experience-dependent plasticity seen in musicians manifests itself at multiple cortical levels corresponding to oscillations at different timescales present in music.

### F108

**NEURAL DYNAMICS OF NOVEL AUDITORY-MOTOR MAP LEARNING** Alexander Herman[1], Damien Harrell[2], Megan Thompson[1], John Houde[1], Srikantan Nagarajan[1]; [1]University of California, San Francisco, [2]University of Connecticut — The neural dynamics underlying audiomotor learning are not well understood. This study sought to characterize the neural correlates of feedback in audiomotor map learning through the use of a magnetoencephalography imaging (MEGI)-compatible touchscreen. We hypothesized that learning a novel audiomotor map task would correspond to the development of an internal model of the map, manifesting through efference copy-based suppression in the auditory cortex in correct feedback and error/conflict monitoring in frontal areas in incorrect feedback. 15 subjects were trained to identify locations on a touchscreen corresponding to one of six randomly assigned tones. Following training, subjects were given a target tone via headphones and attempted to reproduce it by identifying the corresponding area on the touchscreen. 10 out of 15 subjects demonstrated better-than chance responses improving upon their initial performance, indicating stable learning. The mean correct response rate in these 10 subjects increased from 24% initially to 38% at the conclusion of the ~1.5 hour experiment. In addition to demonstrating an increased rate of correct responses, MEGI showed significant differences in post-learning response between correct and incorrect trials. Correct trials showed increased suppression in early high gamma (125ms) and theta/alpha (200ms) power over incorrect trials. Frontal areas, however, showed increased high gamma power (250ms) followed by a relative increase in beta power (350ms). This increased activation in areas responsible for error monitoring in incorrect trials and suppression in sensorimotor areas during correct responses is consistent with efferent copy comparison based on the development of an audiomotor map internal model.

### F109

**ELECTROPHYSIOLOGICAL EVIDENCE FOR FACILITATION OF AUDITORY CHANGE DETECTION WITH SPATIALIZED AUDIO** Matthew Jesso[1], Daniel M. Roberts, George A. Buzzell, Craig G. McDonald, Carryl L. Baldwin; [1]George Mason University — Individuals often fail to notice changes to auditory scenes containing several sound objects unless attention is directed to the object that may change, a phenomenon termed "change deafness." In the current task, EEG in conjunction with a continuous change detection paradigm was utilized to investigate the relative importance of spatial and identity information to change detection performance. Participants listened to auditory scenes composed of six unique auditory objects and attempted to identify when changes to the scene (disappearance of one of the six objects) occurred. Between blocks, the objects in the scene were dissociated by either object identity information alone, or both object identity and object location information. Stimuli were presented over headphones, with spatialized audio accomplished via the use of a generic head-related transfer function. In an analysis of trials in which a change to the auditory scene occurred, the event-related potential (ERP) was computed time-locked to the occurrence of the scene change. This analysis revealed that the P3b component of the ERP was not only larger for detected changes relative to undetected changes in general, but was also larger for changes presented in trials with spatialized audio relative to trials without spatial information. It is suggested that spatial information within the auditory scene supports auditory stream segregation, leading to improved change detection.

## PERCEPTION & ACTION: Multisensory

### F110

**MULTISTAGE AUDIOVISUAL SPEECH PROCESSING MODULATING THE MISMATCH NEGATIVITY** Orestis Papaioannou[1], Julia Strand[2], Christian Graulty[1], Kevin Ortego[1], Enriqueta Canseco-Gonzalez[1]; [1]Reed College, [2]Carleton College — This study investigates the time-course of audiovisual (AV) integration of speech using the mismatch negativity (MMN)

event-related potential as a temporal marker. In an oddball paradigm with McGurk-style stimuli, congruent AV syllables (/ba/ or /da/) served as the standard, while two types of stimuli served as deviants: auditory only (AO) and audiovisual (AV). In the AO deviants, the audio of the standard was replaced by an ambiguous syllable lying on the ba-da boundary, while the video remained the same as the standard. In the AV deviant, the video presented the opposite syllable to the standard (i.e. ba for da, and vice versa) while the audio was the same ambiguous stimulus used in the AO deviants. We found no significant differences in MMN amplitude or latency to AV and AO deviants in participants with a high ease of integration (as assessed by a McGurk Integration Measure), suggesting that the MMN was unaffected by perceived audiovisual integration. In contrast, participants with low ease of integration showed a larger MMN for AO stimuli than for AV stimuli. This pattern of results suggests a multi-stage AV integration process, where stimuli are first determined to be audio-visually congruent or incongruent and then integrated to form a multimodal percept, with the latter process taking place at a time too late to affect the MMN.

## F111

### FUNCTIONAL CONNECTIVITY OF LETTER-SOUND PROCESSING IN ENGLISH ADULT READERS

Osamu Takai[1], Anthony Herdman[1]; [1]University of British Columbia — One of the first steps to learning to read in alphabetic languages is to associate alphabet letters (e.g., B) to their names (e.g., /bi:/), but the literature lacks knowledge of how multiple brain regions dynamically achieve such associations. Our goal was to uncover the neural networks for the audiovisual processing of single alphabet letters. Letter names and written letters were presented simultaneously as congruent or incongruent audiovisual stimuli. We combined dipole source models of the unimodal responses to identify node locations for performing functional connectivity analyses of audiovisual responses. We hypothesized that the incongruent stimuli, which do not match, would evoke stronger interregional connectivity in order resolve the audiovisual conflict (cf. Re-entrant theory, Di Lollo et al., 2000). However, we rejected this hypothesis because congruent audiovisual stimuli elicited stronger and more global network synchronizations in the theta-band (4-8 Hz) between 160 ms to 550 ms than did incongruent stimuli. We concluded that the functional connectivity observed for congruent stimuli likely involved global network coherence for object binding (e.g., Ward, 2003), not re-entrant processing.

## F112

### AUDIOVISUAL COLOUR-WORD STROOP MATCHING TASK: INTERFERENCE BUT NOT FACILITATION FROM WRITTEN WORD MEANING

Ido Bornstein[1], Anthony Herdman[1]; [1]University of British Columbia — Previous audiovisual Stroop studies used spoken colour words as ignored distractors when performing the visual Stroop task; however, making auditory stimuli task-relevant might identify how written word meaning affects an audiovisual judgement. Our study's main objective was to explore how written word meanings affect audiovisual matching of spoken colour words and font colours. We presented colour words written in congruent or incongruent font colours simultaneously with spoken colour words. Participants manually indicated if the spoken word and font colour were "Same" or "Different", while ignoring written word meaning. We recorded response times and accuracy to measure interference and facilitation effects between experimental and control conditions. We hypothesised that incongruent written words (e.g., "red") would interfere with "Same" responses (e.g., font colour = green, spoken = /green/) but facilitate "Different" responses (e.g., font colour = green, spoken = /blue/); and that congruent written words (e.g., "green") would facilitate "Same" responses (e.g., font colour = green, spoken = /green/) but interfere with "Different" responses (e.g., font colour = green, spoken = /blue/). Our findings showed large interference effects but no facilitation effects on audiovisual judgements. The largest interference effect occurred when the written word was incongruent with both the spoken word and font colour. Smaller interference effects occurred when the written word was congruent with either the spoken word or font colour. Consistent with previous Stroop findings, our audiovisual matching task showed that in the case of cross-modal colour judgements, written word meaning predominantly interferes with but does not facilitate performance.

## F113

### INVESTIGATING BODY PERCEPTION IN HEALTHY AND EATING DISORDERED FEMALES.

Katie Groves[1], Steffan Kennett[2], Helge Gillmeister[3]; [1]University of Essex, [2]University of Essex, [3]University of Essex — There is growing evidence to suggest that human bodies are processed distinctively from other visual stimuli in the brain. In particular, event related potential studies have shown that the visual observation of human bodies elicits an enhanced N190 component over occipito-parietal electrodes. However, little research has addressed whether the way people think and feel about their own body and those of others', modulates the N190. Therefore, the aim of the present study was to explore the relationship between electrophysiological body perception, cognitive body perception and body image. Electroencephalography (EEG) was used to assess the prevalence of the body-specific N190 component and the 'Eating Disorders Inventory 2' (EDI2) was used to assess unhealthy attitudes and behaviours relating to one's body including body image. Cognitive body perception was measured with body size estimation tasks and tactile estimation tasks. Three groups of females were recruited; those had had experienced either Anorexia or Bulimia at least once in their life, and those who reported no history of body perception disorders or body image disturbances. Task responses and N190 amplitude were correlated and compared between groups, with findings indicating a close link between the early visual processing of human bodies and the observers' thoughts about their own body. Additionally, an enhanced body-specific N190 in response to same-sex stimuli was found, with a more pronounced effect in clinical groups. Such findings therefore suggest a relationship between the visual analysis of human bodies and the observer's body image during very early stages of cortical processing.

## F114

### THE SHAPE AND COLOR OF MUSIC: NATURALLY BIASED ASSOCIATIONS ACROSS SENSORY DIMENSIONS.

Leah Sanson[1], Ferrinne Spector[2]; [1]Edgewood College, [2]Edgewood College — Adults do not usually see colors and shapes while hearing music. Nevertheless, there are surprising consistencies among adults when asked to match stimuli across these sensory dimensions. Examining such consistencies may reveal clues into underlying perceptual processes, particularly when combined with the experiences of individuals with synesthesia, who do experience extraneous concrete percepts in response to sensory stimuli. The purpose of this study was to combine the two approaches and examine whether non-synesthetic adults match visualizations to music similarly to that of audio-visual synesthetes - who perceive color and/or shape when hearing sounds/music. In each of two experiments, non-synesthetic adults (n = 40) listened to 14 music clips and made two-alternative forced choices between congruent and incongruent visualizations. In both experiments, the congruent visualizations came from audio-visual synesthetes responses to the target music clip, and the incongruent visualizations came from responses to a different clip of music from either the same audio-visual synesthete (Experiment 1) or a non-synesthete (Experiment 2). We randomized trial presentation with each experiment and counterbalanced the presentation of experiments across participants. Preliminary results from a subset of non-synesthetes (n = 11) suggest that non-synesthetes associate music to visualizations similarly to synesthetes. These results support the hypothesis that synesthetic percepts and non-synesthetic sensory associations may reflect the same inherent neural organization, with both providing valuable insight into the processes underlying multisensory perception.

## F115

### WHITE MATTER INTEGRITY IN VISUAL, MOTOR AND LIMBIC BRAIN REGIONS PREDICT SUBSEQUENT GAMING SKILL

Johan Mårtensson[1,3], Jürgen Gallinat[2], Ulman Lindenberger[1], Simone Kühn[1]; [1]Max Planck Institute for Human Development, [2]Charité University Medicine, [3]Lund university — Video gaming as a pastime has increased rapidly over the past thirty years and gaming is becoming a dominant cultural medium. Today every American household has an average of two video game players. Recent longitudinal findings into the effects of video gaming on the brain showed that practicing a 3D platform game on a mobile console could lead to increases in local cerebral grey matter volume. We employed diffusion tensor imaging to investigate whether white matter integrity between known areas of grey matter change can be used to predict later gaming skill

in novice video game players. Probabilistic tractography between the right dorsolateral prefrontal cortex, the right hippocampus and the cerebellum revealed that participants with higher values of fractional anisotropy in visual areas, the limbic system and motor regions in the right hemisphere became better gamers following training. An independent whole-brain search in major white matter connections using tract based spatial statistics corroborated these findings by showing highly similar areas bilaterally when looking for voxels that were predictive of later skill level. Our findings point towards the importance of local white matter integrity in task relevant visuomotor and limbic areas of the brain for training outcomes in a 3D platform game.

### F116

### HAPTIC PRIMING IN EMBODIED COGNITION: SOMATOSENSORY CONTRIBUTIONS TO ACCESSING MOTOR KNOWLEDGE

Chelsea Ekstrand[1], Eric Lorentz[1], Layla Gould[1], Marla Mickleborough[1], Ron Borowsky[1]; [1]University of Saskatchewan — Cognitive embodiment refers to idea that cognitive processes are rooted in perception and action experience. Although much research has been focused on motor involvement in response to presented stimuli of graspable objects, somatosensory contributions to accessing motor knowledge have remained relatively unexplored. We employed a haptic vibratory prime to either the hands or the feet in order to pre-engage the somatosensory cortex, followed by a picture stimulus of a graspable object. Stimuli consisted of items either associated with the hands (e.g., 'cup') and items more associated with the feet (e.g., 'skis'). Objects more commonly used by the hands (i.e., hand items) should show faster response times when preceded by a somatosensory prime than items less commonly used by the hands (i.e., foot items) if motor knowledge is involved. In Experiment 1, participants were required to name the object as quickly as possible. Reaction times (RTs) indicated that somatosensory priming had no effect on hand items and hindered naming performance on items associated with the feet, suggesting that somatosensory and motor knowledge have differential effects in naming. Experiment 2 required participants to state how they would interact with the presented object. RTs indicated that somatosensory priming benefitted responses to hand related objects regardless of the vibration location (i.e., foot or hand) and that somatosensory stimulation of the feet hindered responses to items associated with the feet. Together, these results suggest that somatosensory priming may influence access to motor knowledge for objects depending on the nature of their affordances.

### F117

### VISUAL PREDICTIVE INFORMATION MODULATES MUSICAL SYNTACTIC PROCESSING: AN ERP STUDY

Hana Shin[1], Takako Fujioka[1]; [1]Stanford University — The early right anterior negativity (ERAN), a component of event-related brain potentials (ERPs), is typically elicited when an out-of-key chord replaces the most expected chord in a tonal sequence, thereby creating a violation of syntactic expectation. Here, we examined how anticipatory process influences the ERAN when information about the critical chord is available visually before hearing the sound. We recorded the EEG from musicians using the same auditory chord stimuli with two types of visual stimulus: the exact musical notation, and words representing the quality of the last chord ("regular", or "irregular"). The irregular sequences constituted 50% of the total stimuli. An audio-only control condition was also used. The ERAN was observed in both right and left fronto-central electrodes in all conditions. In the left hemisphere, the ERAN was larger and more consistent across all conditions compared to the right hemisphere, where the ERAN was much smaller and more negatively shifted between 100ms and 400ms in the music-notation condition. In addition, in both visual conditions, a gradual DC shift starting about 300ms after the first chord separated the regular and irregular conditions over the course of the whole sequence. The shift likely indicates the build-up of constant anticipation for the following chords. Interestingly, this component was strongly right-lateralized in the word condition. Our data suggest that the knowledge of the upcoming chord provided by musical and linguistic information differently modifies how auditory information is processed between the hemispheres.

### F118

### THE SPACE AROUND YOU. VENTRAL INTRAPARIETAL AREA CODES PERIPERSONAL SPACE AROUND ONE'S OWN AND OTHER FACES.

Andrea Serino[1], Manuela Ansaldo[2,3], Gaspare Galati[2,3]; [1]Laboratory of Cognitive Neuroscience, Ecole Polytechnique Fédérale de Lausanne, Switzerland, [2]Department of Psychology, Sapienza University, Roma, Italy, [3]Laboratory of Neuropsychology, Foundation Santa Lucia, Roma, Italy — The ventral intraparietal area (VIP) both in humans (Sereno and Huang 2006; Huang et al. 2012) and in monkeys (Avillac et al. 2005) underlies a multisensory representation of the space around the body (i.e., peripersonal space, PPS), in that it integrates tactile stimuli on the face with visual stimuli occurring within the PPS. Here we show that the PPS representation in VIP also codes other people's PPS. By combining psychophysics and fMRI experiments based on virtual reality, we found that visual stimuli approaching the face of another character activates the representation of one's own PPS and are coded by VIP as they were approaching one's own face. We suggest that this mechanism, by re-mapping the space around the Other as the space around oneself, might be a primitive mechanism of social cognition.

## THINKING: Other

### F119

### STRUCTURAL MRI IN DEFAULT MODE NETWORK REGIONS IS RELATED TO DISSOCIATION AND ABSORPTION

Matthew Jerram[1], Alyson Negreira[1]; [1]Suffolk University — Dissociation is a multifaceted construct defined by disruptions in consciousness that range from normative to pathological. One of dissociation's components is absorption, which reflects an introspective approach and is associated with imagery and daydreaming. Little is known about the neural correlates of dissociative traits, including absorption, in healthy populations. The internal focus of dissociation, especially absorption, leads to speculation of default mode network (DMN) involvement, as this network is active during introspection. This study used structural MRI (sMRI) metrics and dissociative trait measures to examine the hypothesis that dissociation measures, specifically absorption, would be positively correlated with sMRI metrics in DMN regions. Sixteen right-handed healthy men were recruited from the community and underwent MRI scanning and psychological testing. Dissociation was measured using the Dissociative Experiences Scale-II (DES-II) and its absorption subscale (DES-Ab). sMRI data were analyzed using a standard analysis pipeline in freesurfer and several metrics were extracted, including gray matter volume (GVM), cortical surface area (SA) and cortical thickness (CT). The metrics were obtained only in regions identified as part of the DMN in Yeo, et al (2011) and aggregated into a single DMN ROI for the brain. These metrics were correlated with DES-II total scores and DES-Ab. Results supported the hypothesis, as DES-II and DES-Ab were significantly correlated with CT (DES-II: $r = 0.42$; DES-Ab: $r = 0.50$). GVM and SA were not significantly correlated with either DES-II or DES-Ab. The results suggest the DMN may be the neural foundation of dissociation and absorption.

### F120

### 6 X 3 = ... 20? EVENT-RELATED POTENTIALS REVEAL HEMISPHERIC DIFFERENCES AND SIMILARITIES IN PROCESSING OF MATHEMATICAL FACTS

Danielle S. Dickson[1], Kara D. Federmeier[1]; [1]University of Illinois at Urbana-Champaign — Multiple studies of mathematical fact retrieval in the context of multiplication problems have used ERPs to examine how correct versus incorrect answers are processed, and, like sentence final words that are contextually congruent or not, N400-like effects are typically reported. Answers that are unexpected (incorrect) but are closely related to the correct answer have been reported to elicit intermediate N400s. Despite interesting fMRI and lesion work, there have been no ERP studies investigating each hemisphere's response to these types of stimuli. Therefore, we presented equation contexts ("6 x 3 =") serially at central fixation, and then critical answers (either correct, unexpected/related, or unexpected/unrelated) were presented to either the left visual field (right hemisphere, LVF/RH), right visual field (left hemisphere, RVF/LH) or centrally while ERPs were recorded. In the N400 timewindow, we found an effect that tracked correctness but was not responsive to relatedness – and this effect was similar across both hemispheres and in central presentation.

Thus, both hemispheres seem able to assess answers for correctness at fairly early stages of processing (ie, initial semantic analysis). The relatedness of incorrect answers in our study was only appreciated later, reflected by a late positive complex (LPC), with the largest LPC for incorrect/unrelated answers, an intermediate one for incorrect/related answers, and the least positivity for correct answers. Interestingly, this LPC effect did differ across hemispheres (most prominent in the LVF/RH), suggesting that the RH may have a unique contribution to the retrieval of mathematical facts and their subsequent assessment and analysis.

## F121

## DIFFERENTIAL EFFECTS OF GLOBAL AND LOCAL VISUAL PERCEPTION ON MIND WANDERING AND CREATIVE COGNITION

Emilee R. Naylor[1,2], Marjorie Taylor[1]; [1]University of Oregon, [2]Georgetown University — Creativity is a driving force for innovation in science, technology, engineering, mathematics, the arts and humanities. Existing research has focused on cognitive and conceptual explanations for how creative ideas are generated, but much less has been asked about the roles perceptual mechanisms play in facilitating creative output. This study investigated the effects of global (broadened) and local (narrowed) visual perceptual priming on mind wandering and creative cognition in young adults (n=91). Visual priming was implemented using a variant of the Navon-letter-task paradigm (Förster, 2012; Navon, 1977). Errors and Response Times (RTs) were recorded during the priming task and used to assess the efficacy with which participants adopted either a global or local visual field. Two divergent thinking Alternative Uses Tasks (AUTs) and a novel, social creativity task were used to assess creative cognition. Creativity was calculated based on the Consensual Assessment Technique (Amabile, 1982) using 3 independent judges blind to condition. Self-reported mind wandering was retrospectively measured after the priming task. An RT by priming condition interaction significantly predicted percent increase in creativity scores between pre- and post-priming, such that global perception yielded the highest increase in creative cognition. Global perception also elicited the highest rates of mind wandering. Taken together, these results suggest that global visual priming induces mind wandering, which, in turn, may facilitate creative thinking. Further, the data show that creative output can be augmented by activating specific perceptual processes during incubation and have implications for education and pedagogically-oriented creativity training programs.

## F122

## NETWORK CENTRALITY IN PREFRONTAL CORTEX IS ASSOCIATED WITH GENERAL INTELLIGENCE

Kirsten Hilger[1,2], Matthias Ekman[3], Christian J. Fiebach[1,2,3], Ulrike Basten[1]; [1]Goethe University, Frankfurt am Main, Germany, [2]IDeA Center for Individual Development and Adaptive Education, Frankfurt am Main, Germany, [3]Donders Institute for Brain, Cognition, and Behaviour, Radboud University Nijmegen, The Netherlands — Graph theory provides a fruitful framework for the precise mathematical representation of complex neuronal networks. Using graph theoretical metrics, previous studies have linked individual differences in intelligence to the global communication efficiency of the human brain. Here, we investigate whether local connectivity metrics can further elucidate the neural locus of the relationship between network topology and individual differences in intelligence. Based on functional magnetic resonance imaging data acquired during cognitive rest, individual functional brain networks were modeled as graphs for 54 healthy adult participants (18 – 30 years; Nooner et al., 2012). Subsequently, metrics of graph properties were correlated with intelligence (Wechsler Abbreviate Scale of Intelligence, WASI, Wechsler, 1999). Consistent across different sparsity thresholds applied to the modeled networks, brighter subjects showed higher centrality in the right inferior frontal gyrus (IFG). Specifically, in more intelligent persons the right IFG is characterized by (i) higher degree centrality, reflecting overall more direct connections to neighboring nodes in the functional network, as well as by (ii) higher nodal efficiency reflecting on average shorter connections from IFG to all other nodes of the network. In sum, our data suggest that the topological integration of right IFG in the cortical network is predictive of general intelligence. The role of the rIFG in reconfiguring representations of currently relevant stimuli and responses may be critical for its contribution to human intelligence, and may be facilitated by easier access to greater portions of the cortical network in more intelligent persons.

## F123

## TASK-GENERAL AND TASK-SPECIFYING FUNCTIONAL BRAIN DYNAMICS

Doug Schultz[1], Michael Cole[1]; [1]Rutgers University - Newark — We recently found that the human brain's functional networks are similar but not identical between rest and a variety of task states (Cole et al., 2014). Here we sought to characterize these changes from rest, identifying the network dynamics that likely make adaptive, task-specific behavior possible. Data from the Human Connectome Project (WU-Minn consortium, N=100) was used for analysis. This involved 60 min of rest functional MRI (fMRI) data, as well as 45 min of task fMRI data split among seven highly distinct tasks (as previously described; Barch et al., 2013). We conducted a series of analyses comparing functional connectivity across previously defined brain regions and networks (Power et al., 2011). We compared functional connectivity between each of the seven tasks and an equivalent period of resting-state data. All tasks were characterized by prominent decreases in connectivity relative to rest, primarily within networks. Surprisingly, connectivity between the visual and motor networks was also decreased, even for visuo-motor working memory tasks. Follow-up analyses revealed that these visuo-motor decreases were evident during all blocks of the working memory tasks, but that they were accompanied by small, but specific increases in connectivity. These results indicate that task related changes in connectivity may be largely negative, reflecting a large-scale suppression of intrinsic connectivity along with a select set of task-specifying increases in connectivity.

## F124

## MODULATION OF FRONTAL MIDLINE THETA DURING AUDITORY PRESENTATION OF FICTIONAL AND NONFICTIONAL NARRATIVES

John Treffalls[1], Brian Fremaux[1], Hannah Wojciehowski[2], Dan Lochman[3], Reiko Graham[1]; [1]Department of Psychology, Texas State University, [2]Department of English, University of Texas at Austin, [3]Department of English, Texas State University — Frontal midline theta (FMT) consists of 4-7 Hz oscillations over frontal areas that are sensitive to task demands: increases in power have been associated with mental effort and attention, while decreases have been associated with activation of default mode network. The objective of the current study was to examine differences in FMT during different narratives (fiction vs. nonfiction). To this end, we recorded EEG in participants (N = 15) while they while they listened to a nonfictional and a fictional narrative (eyes closed), and while resting with eyes closed. Overall, participants rated the fictional narrative as more vivid and interesting than the nonfictional narrative. EEG analyses revealed an anterior-posterior gradient to theta, which differed as a function of condition. Relative to the eyes closed condition, FMT was enhanced for the nonfictional narrative. In contrast, FMT for the fictional narrative was more similar to the eyes closed resting condition. Exploratory correlational analyses revealed that FMT to the fictional narrative was negatively correlated with the ability to feel empathy for characters in a story. In contrast, the importance of plot in a narrative was inversely related to FMT for both narratives. Reader reactions to the stories (e.g., vividness, interest) were not correlated with FMT. We hypothesize that increases in FMT during the nonfictional narrative were due, at least in part, to mental effort (e.g., attention, cognitive load). Decreases in FMT during the fictional narrative may be due to increased activity in the default mode network due to increased mentalizing or self-referential processing.

## F125

## NUMERICAL ABILITIES DEVELOP INDEPENDENT OF VISUAL EXPERIENCE

Shipra Kanjlia[1], Connor T. Lane[1], Lisa Feigenson[1], Marina Bedny[1]; [1]Johns Hopkins University — The ability to perform symbolic math depends on the ability to process nonsymbolic numerical information in the visual environment. Individual differences in the ability to visually estimate sets of items in infancy and childhood predict performance on future math assessments (Mazzocco et al., 2011; Starr et al., 2014). Math tasks also activate areas of the intraparietal sulcus (IPS) that respond to the numerosity of visual sets (Piazza et al., 2007). Given the link between visual numerical approximation and math abilities, we asked whether visual experience is necessary for typical development of neural structures involved in symbolic math processing. While undergoing fMRI, congenitally blind and sighted participants heard pairs of algebraic equations and determined

whether the value of the unknown variable in each were the same. Half of the equations were simple (single-digit e.g. X-2=5) and half were complex (double-digit e.g. X-12=15). In a second task, participants judged whether pairs of sentences had the same meaning. Half of the sentences were syntactically simple (subject-relative) and half were complex (object-relative). As shown previously, we find greater activation in bilateral IPS for math calculation than sentence comprehension in sighted adults. Critically, bilateral IPS in congenitally blind individuals 1) also respond more to math than sentences (group-by-condition ANOVAs main effect of math $F(1,25)=194.85$, $p<0.0001$; group-by-condition interaction $F(1,25)=1.90$, $p=0.18$) 2) is sensitive to manipulations in math complexity ($t(16)=-5.42$, $p<0.0001$) and 3) is not sensitive to differences in syntactic complexity ($t(16)=-0.22$, $p=0.83$). Thus, visual experience is not necessary for the development of neural structures supporting math calculation.

## F126

### INTERACTION BETWEEN BRAIN-DERIVED NEUROTROPHIC FACTOR VAL66MET GENOTYPE AND SEX AFFECTS HIPPOCAMPAL FUNCTION DURING SPATIAL NAVIGATION IN HEALTHY ADULTS

Hillary Raab[1], Shau-Ming Wei[1], Philip Kohn[1], J. Shane Kippenhan[1], Bhaskar Kolachana[2], Karen F. Berman[1]; [1]Section on Integrative Neuroimaging, Clinical and Translational Neuroscience Branch, NIMH, NIH, [2]Clinical and Translational Neuroscience Branch, NIMH, NIH

— While there is evidence of sex differences in hippocampus-dependent spatial abilities, the literature in humans is far from unanimous. Aside from methodological differences, a number of yet-to-be-defined contextual, demographic, and genetic factors might contribute to the observed variability in the findings. Brain-derived neurotrophic factor (BDNF), crucial for cellular function in the hippocampus, is one such potential factor. Because the Val66Met single nucleotide polymorphism in the BDNF gene has been associated with abnormal hippocampal function during performance of affective and cognitive tasks, and because animal studies have shown that BDNF and gonadal steroid hormones conjointly influence function of hippocampal neurons, we used fMRI together with a virtual reality-like hippocampus-dependent spatial navigation task to test for sex-by-BDNF genotype interactions in 49 healthy adults (age=32.36, 15 Met carriers). We found significant sex-by-genotype interactions in the right hippocampus ($p=.05$, FWE with small volume correction): Val homozygotes showed greater hippocampal activation in men than women, whereas in Met carriers the relationship between the sexes was opposite. These data demonstrate that BDNF allelic variation and sex interactively affect hippocampal function during spatial navigation. These results extend to humans previous findings in animals showing interactions of estradiol and BDNF in the brain, and also offer an explanation for the variable results noted in human studies. Future work will examine whether BDNF genotype and menstrual-cycle-phase interactively affect navigation-related hippocampal recruitment in women. Additionally, analyses of functional connectivity between hippocampus and other brain regions will elucidate circuit-level repercussions of BDNF genotype-by-sex interactive effects on hippocampal function during spatial navigation.

## F127

### BECOMING CENTERED: META-ANALYSIS OF FMRI REVEALS LATERAL-MEDIAL TRANSITION BETWEEN NOVICES AND EXPERTS IN MINDFULNESS

Gina Falcone[1], Matthew Jerram[1]; [1]Suffolk University

— Interest in mindfulness has grown in the past decade, especially as mindfulness-based third-wave cognitive therapies have been found to be efficacious. This has encouraged imaging research into the brain mechanisms of mindfulness. Researchers have tended to take one of two approaches to these studies – either training individuals with no experience in mindfulness for the study or sampling individuals who are experienced or expert in mindful meditation. Therefore, broad conclusions about the neural representation of mindfulness have confounded the processes of learning and automaticity; we used meta-analysis to parse these processes. Meta-analysis was performed with GingerALE 2 using data extracted from published studies examining mindfulness using fMRI. Studies for inclusion were identified through keyword search (such as ("fMRI" AND "mindfulness")). Twenty studies were identified, of which twelve studies trained naïve individuals in mindfulness during the study (NEW) and 8 studies used experienced mindfulness meditators (EXPERT). Significant cluster peak voxels and sample sizes were entered into GingerALE 2 and activation likelihood estimate (ALE) maps were obtained. For NEW studies, meta-analysis identified ALE clusters in amygdala, insula, inferior frontal gyrus, middle temporal gyrus, and middle frontal gyrus. In the EXPERT studies, ALE clusters were found in precuneus, posterior cingulate, medial frontal gyrus and anterior cingulate. These results are consistent with previous research demonstrating that learning is associated with more lateral brain activation and automaticity with more medial activity and provide information about differences in mindfulness-related brain activity in naïve and expert practitioners.

## F128

### REPRESENTATION OF SYMBOLIC FRACTIONS RECRUITS CIRCUITS TUNED TO NONSYMBOLIC RATIO MAGNITUDE.

Mark Lewis[1,2], Elizabeth Toomarian[2], Edward Hubbard[2]; [1]University of Delaware, [2]University of Wisconsin-Madison

— Both children and adults experience pervasive struggles understanding fractions, leading some theorists to propose that fraction concepts might lack a cortical specialization analogous to the Approximate Number System. However, emerging data and theory suggest that newly identified circuits – a Ratio Processing System (RPS) - may be ideally suited for learning about fractions. We will present results from neuroimaging and behavioral experiments that suggest that an understanding of symbolic fraction magnitude may build upon the ability of the RPS to represent the magnitudes of nonsymbolic ratios like pairs of lines. The results of an fMRI adaptation experiment demonstrate cross-notational recovery from adaptation to nonsymbolic ratio magnitudes. After participants (n=6) were adapted to a specific nonsymbolic ratio magnitude (a series of line ratios in which the component line lengths varied but the shorter line length was always the same fraction of the longer line), activation in right mid-IPS recovered in a distance-dependent fashion when a new nonsymbolic ratio or corresponding symbolic fraction was presented. The fact that adaptation transferred from nonsymbolic line ratios to symbolic fractions in a distance-dependent manner suggests that adults have made links between symbolic fractions and the more basic RPS that represents fraction magitude. Results from a two-alternative-forced-choice experiment in which participants (n=40) chose the line ratio that matched a symbolic fraction showed that the precision of these links predicts fraction knowledge as assesed by a symbolic fraction comparison task, suggesting that building upon this system may be an important part of fraction learning.

## F129

### LACK OF REPLICATION FOR THE MYOSIN-18B ASSOCIATION WITH MATHEMATICAL ABILITY IN INDEPENDENT COHORTS

Samuelle Filea Fajutrao Valles[1], Kerry Pettigrew[1], Kristina Moll[2,3], Kate Northstone[4], Susan Ring[4], Craig Pennell[5], Carol Wang[5], Ruth Leavett[3], Marianna E. Hayiou-Thomas[3], Paul Thompson[6], Nuala H. Simpson[7], Simon E. Fisher[8,9], Andrew J.O. Whitehouse[10], Margaret J. Snowling[6,11], Dianne F. Newbury[7,11], Silvia Paracchini[1]; [1]School of Medicine, University of St Andrews, [2]Department of Child and Adolescent Psychiatry, Psychosomatics, and Psychotherapy, Ludwig-Maximilians-University, [3]Department of Psychology, University of York, UK, [4]School of Social and Community Medicine, University of Bristol, [5]School of Women's and Infants' Health, University of Western Australia, [6]Department of Experimental Psychology, University of Oxford, [7]Wellcome Trust Centre for Human Genetics, Oxford University, [8]Max Planck Institute for Psycholinguistics, [9]Donders Institute for Brain, Cognition and Behaviour, Radboud University, [10]Telethon Kids Institute, University of Western Australia, [11]St. Johns College, University of Oxford

— From shopping to telling the time, mathematical ability is an essential skill for everyday life. Twin studies indicate that dyscalculia (or mathematical disability) is caused partly by a genetic component, which is yet to be understood at the molecular level. Recently, a coding variant (rs133885) in the Myosin-18B gene was shown to be associated with mathematical abilities with a specific effect among children with dyslexia. This association represents one of the most significant genetic associations reported to date for mathematical abilities. However, this association has not been replicated before. We conducted association analysis in different cohorts characterised with maths-related measures, with the aim of replicating the rs133885 association. The study was conducted primarily using the Avon Longitudinal Study of Parents and Children (ALSPAC), which was ade-

quately powered for this analysis. We tested additional cohorts including the York Cohort, the Specific Language Impairment Consortium (SLIC) and the Raine Cohort. In a total we analysed 4854 individuals that were stratified for a definition of dyslexia whenever possible. We did not observe any associations between rs133885 in Myosin-18B and mathematical abilities among individuals with dyslexia or in the general population. Our results then suggest that the Myosin-18B variant is unlikely to be a main factor contributing to mathematical abilities.

# Poster Session G

## ATTENTION: Other

### G1

**FEATURE CORRELATION GUIDANCE IN CATEGORY VISUAL SEARCH** Rachel Wu[1], Zoe Pruitt[1], Megan Runkle[1], Kristen Meyer[1], Gaia Scerif[2], Richard Aslin[1]; [1]Brain and Cognitive Sciences, University of Rochester, [2]Department of Experimental Psychology, University of Oxford — Compared to objects with uncorrelated features (e.g., jelly beans come in many colors), objects with correlated features (e.g., bananas tend to be yellow) enable more robust object representations (e.g., Austerweil & Griffiths, 2013; Wu et al., 2011) and object categories (e.g., Younger & Cohen, 1986). It is unclear whether these more robust representations resulting from feature correlations impact working memory representations (e.g., attentional templates). Adults participated in four visual search tasks where targets were defined as either one item (e.g., exemplar search: one alien with triangle-shaped back spikes and a triangle belly shape), or categorically (e.g., category search: any alien with matching vs non-matching back spikes and belly shapes) with correlated (e.g., circle belly shape, circle back spikes) and uncorrelated features (e.g., circle belly shape, triangle back spikes). We measured behavioral responses and the N2pc component, an event-related potential (ERP) marker of target selection. Both behavioral responses were better and the N2pc was larger for exemplar search compared to category search, and behavioral responses were worse for search for uncorrelated than for correlated features. Importantly, the N2pc was present for category search with correlated features, while search for uncorrelated features revealed no N2pc. There were no differences between the large N2pc components for exemplar search. Our ERP results demonstrate that correlated features for novel categories provide a more robust category representation compared to categories with uncorrelated features, which enables more efficient category search.

### G2

**FUNCTIONAL COUPLING BETWEEN THE RIGHT ANTERIOR INSULA AND OCCIPITAL ALPHA POWER DISTINGUISHES BETWEEN DECISIONS TO ATTEND LEFT OR RIGHT: A COMBINED EEG FMRI STUDY.** Jesse Bengson[1], Ron Mangun[1]; [1]University of California-Davis — Experimental studies of visual spatial attention typically use instructional cues to direct attention, but in everyday vision, attention is often directed by endogenous decisions. Here, we employ a novel willed attention paradigm along with Electroencephalographic and functional Magnetic Resonance Imaging recordings in order to investigate the neural processes that initiate the control of decision-driven attention. With respect to the fMRI data, we isolate a unique network of activation for willed attention that includes the Anterior Cingulate, Middle Frontal Gyrus, and the Left and Right Anterior Insula. We also isolate decision-specific reduction of occipital alpha power over the visual cortex during the decision process. Finally, we find that coupling between the decision specific alpha reduction and BOLD activation in the right anterior Insula uniquely differentiates between decisions to attend left vs. right. Based on these data, we put forward a model whereby the right anterior Insula is critical in mediating between visual-cortical sensitivity and the influence of this sensitivity upon the decision process.

### G3

**FLANKER-TASK INCONGRUENCY INDUCES RAPID ATTENTIONAL DISTRACTION FOLLOWED BY CORRESPONDING SUPPRESSION TO FACILITATE NEXT-TRIAL PERFORMANCE** Berry van den Berg[1,2], Monicque Lorist[2], Frank Lee[1], Marty Woldorff[1]; [1]Center for Cognitive Neuroscience, Duke University, Durham, NC, [2]BCN Neuroimaging Center, University of Groningen, Groningen, Netherlands — Relatively little is understood concerning the neural mechanisms, especially the underlying neural cascade, by which humans can successfully modulate visual inputs to suppress irrelevant or conflicting stimulus information and thus improve behavioral performance. Here, we used a novel lateralized flanker paradigm (e.g., congruent: HHHHH, bilateral incongruent: HHXHH, partial incongruent: XXXHH), in combination with high-temporal-resolution EEG recordings, to investigate the effects of conflicting visual input on both time-locked ERPs and attention-related Alpha power (8-14 Hz). Results indicate: (1) A rapid early ERP response elicited contralateral to the conflicting input (200-400 ms), consistent with attentional capture by the incongruent information; (2) This was followed by a contralateral Alpha decrease (500-800 ms), also consistent with a shift of attention towards the incongruent information; (3) This contralateral Alpha decrease was followed in turn by a bilateral occipital Alpha increase (1100-1500 ms) that was predictive of subsequent response-time performance (more Alpha predicted faster RTs); (4) This was then followed towards the end of the trial (just before the next trial), by a lateralized Alpha increase contralateral to the incongruent side (1700-2500 ms). These results suggest a cascade of attention-related processes lasting over several seconds by which humans deal with conflicting stimulus input. In particular, attention appears to be initially and rapidly shifted toward incongruent information (contralateral ERP effect and alpha decrease), which is followed by an alpha suppression of the information that is irrelevant (alpha increases, bilateral and then contralateral), leading in turn to better preparation for, and better performance on, the next trial.

### G4

**EXPLORING SOCIAL INFLUENCES ON ANTICIPATORY EEG ACTIVITY IN A CUED SPATIAL ATTENTION TASK** Ashley R. Drew[1], Peter J. Marshall[1]; [1]Temple University — Various anticipatory changes in brain oscillations emerge following a visual cue to direct one's attention toward an upcoming target stimulus that requires a behavioral response. We attempted to connect work in this area to the emerging field of joint action, in order to fill a gap in the literature on social influences on selective attention. We measured alpha desynchronization and ERP (specifically the late directing attention positivity component; LDAP) patterns after participants viewed cues that signaled whether they would respond to an impending target or whether another person would respond to it. EEG was recorded from undergraduates (N=23) who sat next to a partner (experimenter). An arrow cue indicated the side of the screen the target would appear, with cue color indicating whether 1) the participant or 2) the partner or 3) nobody was to press a button determining whether the target was a short or long bar. The instructed goal for the participant and partner was to jointly maximize discrimination performance. Significantly greater alpha desynchronization and larger LDAP amplitudes to the cues were found when the cues were for the participant to respond, rather than the partner. There was no significant difference between alpha and LDAP responses to the cues indicating that the partner should respond and the cues indicating that no response was required from either person. This lack of difference may be partly due to a lack of social connection between participant and partner, which could be strengthened in future work relating selective attention and joint action.

### G5

**EFFICIENT TASK SWITCHING UNDERLIES OPTIMAL MULTITASKING PERFORMANCE** Omar AlHashimi[1], Ted Zanto[2], Joaquin A. Anguera[2], Adam Gazzaley[2]; [1]UCLA Department of Psychology, [2]UCSF Department of Neurology — Performance deficits characterized by response delays and errors often arise when multitasking. Dual-tasking experiments often use two discrete tasks to characterize these costs. However, real-world interruption often occurs while continuously engaging in a non-discrete task such as driving or talking. We use NeuroRacer, a complex continuous task paradigm previously used to characterize age-related deficits and midline frontal theta training-related gains to characterize these multitasking costs. To investigate, we focused our analysis on driving performance in isolation and in the context of another task (discrimination) among naive participants aged 20 to 29 years old. We examined individual variability differences between overall task performance and midline frontal theta activity finding increased midline frontal theta activity in higher multitask performers. Specifically, participants with higher theta activity during the interrupting

discrimination task was found to correlate with faster disengagement of the continuous driving task, improved discrimination performance and a faster re-engagement of the driving task, resulting in decreased driving error.

### G6

### THE TEMPORAL DYNAMICS OF ATTENTIONAL SHIFTING AND FEEDBACK PROCESSING AFTER PARTIAL FEEDBACK ON THE PROBABILITY OF REWARD

Rene San Martin[1,2], Joshua Stivers[2], Marty Woldorff[2]; [1]Centro de Neuroeconomía, Facultad de Economía y Empresa, Universidad Diego Portales, Santiago, Chile, [2]Center for Cognitive Neuroscience, Duke University — We used eventrelated potentials (ERPs) in a learning-based, decision-making task to investigate the neural processing of partial-feedback information on the probability of reward and how such partial information interacts with the processing of final feedback. On each trial participants chose between a green and a purple circle, which were associated with asymmetric probabilities (60/40) of winning in that run, with the direction of these "biased-coin" probabilities being reset each run. A second 'partial-feedback' screen presented a circular array of 8 lateralized circles, where the proportion of green versus purple circles indicated the probability that the choice made was a winner. Each trial ended when one of these lateralized circles turned into a feature-popout, providing the final outcome of the trial. Partial feedback indicating 100% vs. 0% probability of losing elicited the hallmark fronto-central feedback-related negativity (FRN) peaking ~250ms. Moreover, both of these high-certainty initial-feedback conditions, versus low-certainty ones, were associated with a greater attention-related P3 component (~350-500 ms). The final feedback event elicited a robust N2pc component (~250ms) reflecting lateralized attentional shifting towards the winner feedback stimulus. This N2pc was followed by a relatively delayed FRN (by ~150ms) for losing versus winning bets, suggesting the need for an attentional shift to the relevant, outcome-indicating, environmental item before full analysis of the bet outcome could be realized. We also found that the final-outcome FRN and P3 components were greatly attenuated after partial-feedback of 100% vs. <100% certainty, indicating the influence of partial feedback information on the processing of a final outcome.

### G7

### A MECHANISTIC MODEL OF ALPHA-INDUCED INFORMATION SUPPRESSION

Stefan Berteau[1], Daniel Bullock[1], Robert Sekuler[2], Paul Miller[2]; [1]Boston University, [2]Brandeis University — Alpha-induced information suppression, the functional inhibition of a cortical region by alpha (8-14 Hz) oscillations, has been established through both correlative and causal experiments. Despite the extensive body of experimental work, there are no existing computational models of this functional inhibition. We introduce the first mechanistic, computational neural model of alpha information suppression. When the model's thalamo-cortical system is driven at or near its resonant frequency of 10Hz, the amplitude of thalamic oscillations increases. This in turn transitions the cortical excitatory cells from occasional input-correlated bursts into periodic suprathreshold activity. The activity then drives cortical inhibitory interneurons, creating "pulses" of GABAergic inhibition like those proposed by Jensen and Mazaheri in 2010. This alternating saturation and inhibition reduces the impact of any incoming signal on cortical excitatory population activity. Our model's results show a significant reduction in communication, measured by mutual information, in the alpha range but not in the range of cortical theta (4-7 Hz). This mirrors transcranial magnetic stimulation results which found suppression of sensory input only when the cortex was stimulated at alpha frequencies, not lower or higher. We also replicate EEG and behavioral results from Busch et al., 2009, showing significant phase effects in low alpha/high theta and supporting Klimesch's 2007 Inhibition Timing Hypothesis. Finally, extending the model to mimic coherence-based functional network studies, we examine the role that coherence and relative phase play in communication between two modeled cortical regions. We demonstrate their important role at theta frequencies, but (due to information suppression) not in alpha.

## ATTENTION: Spatial

### G8

### ERP CORRELATES OF TACTILE SEARCH: THE N140CC

Alexander Jones[1], Bettina Forster[2]; [1]Middlesex University London, [2]City University London — Our brain constantly receives tactile information coming from the body's surface. We often only become aware of this information when directing our attention towards the body. Here, we report a study investigating the behavioural and neural response when selecting a target amongst distractor vibrations presented simultaneously to several location either across the hands or body. Comparable studies in the visual modality have revealed the N2pc as the neural correlate of visual selective attention. Analogously, we describe an enhanced contralateral negativity which reaches a maximum around 220 ms after stimuli onset. This negativity is strongest over central electrodes close to and over somatosensory areas and lasts for around 200 ms from the onset of the somatosensory N140 ERP component. Based on these characteristics we named this electrophysiological signature of attentional tactile target selection the N140-central-contralateral (N140cc). Furthermore, this component appears to reflect mainly attentional selection of target locations rather than suppression of distractors as it was not reliably altered by distractor location but by target location. Taken together, our findings present a novel electrophysiological marker and show that attentional selection of touch operates mainly by enhancement of task relevant locations within the somatosensory homunculus allowing to track the allocation of attention between limbs.

### G9

### MEAN SIZE OF STIMULI IN VISUAL SEARCH GUIDES SPATIAL ATTENTION

Suhyon Ahn[1], Eunhee Ji[1], Yu-Jin Choi[1], Kyung-Min Lee[1], Min-Shik Kim[1]; [1]Yonsei University — Does the mean total size of the stimuli within a visual search display affect the speed with which an individual finds the target's location? In this experiment, subjects were trained to search for a target (a black circle with a gap), among arrays of distractors (closed black circles), both varying sizes within a subset. Sets of eight circles, varying sizes with equal interval were used as stimuli. Within a set, four circles ordered in the middle (the 3rd to the 6th) were considered as a subset and the 1st, 2nd, 7th and 8th circles as another subset. Both subsets in a set were identical in mean size of stimuli, but differed in variance and individual sizes. The target location was linked to the mean total size of the stimuli while the distractors were located randomly across trial. After training, subjects were tested on four conditions, where the target either appeared in the original "old" location (as trained) or a "new" location, and where the sizes of the circles were either the "same" (as trained) or "different". We found that response times for the OLD condition where the target appeared on the same location faster than in the NEW condition where the target appeared in the new location, regardless of whether the sizes of the stimuli were same or different. This finding suggests that the mean total size of stimuli in a visual search display could be linked to a specific location and could guide spatial attention as a contextual cue.

### G10

### NEURAL SUBSTRATES OF VOLUNTARY SELECTION IN TOP-DOWN SELECTIVE ATTENTION

Yuelu Liu[1], Chun-Jui Chen[1], Jesse J. Bengson[1], Xiangfei Hong[1,2], Jane-Ling Wang[1], Mingzhou Ding[3], George R. Mangun[1]; [1]University of California, Davis, [2]Shanghai Jiao Tong University, [3]University of Florida — An important aspect of top-down attentional control is the voluntary selection of behaviorally-relevant information according to one's goals and expectations. While studies utilizing explicit cues to examine attentional control mechanisms have identified structures within the dorsal frontoparietal cortex in the maintenance of top-down attentional influence, the neural substrates underlying the voluntary selection process remain relatively unexplored. We addressed this issue by applying multi-voxel pattern analysis on blood-oxygen-level-dependent (BOLD) activity measured during a willed attention task, where visual symbolic cues either allowed participants to spontaneously select a spatial location to apply covert attention (choice cues) or explicitly instructed them to attend to the cued locations (instructional cues). Following choice cues, we found that besides regions in the dorsal frontoparietal attention network, BOLD activities in extensive areas within the midline frontal and parietal cortex, frontopolar

cortex, lateral frontal cortex, and temporal cortex predicted participants' intentions about which spatial location to attend. Among these regions, the decoding accuracy in dorsoanterior cingulate cortex, pre-supplementary motor area, precuneus, bilateral anterior insula, left middle frontal gyrus, and right frontopolar cortex was significantly higher during willed attention than during explicitly-cued attention. In addition, enhanced decoding accuracy was further observed in the dorsal frontoparietal attention network for willed attention, including bilateral frontal-eye field and regions in the anterior intraparietal sulcus. Our results suggest that the process of voluntary selection is functionally segregated from attentional control and involves extensive regions other than those within the frontoparietal attention network.

### G11

### INTER-AREAL ALPHA-BAND SYNCHRONY IS MODULATED BY SELECTIVE SPATIAL VISUAL ATTENTION

Muriel Lobier[1,2], J Matias Palva[1], Satu Palva[1]; [1]Neuroscience Center, University of Helsinki, Finland, [2]BioMag laboratory, HUS Medical Imaging Center, Helsinki University Central Hospital — Spatial selective visual attention is classically associated with alpha-band power suppression contralateral to the attended hemifield in sensory cortex. Little is known, however, of the putative cortex-wide, systems-level neuronal mechanisms associated with the allocation of visual selective attention. To investigate the role of large-scale neuronal synchronization in coordinating spatial attention, we recorded magnetoencephalography (MEG) while participants carried out a Posner-like spatially cued stimuli detection/discrimination task. Participants were cued to covertly attend to the left or right hemifield using a central cue. We used cortically-constrained minimum-norm estimates and individual surface source models to reconstruct the source time series of cortical parcels (400). Phase and amplitude time series were extracted for each parcel using Morlet wavelets for frequencies from 3 to 40 Hz. We characterized cortex-wide inter-areal phase interactions by computing the phase locking value (PLV) and weighed phase lag index (wPLI) for each source parcel pair. We then tested for modulations of oscillation amplitude and of phase synchrony patterns in overlapping 400 ms time-windows covering the first post-cue second using a Wilcoxon Signed-Rank test. All statistical analyses were (FDR) corrected for multiple comparisons. Spatial visual selective attention was associated with alpha-band suppression in contralateral compared to ipsilateral visual cortex. In addition, it was correlated with strengthened theta (5-7 Hz) and alpha (8-13 Hz) band cortex-wide synchrony, of which anatomical patterns were modulated by the cued hemifield. These data support the hypothesis of inter-areal alpha synchronization as a mechanism supporting the allocation of visual attention.

### G12

### TONIC AND RETINOTOPICALLY-ORGANIZED ALPHA-BAND MODULATIONS BY VISUOSPATIAL ATTENTION

María Melcón[1], Isabelle Duplan[1], Santiago Fernández-González[2], Almudena Capilla[1]; [1]Universidad Autonoma de Madrid, [2]Universidad Complutense de Madrid — Alpha-band (8-14 Hz) power is typically modulated by visuospatial attention. This modulation is lateralized with respect to the locus of attention, i.e. alpha power is reduced in parieto-occipital sites contralateral to the cued location. Given that alpha-band suppression is thought to be originated in extrastriate visual cortex, we aimed to investigate whether alpha-band attentional modulations are retinotopically mapped. To address this issue, we conducted an electroencephalography (EEG) experiment with 59 channels, while participants performed a visuospatial cued detection task. They were instructed to pay covert attention to one out of 60 sectors of the visual field, as indicated by a 100% valid cue (attention condition; in the control condition the cue was 0% valid). Both, the attention and the control condition were presented in a block design. Our results show a marginal effect of retinotopic alpha-band organization. This effect was masked by a more prominent tonic difference between conditions starting before cue presentation (-200 to 100 ms with respect to cue onset) over right parieto-occipital electrodes. This tonic suppression in alpha-band power might represent a general, right lateralized alert mechanism for the deployment of attention, rather than a retinotopically organized expectancy mechanism. The precedence of the tonic mechanism over the retinotopic one in this experiment is likely due to the use of blocks in the experimental design. More studies employing event-related designs would be necessary to elucidate to what extent attentional modulations of alpha-band oscillations are retinotopically organized. [Funded by the Spanish Ministry of Economy and Competitiviness, MINECO, PSI2012-34558]

### G13

### SEX DIFFERENCES IN PERFORMANCE AND STRATEGY SELECTION DURING EXECUTION OF A REAL WORLD NAVIGATION TASK

Mashal Fida[1], Erin.L Zelinski[1], Iasmim Montechiare[1], Robert.J Sutherland[1]; [1]Canadian Centre for Behavioural Neuroscience, University of Lethbridge — Sex differences in spatial abilities have been reported in many mammalian species, including humans. The Morris Water Task (MWT) is an often-used behavioural assay of spatial ability in rodents that has been adapted to use in humans, typically as virtual reality or tabletop versions. Such variations have lead some to theorize that males and females implement different strategies to solve spatial problems. On average, men tend to use cardinal directions or environmental geometry, whereas women tend to use landmarks to solve these tasks. However, it could be the case that peri-personal tasks recruit different neural regions than would be engaged during large-scale, real-world traversals. Thus, we developed a dry-land version of the MWT wherein subjects were required to traverse a circular, outdoor area (diameter: 20-meters). We hypothesized that men and women (aged 19-25) would implement different strategies to solve the task. Forty-three subjects (27 women) were asked to locate a single, hidden target location over several trials with varying start locations. Both sexes reached the same level of performance by the end of training, but results implied that men and women use, as a default, allocentric and egocentric strategies, respectively. A second group of women performed the task, but the starting location remained constant for the first and second trials. In the second condition, women proceeded directly to the platform location on the second trial. Together, these results indicate that although men and women can both solve spatial tasks, the default strategy is allocentric for men and egocentric for women.

## EMOTION & SOCIAL: Emotion-cognition interactions

### G14

### THE BRAIN ACTIVATION ON THE RIGHT HEMISPHERE IN DISCRIMINATING FACES ALONG THE MORPHED CONTINUUM OF HAPPY AND FEARFUL EXPRESSIONS

Shih-Tseng T. Huang[1], Ming-Chun Lee[2]; [1]Department of Psychology, National Chung-Cheng University, Taiwan, [2]Center for research in Cognitive Science, National Chung-Cheng University, Taiwan — The present study used ERP to investigate the advantage of between- categorical differences compared with within-categorical facial expressions. Twenty-nine participants (15 males and 14 females, mean range from 19 to 24) with normal or corrected normal vision participated. In the study, two morphed faces made of a happy and fearful face were presented in sequence in one of the same, or between-category conditions. There were 288 trials including 144 same pairs, 72 within pairs, and 72 between pairs. The results found the P120 and N170 of second faces were higher than those of the first faces on PO8. Higher p120 was found on PO8 than on PO7 and, similarly, higher on O2 than O1 suggesting greater activation on the right hemisphere. Both mean amplitudes (MAs) of P300-500 at the Cz and Pz found higher in the Between condition than those in the Same and Within conditions. The MAs of p300-500 was found higher at P4 than at P3 as well as higher at O2 than at O1 in the Between condition than those in the Same and Within conditions. Results suggested that activations at right hemisphere were higher than the left in processing faces and activation in occipital and parietal lobes appears to be related to emotional perceptual categorization.

### G15

### LARGE-SCALE NETWORK INTERACTIONS IN REGULATING THE IMPACT OF INTERNAL EMOTIONAL DISTRACTION ON WORKING MEMORY

Alexandru D. Iordan[1], Sanda Dolcos[1], Florin Dolcos[1]; [1]University of Illinois at Urbana-Champaign — Emotional distracters may originate not only in the external world but also in the internal environment, and clinical evi-

dence suggests that distressing memories or thoughts that occur during rumination may act as powerful internal distracters. However, the neural mechanisms by which internal emotional distraction affects cognitive processing and the consequences of its on-line regulation on concurrent cognitive performance are not known. These issues were investigated using a working memory (WM) task with cues for negative autobiographical memories used as internal distraction. Regulation was manipulated by instructing participants to focus on or away from the emotional aspects of their memories. Behavioral results from 29 subjects showed that focusing away from emotion was associated with increased WM performance, compared with focusing on emotion. Consistent with the behavioral results, fMRI analyses (17 subjects) showed reduced activity in brain regions associated with the salience network (amygdala, anterior insula, ventrolateral prefrontal cortex, and anterior cingulate cortex) when subjects were focusing away from emotion, in the context of a similar impact of internal distraction on executive parietal regions, irrespective of focus. Finally, functional connectivity analyses showed increased coupling between brain regions part of the default-mode and salience networks when subjects were focusing on emotion, indicating a potential neural mechanism by which internal emotional distraction impairs on-line cognitive processing. These findings demonstrate that focusing away from the emotional aspects of internal distracters is an effective regulation strategy and that the impact of internal emotional distraction is linked to changes in the interactions between large-scale functional brain networks.

## G16

### MODULATION OF AFFECTIVE INTERFERENCE DURING WORKING MEMORY

Madison L. Stroup[1], Jenny Liu[2], Tracy S. Nolan[2], Seong K. Mun[3], David A.S. Kaufman[1], Linda J. Larson-Prior[2]; [1]Saint Louis University, St. Louis, MO, [2]Washington University School of Medicine, St. Louis, MO, [3]Arlington Innovation Center, Virginia Polytechnic Institute and State University, Arlington, VA — Goal-directed behavior requires two competing forms of mental control: the ability to maintain goals over time despite distraction and the ability to flexibly switch between goals with updates from working memory. Affective interference has been shown to disrupt the maintenance and flexibility of higher-order cognitive processes, with the greatest effects typically observed for negatively valenced distracters. However, little is known about factors that may modulate the impact of affective interference on executive functions. The current study investigated whether psychological state modulated the effects of affective interference on the maintenance of task-relevant representations in working memory. Twenty-three participants completed low and high load conditions of a working memory task in which faces with neutral emotional expressions were presented with intermittent neutral and negative interfering pictures. Behaviorally, results indicated that negatively valenced distracters were associated with significantly slower reaction times and lower accuracy. Participants also completed questionnaires assessing aspects of psychological state (e.g. mood, anxiety, and sleep), and results indicated that better functioning was associated with a greater effect of negative distracters on task performance. In order to explore the neural correlates of these effects, fMRI was acquired on an additional five participants. Results of preliminary fixed-effects analyses suggest greater recruitment of visual attention networks following negative interference relative to neutral or no interference. Taken together, these findings are consistent with previous research suggesting that positive mood biases cognitive processes towards more flexible, but also more distractible, behavior.

## G17

### SUSTAINED AND TRANSIENT REWARD EFFECTS ON COGNITIVE CONTROL IN SCHIZOPHRENIA: THE RELEVANCE OF NEGATIVE SYMPTOMS

Yu Sun Chung[1], Deanna Barch[2]; [1]Department of Psychology, Northwestern University, [2]Department of Psychology, Psychiatry, and Radiology, Washington University in St.Louis — Schizophrenia (SCZ) has been characterized by a core deficit of non-emotional context processing (i.e., the ability to maintain context information necessary to regulate upcoming behavioral response towards goal-directed behavior), thought to be supported by the dorsolateral prefrontal cortex (DLPFC) (e.g., (Cohen, Barch, Carter, & Servan-Schreiber, 1999). Recent evidence from both animal and healthy human neuroimaging work suggests that the DLPFC plays a crucial role in representing and integrating reward-related context information. However, it has been unknown whether individuals with SCZ can represent and integrate reward-related contextual information to modulate cognitive control. Thirty-six individuals with SCZ and twenty-seven healthy controls performed a response conflict task developed by Padmala et al. (2011) during scanning. The job of participants was to categorize images as either houses or buildings with either congruent or incongruent overlaid words. First, participants performed no-reward baseline conditions, followed by reward conditions with monetary incentives on some cued trials (reward cues) for fast and correct responses. Using a state-item fMRI design, we examined both sustained context-dependent and transient cue-related effects of rewards on cognitive control. Contrary to our prediction, individuals with SCZ showed an intact pattern of increased sustained activity during reward contexts in the bilateral DLPFC at a group level. However, individual difference analyses revealed that more increased transient cue-related DLPFC activity during rewarded versus no-rewarded trials was associated with lower amotivation scores. These results suggest that patients' motivational impairments are related to DLPFC function in motivationally salient situations.

## G18

### FUNCTIONAL CONNECTIVITY OF BRAIN LESIONS HELPS EXPLAIN INDIVIDUAL DIFFERENCES IN COMPLEX DECISION-MAKING

Matthew J Sutterer[1], Tara Slade[1], Joel Bruss[1], Michelle W Voss[1], Antoine Bechara[2], Daniel Tranel[1]; [1]University of Iowa, [2]University of Southern California — Studies of patients with brain damage have highlighted the necessity of limbic and prefrontal areas for adaptive decision-making. However, patients with damage outside these regions sometimes demonstrate impaired decision-making, and it remains unclear how this might be explained. These cases have widely varying patterns of damage, preventing parsimonious lesion-deficit explanations. Here we examined patients with focal damage ventromedial prefrontal cortex (vmPFC), amygdala, or areas outside these regions. We used each patient's lesion mask as a separate region-of-interest seed for resting-state functional connectivity in 198 healthy subjects to characterize typical patterns of functional connectivity with each lesion location. We examined the overlap of these "lesion-derived networks" in groups of patients classified as "impaired" or "unimpaired" on the Iowa Gambling Task (IGT). Lesion-derived networks from the IGT-impaired patients with vmPFC and amygdala damage showed connectivity with default mode areas (inferior parietal lobule, posterior cingulate, and anterior insula). In contrast, connectivity networks derived from the impaired patients with damage outside vmPFC and amygdala showed functional connections with attention areas (intraparietal sulcus, precentral gyrus, middle temporal areas, and insula). Lesion-derived networks from IGT unimpaired amygdala and vmPFC patients showed connectivity with the posterior insula, hippocampus, and temporal pole while connectivity derived from lesions outside these areas showed connections with default mode areas. We also observed distinct cognitive profiles for patients with lesion-derived connectivity including attention networks compared to affective and executive areas. Healthy connectivity profiles of brain lesions have potential to shed new light on patients with otherwise idiosyncratic patterns of damage and deficits.

## G19

### RETRIEVAL OF NEUTRAL SCENES PRESENTED WITH NEGATIVE RELATIVE TO NEUTRAL CONTENT DURING ENCODING ELICITS GREATER VISUAL ACTIVITY AFTER SLEEP

Kelly Bennion[1], Jessica Payne[2], Elizabeth Kensinger[1]; [1]Boston College, [2]The University of Notre Dame — While research has investigated how sleep affects emotional memory and how emotion enhances visual processing, these questions are typically asked using an emotional cue (i.e., a negative object within a scene). To our knowledge, no prior study has investigated how the effects of sleep on retrieval of a neutral stimulus differ depending on if the neutral stimulus was presented with emotional versus non-emotional content during encoding. In the present study, participants encoded scenes composed of a negative or neutral object on a neutral background either in the morning (preceding 12 hours awake; Wake group) or evening (preceding 12 hours including a night of sleep; Sleep group). At retrieval, during fMRI, participants viewed the objects and backgrounds separately, distinguishing new objects and backgrounds from studied ones. Many occipital regions (lingual gyrus, middle occipital gyrus, inferior occipital gyrus) were more

active within the Sleep group than Wake group during the successful retrieval of neutral backgrounds that had been paired with negative (but not neutral) objects during encoding. Further, REM sleep correlated with activity in the lingual gyrus, middle occipital gyrus, and cuneus during the successful retrieval of neutral backgrounds previously paired with negative objects. This builds upon prior work showing that emotion enhances perceptual processing by demonstrating that emotion effects persist even once the emotional element of the scene has been removed. The results further suggest that the ability for emotion to enhance perceptual processing may be maximized by REM sleep, leading to enhanced visual activity during successful retrieval.

## G20

### AFFECTIVE FLANKER TASK REVEALS DIFFERENCES IN THE ERROR-RELATED NEGATIVITY BETWEEN ADOLESCENTS AND ADULTS

Rebecca Reed[1], Jill Grose-Fifer[1,2]; [1]The Graduate Center, CUNY, [2]John Jay College of Criminal Justice, CUNY — Neurobiological evidence suggests that adolescents may be less able to self-regulate in situations where decisions are made in an emotionally aroused state. It has been theorized that subcortical areas that mediate emotional responses develop more rapidly than prefrontal cortical control areas. In this study, we used event-related potentials (ERPs) to examine response monitoring and error detection in adolescents. We hypothesized that immaturities in the anterior cingulate cortex (ACC) would result in adolescents being less able than adults to ignore distractors. We compared amplitude differences in the error-related negativity (ERN), which is thought to be generated in the ACC, in adults (25-35 years) and adolescents (15-17 years) in an emotional face flanker and a traditional letter flanker task. The results showed age-related differences in the ERN in the face task; errors elicited larger ERNs in adults than in adolescents. When errors were made, congruent stimuli elicited larger ERNs than incongruent stimuli. There was a stimulus by congruency interaction such that fearful distractors elicited a smaller ERN than happy distractors. There were no significant age-related differences in ERN amplitude for letter stimuli, These data demonstrate that adolescents are less able to self-regulate in cognitively "hot" situations and offer further support for current neurobiological models of adolescent brain development.

## G21

### ENHANCED NEURAL PROCESSING OF EMOTIONAL STIMULI IN LATE ADOLESCENCE VS ADULTHOOD

Lesa Ellis[1], Benjamin Cohen[1], Chrono Nu[1], Hannah Zweifel[1], Rachel Westmoreland[1], Russell Costa[1]; [1]Westminster College, Salt Lake City, Utah — Emotional Stroop tasks are frequently used to examine interference effects resulting from presentation of negative vs. neutral stimuli, measured via longer reaction times. This interference is thought to reflect an inability to disengage attention from negative stimuli, associated with higher levels of anxiety. However, additional studies have reported that many individuals display shorter reaction times to emotional stimuli vs. neutral, suggesting a facilitation rather than interference effect. Event Related Potential (ERP) studies of Emotional Stroop tasks have reported enhanced Early Posterior Negativity (EPN) effects for emotional vs. neutral stimuli, suggesting automaticity of processing of emotional stimuli. Adolescents have comparative overactivation of reward and threat detection pathways and display heightened emotional sensitivity and reactivity when compared to adults. Therefore, we suspected that previous work in our lab confirming facilitation and enhanced EPN effects to emotional stimuli in a late adolescent sample may only be a representation of a transient behavior unique to the adolescent phase. The present study investigated comparisons between late adolescent (n=41) and adult samples (n=28) in ERP and facilitation effects via the use of an Emotional and Counting Stroop Task. Both groups showed significantly greater EPN negative deflections to emotional stimuli (both negative and positive) compared to neutral stimuli. No group differences were found. However, the late adolescent group showed significantly faster reaction times for emotional (both negative and positive) words vs neutral words. This difference was not observed in the adult group, suggesting developmental changes in processing of emotional stimuli that are not reflected in EPN activity.

## G22

### FUNCTIONAL DEFICIT IN PREFRONTAL CORTEX ASSOCIATED WITH EMOTION REGULATION IMPAIRMENT IN PREMENSTRUAL DYSPHORIC DISORDER

Nicole Petersen[1], Andrea Rapkin[1], Dara Ghahremani[1], Letty Liang[1], Linda Goldman[1], Edythe London[1]; [1]UCLA — Premenstrual Dysphoric Disorder (PMDD) afflicts 2 to 5% of women during their reproductive years, and is characterized by decreases in quality of life similar to those observed in major depressive disorder. PMDD has been relatively understudied, and the neurobiology that underlies its symptoms remains obscure. We hypothesized that differences in the neural circuitry that supports emotion regulation may contribute to the negative mood symptoms experienced by women with PMDD. We used a well-validated emotion regulation task while collecting functional imaging data to investigate differences in emotion regulation in women with PMDD compared to healthy controls, both in terms of behavior and brain activity. Consistent with our hypothesis, preliminary data analysis has shown that women with PMDD are less successful at emotion regulation using cognitive reappraisal of negative emotions. Further, as reported previously, reappraisal success in healthy controls was predicted by activity in the right prefrontal cortex. By contrast, activity in the same region failed to predict reappraisal success in women with PMDD, suggesting that dysfunction in this region of the brain may be causally related to the mood dysregulation experienced by women with PMDD. Findings from this study may aid in explaining the etiology of PMDD and perhaps provide biomarkers for assessing behavioral and pharmacological interventions to ameliorate this disorder.

## G23

### AN ERP STUDY OF THE GENDER DIFFERENCES IN FRONTAL BRAIN ACTIVATIONS IN PROCESSING FACE AND VOICE

Ming-Chun Lee[1], Shih-tseng Tina Huang[2]; [1]Department of Psychology, National Chung-Cheng University, Taiwan, [2]Center for research in Cognitive Science, National Chung-Cheng University, Taiwan — The present study used ERP to investigate the brain activations in processing acoustic emotional prosody and facial expression. Twenty young adults participated. Congruous and incongruous faces and voices of angry and sad emotion were presented. In a congruous angry (or sad) pair, an angry (or sad) face was presented with an angry (or sad) tone. The incongruous angry pairs contained an angry face presented with a sad tone, or a sad face with an angry tone. Similarly, the incongruous sad pairs contained sad face with neutral tone or neutral face with sad tone. In the event-related potential procedure, congruous emotional pairs were presented in 85% and the incongruous pairs were in 15% of the trials. The results found the latency of P120 and N170 were greater at Pz than at Fz and Cz. Results also found higher mean amplitudes (MAs) of P300-500 on sad than on angry pairs. Similarly, the MAs at F3 and F4 found greater on sad than on angry pairs. It was also found a significant interaction of emotion and sex on P3 at F3 and F4, suggesting male participants performed higher activation on the sad pairs than on the angry pairs. However, there was no significant difference in MAs of 300-500 or of p500-800 at F7 and F8. The results suggested a greater activation at the parietal lobe at the initial phase and male tended to perform higher activation in the integration of sad pairs of face and tone than angry pairs.

## G24

### ENTERTAINMENT NEWS REDUCES SUBJECTIVE AND NEURAL SENSITIVITY TO SOCIO-MORAL ISSUES: AN FMRI STUDY

Shin Ah Kim[1], Yoo Min Lee[1], Dong Wook Yook[1], Sang Hee Kim*[1]; [1]Korea University — As more entertaining forms of news media have been on the rise, attention has been paid to the potential adverse influence of entertaining news on the viewers' attitude formation. We investigated whether individuals' subjective and neural sensitivity to socio-moral issues differ depending on news delivery context. Twenty-two college students participated in this fMRI study. Inside the scanner, participants viewed video clips of a news reporter's coverage of current social events with moral violation, which was preceded by introductory comments either by the traditional news anchors (traditional condition) or by the entertainment news anchors (entertainment condition). News reports of emotional issues were also included to serve as the control condition. At the end of viewing each video clip of news report, participants rated emotional arousal and moral permissibility in relation to each issue. Outside the scanner, participants also rated neg-

ative social impact that each issue may have. Brain images were analyzed using SPM8. Participants reported greater negative social impact for the issues introduced by traditional anchors as compared with those by entertainment news anchors. Regions of Interest (ROI) analyses indicated that activities in the right TPJ and right STS in responses to socio-moral issues were reduced in the entertainment condition relative to traditional news condition. Furthermore, the degree of activity reduction in the dorsal ACC in the entertainment news condition was associated with reduced ratings of negative social impact. These results provide evidence that entertainment news may alter viewers' attitude toward socio-moral issues by weakening moral reasoning scrutiny.

### G25

### EMOTIONAL CONGRUENCY OF MUSIC AFFECTS NEURAL PROCESSING OF SUSPENSEFUL FILM EXCERPTS

Matthew Bezdek[1], William Wenzel[2], Nicole Martin[1], Eric Schumacher[1]; [1]Georgia Institute of Technology, [2]Stony Brook University — According to the theory of narrative transportation, engaging films can, at times, suppress attention to the physical environment beyond the film. In previous fMRI work, we have shown that moments of rising narrative suspense are marked by a decrease in BOLD response in regions that process the peripheral visual field. Here, we extend that work by examining how aspects of film modulate this process. We manipulated the soundtracks of suspenseful film excerpts to contain either congruent, incongruent, or no music. Participants viewed excerpts of each music type while fMRI volumes were recorded. Following the scanning session, participants completed a surprise recall test for film content. Planned contrasts of BOLD response to increases in suspense revealed that congruent music produced increased activity in visual processing areas when compared to incongruent or no music conditions. Participants also showed more accurate recall for events that occurred during periods of increased suspense than periods of decreasing suspense. Film events that were subsequently recalled, compared to events that were not correctly recalled, produced increased activity in regions including the parahippocampal gyrus. These findings reveal how filmic elements can influence the neural response to suspenseful film excerpts and deepen our understanding of how emotional congruency can affect visual attention and memory using naturalistic stimuli.

## EMOTION & SOCIAL: Emotional responding

### G26

### DISTINGUISHING AROUSAL-BIASED COMPETITION OF VISUAL PERCEPTION IN YOUNG AND OLDER ADULTS

Tae-Ho Lee[1], Steven G. Greening[1], Allison Ponzio[1], Mara Mather[1]; [1]University of Southern California — The arousal-biased competition (ABC) model predicts that arousal biases processing in favor of high priority stimuli and against low priority stimuli (Mather & Sutherland, 2011). Support for the model comes from studies of young adults (e.g., Lee et al, 2014). However, due to declines in attentional selectivity (Schmitz et al., 2010), older adults may show weaker and less specific perceptual selection under arousal than younger adults. To test this, in the main detection task of this fMRI study, we presented place-object image pairs as simultaneous target and distracter stimuli after either a fear-conditioned arousing tone or a neutral tone. The target was more visually salient than the distractor. Participants identified the location of the target. The arousal-by-saliency interaction differed depending on the age group. In young adults, when the place image was salient, parahippocampal place area (PPA) activity was enhanced by a preceding arousing tone. In contrast, when the place was the distracter, arousal reduced PPA activity. Conversely, older adults exhibited a generalized arousal-induced visual enhancement in PPA, regardless of whether the place image was the target or distracter. The current results indicate that arousal increases processing selectivity for younger, but not older adults,. In the older adults, arousal enhanced sensory processing regardless of stimulus priority. These data suggest that arousal-biased competition relies on mechanisms of attention selection which deteriorate with age.

### G27

### NEURAL IMPACT OF TASK-IRRELEVANT DISORDER-RELATED STIMULI IN PATIENTS WITH PANIC DISORDER

Katharina Feldker[1], Carina Yvonne Heitmann[1], Paula Neumeister[1], Thomas Straube[1]; [1]Institute of Medical Psychology and Systems Neuroscience, University of Muenster — Unexpected, recurrent panic attacks and anxious apprehension are two distinct emotional phenomena that constitute the core symptoms for diagnosing panic disorder (PD). PD patients show increased interoceptive sensitivity in response to a wide range of threat stimuli. While previous investigations in PD patients have focused on generally threat-related stimuli, we developed a standardized set of complex disorder-related scenes, e.g. a person fainting in public, which induced anxiety in PD. It is as yet unknown to what extent complex disorder-related visual stimuli which are not relevant to task-solving are processed on the neural level in PD. The present study investigated neural responses to emotional task-irrelevant stimuli which were simultaneously presented with geometric visual objects which participants were asked to compare. PD patients in contrast to healthy controls (HC) showed hyperactivation in limbic areas in response to panic-related versus neutral pictures. The effect was most pronounced in the insula. Since insula activation has previously been linked to the representation of bodily states, insular hyperactivation is consistent with increased interoceptive sensitivity to threat in PD patients, and likely plays a pivotal role in the etiology and maintenance of the disorder. The present results provide evidence that the newly developed set of panic-related scene pictures is suited to elicit hyperactivation in limbic areas in PD patients even when the stimuli do not have to be attended to. This may suggest brain mechanisms related to automatic distraction by disorder-related visual stimuli in PD.

### G28

### BEHAVIORAL AND NEURAL CORRELATES OF PROCESSING COMPLEX DISORDER-RELATED VISUAL SCENES IN SOCIAL ANXIETY DISORDER

Carina Yvonne Heitmann[1], Katharina Feldker[1], Paula Neumeister[1], Thomas Straube[1]; [1]Institute of Medical Psychology and Systems Neuroscience, University of Muenster — Several studies have investigated the neural underpinnings of social anxiety and social anxiety disorder (SAD) using fearful and harsh faces as emotional stimuli. Unfortunately, there is a lack of studies on the processing of more ecologically valid disorder-related visual stimuli such as scenes of persons being the center of attention, e.g. giving a speech. Therefore, we have created a standardized set of fifty complex visual scenes depicting situations which elicit social anxiety in SAD patients, and fifty control pictures. SAD patients compared to healthy controls (HC) rated the pictures as more unpleasant and arousing, and reported greater anxiety. Furthermore, neural correlates of processing these disorder-related scenes were investigated using an emotion-unrelated detection task and functional magnetic resonance imaging (FMRI). FMRI results showed limbic hyperactivation, especially in the bilateral insula, in SAD patients versus HC to disorder-related compared to neutral scenes, which is in line with previous studies reporting insular hyperactivation in SAD. The insula is associated with interoceptive awareness, a core characteristic of SAD in response to social threat. Thus, using a new set of visual social threat scenes which induced social anxiety in SAD, we reveal crucial involvement of the insula in the processing of this class of stimuli in SAD.

### G29

### IDENTIFICATION OF AFFECTIVE STATES FROM AUDIOVISUAL STIMULI BASED ON FMRI DATA

Jongwan Kim[1], Douglas Wedell[1], Svetlana Shinkareva[1]; [1]University of South Carolina — There is converging evidence that people rapidly and automatically encode affective dimensions of objects, events, and environments that they encounter in the normal course of their daily routines. Recent research demonstrated that affective states elicited by viewing pictures that varied in valence and arousal could be identified from the whole brain activation patterns observed with fMRI (Baucom et al., 2012). The current work investigated whether affective states can be identified for dynamic naturalistic stimuli presented in an incidental affective processing paradigm. Eleven participants were presented with audiovisual stimuli reflecting high or low levels of arousal and positive or negative valence in an fMRI experiment. Multivoxel pattern analysis was used to predict valence and arousal within and across participants based on distributed patterns of activity in functionally defined regions of inter-

est. Perceptual features of the stimuli were regressed out prior to analyses. Results demonstrated above chance (p<.05) identification of valence and arousal of the stimuli within participants, with accuracies comparable to Baucom et al. study. Valence of audiovisual stimuli was identified in 10 out of 11 participants and arousal was identified in 8. Identification of valence and arousal across participants was also above chance (p<.05). Valence was identified in 9 participants and arousal was identified in 8. The within-participant decoding results demonstrate that information unique to valence and arousal lies within distributed patterns of brain activation across the whole brain and the cross-participant results provide support for a common neural basis for representation of affect across people.

## G30

### FEAR CONDITIONING IN A FLIP-BOOK – THE DUAL CEREBRAL REPRESENTATION OF CUED AND CONTEXTUAL FEAR

Hannah Genheimer[1], Marta Andreatta[1], Katharina Nueckel[1], Evelyn Glotzbach-Schoon[1,2], Andreas Muehlberger[3], Paul Pauli[1]; [1]University of Wuerzburg, [2]Seoul National University College of Medicine, [3]University of Regensburg — Contexts are a multimodal set of circumstances around an event (Maren et al., 2013). According to animal studies, a context entails dual cerebral representation, which involves increased amygdala activity for the processing of distinct elements and hippocampus activity elicited by the processing of a conjunctive context. Goal of the current study was to disentangle the neural processes underlying the elemental and hierarchical representations of a threatening context in humans. Twenty-seven subjects participated in habituation, acquisition and test phases. Forty-nine controlled screenshots depicting two virtual offices were presented in quick succession in order to create the impression of walking through the rooms. During acquisition, one office became the anxiety context (CXT+) since a painful electric shock, serving as unconditioned stimulus (US), was paired with the offset of 1-3 screenshots. Participants never perceived the US when the other room was presented, serving as safety context (CXT-). After the acquisition, CXT+ evoked increased arousal and anxiety and less valence compared to CXT-. Screenshots presenting either the safety context or the anxiety context when no US was applied showed decreased early posterior negativity (EPN) amplitudes compared to screenshots depicting the anxiety context at the time when an US was presented, which indicates cue conditioning. The paradigm allows the determination of not only sustained fear of the context, but also cued fear of distinct screenshots serving as cue for the US. Our explicit data and physiological recordings of neural correlates emphasize that two separated neural systems are involved in contextual fear learning in humans.

## G31

### EVENTED RELATED POTENTIALS USING AN AIR JET TACTILE STIMULATION

Mohamed Yassine Tsalamlal[1], Will Rizer[2], Jean-Claude Martin[1], Mehdi Ammi[1], Mounia Ziat[2]; [1]Paris-South University, The Computer Science Laboratory for Mechanics and Engineering Sciences (LIMSI-CNRS), [2]Northern Michigan University, Psychology Department — In this study, we examined events related potentials during tactile air jet stimulation. The main goal was to investigate a suitable tactile stimulation intended for affective communication systems such as being touched by a robotic device that has the same features than a human touch. Participants were asked to rate a five point Likert scale the valence (attractiveness or aversiveness) of the stimuli presented on their forearm. The stimulus consisted of an air flow that varied in intensity (3 levels) and moving velocity (4 levels) along the left forearm. Generally, low intensity stimuli were rated more positively than high intensity stimuli. The EEG data were sampled to 256 Hz and high-pass filtered at 1 Hz and epoched into segments stating at -500ms prior stimulus onset and continued 2000ms post-stimulus onset. Independent component analysis was used for blind-source decomposition of the data into 64 components. Preliminary results showed significant differences between the conditions in the contralateral central-parietal electrodes sites (CP4). ERPs of low intensity stimuli show higher amplitudes compared to high intensity stimuli. Taking subjective ratings and EEG data together, results suggest that light air jet stimulation is perceived as pleasant and may be assimilated to a real human touch.

## G32

### NEUROPHYSIOLOGICAL SIGNATURE OF VIOLENCE DESENSITIZATION AND N2 ACTIVATION: AN EVENT-RELATED POTENTIAL STUDY

Shannin Moody B.S.[1], Jena Michel[2], Connie Lamm Ph.D.[3]; [1]University of New Orleans — One factor associated with increases in violent behavior is emotional desensitization. Emotional desensitization to violence is the normalization of violent or aggressive stimuli leading to deviant action patterns. Using dense-array electroencephalography (EEG) and ERPs (event-related potentials; averaged EEG) this study examines the neurophysiological signature underlying violence desensitization by looking at N2 activation, a medial frontal ERP associated with response monitoring. N2 activation was measured in late adolescent and young adults between the ages of 18-25 years. The N2 was measured as the minimum (most negative) activation between 200 – 350 ms. We used a modified version of the AX-CPT task to assess how much neurocognitive activation is used in order to switch action strategies in the context of affectively charged pictures. Additionally, we measured levels of aggression using the Buss Perry Scale (BPS). The BPS is a widely used self-reporting measure of aggressive behavior. Results revealed that in the context of affectively charged pictures more hostile participants showed smaller N2 amplitudes (less negative) than less hostile participants, r2change = .06, F-change (1, 35) = 4.28, p = .05, $\beta$ = .33. These results suggest less emotional interference for aggressive participants while switching action strategies. While these results cannot directly point at a specific causal factor contributing to aggression, it does suggest that participants who score high in levels of aggression show less emotional interference while executing an action. Thus, this emotional desensitization might contribute to ongoing violent actions.

## G33

### CORTICAL THINNING IN BIPOLAR DISORDER SUBTYPES

Derrek Hibar[1], Christopher Ching[1,2], Benson Mwangi[3], Jair Soares[3], Paul Thompson[1]; [1]Imaging Genetics Center, USC, Marina del Rey, CA, USA, [2]Interdepartmental Neuroscience Graduate Program, UCLA School of Medicine, Los Angeles, CA, US, [3]Department of Psychiatry and Behavioral Sciences, University of Texas Medical School, Houston, TX, USA — Reductions in anterior temporal, prefrontal, and parietal cortical thickness have been reported in bipolar disorder but few studies have compared thickness measures across the bipolar spectrum by clinical subtype (BD type I, II and not otherwise specified). Working with a large data set of 294 patients diagnosed with BD (185 BDI, 67 BDII, and 42 BD NOS) and 179 matched healthy controls, we hypothesized that bipolar subtype would be associated with lower cortical thickness in regions supporting emotional and reward processing and control. Cortical thickness measures were derived from brain MRI using FreeSurfer. Statistical analyses were carried out over 35 bilateral cortical regions using multiple linear regression, and correcting for age, sex, age*age, and age*age*sex. We set a significance threshold of P = 0.05/(35 ROIs * 6 diagnostic contrasts) = 2.38x10-4. We did not detect significant differences in cortical thickness between any BD subtype and controls. However, we found BD patients diagnosed as "not otherwise specified" had significantly greater cortical thinning in entorhinal, inferior temporal, middle temporal, rostral anterior cingulate, superior temporal, and temporal pole cortical ROIs compared to patients diagnosed with BD type 1. Our study reveals a pattern of reduced cortical thickness mainly in temporal cortical regions previously hypothesized to be involved in BD and implicated in emotional and reward processing. These findings provide insight into the neurobiological patterns across the spectrum of bipolar disorder.

## G34

### NEURAL NETWORKS FOR ANXIETY? DECREASED INTEGRATION IN ASD OF SENSORIMOTOR AND EMOTIONAL PATHWAYS THAT SUPPORT CLASSICAL FEAR CONDITIONING

Christopher Doxey[1], Mikle South[1], Nick Top[1], Kevin Stephenson[1], Brock Kirwan[1]; [1]Brigham Young University — Multimodal neuroimaging methods have the potential to elucidate specific networks underlying behavioral symptoms related to autism spectrum disorders (ASD). We performed a classical fear conditioning fMRI experiment that revealed abnormal right amygdala and left anterior insula activation in ASD during early fear acquisition. We collected DTI data from the same individuals and hypothesized that atypical activation during acquisi-

tion and extinction of learned fear may be due to differences in white matter connectivity in neural networks related to integrating fear recognition and response. Participants included seventeen adults ages 18-29 diagnosed with ASD and age- and IQ- matched controls. ROIs in right amygdala and left insula, de¬fined from our fear conditioning fMRI data, were used as seeds for a tractography analysis. Analyses of right amygdala tractography revealed significantly lower connectivity within the uncinate fasciculus, inferior fronto-occipital fasciculus, and inferior temporal gyrus white matter tracts for ASD. The left anterior insula seed had greater connectivity with the inferior frontal gyrus in ASD, but overall decreased connectivity in the thalamocortical tract, superior longitudinal fasciculus, corticospinal tract, and superior frontal gyrus white matter compared to controls. These DTI results highlight underconnected networks from amygdala to frontal lobe monitoring and decision making areas, and insula cortex to integration of sensorimotor information. These data support our hypothesis that chronic everyday anxiety in individuals with ASD may arise from uncertainty regarding environmental cues related to fear and safety. Improved understanding of the neural mechanisms that underlie unique manifestations of anxiety in ASD may result in better treatment specificity.

# EXECUTIVE PROCESSES: Monitoring & inhibitory control

## G35

### SEQUENTIAL GAINS AND LOSSES DURING GAMBLING FEEDBACK: DIFFERENTIAL EFFECTS IN TIME-FREQUENCY THETA AND DELTA MEASURES

Matthew Bachman[1], Amanda Lin[1], Andrew Gradone[1], Srikant Kothur[2], Samuel Eckrich[3], Edward Bernat[1]; [1]University of Maryland College Park, [2]Florida State University, [3]University of Central Florida — Recent work has documented significant effects of sequential gain and loss outcomes on the feedback negativity (FN) and P300 event-related potential (ERP) components from gambling tasks (Osinsky et al., 2012). Recent work from our group has indicated that the FN and P300 can be better understood as a mixture of theta (3-7 Hz) and delta (0-3 Hz) activity using time-frequency (TF) approaches. In this study participants (n=27) completed a modified version of the gambling task where outcomes for the task were forced into sequences of one to eight gains or losses in a row. Using TF analysis, we extracted delta and theta principal components to assess modulation relative to sequential outcomes. Results first replicated previous findings that delta showed increases to gains and theta to losses. Next, a linear decrease was observed across sequences for theta and delta (ps <= .017, Fs >= 6.649). For delta, this was qualified by a significant decrease in amplitude for losses (p = .001, F = 13.863) but no decrease for gains. This resulted in a growing gain-loss difference across the sequences for delta. For theta, both gains and losses decreased in amplitude across presentations, but gain-loss differences were significant only in the first two presentations (ps <= .012), becoming non-significant after that. Findings suggest that delta was more sensitive to sequence effects than theta, supporting the view that theta is a more simple response to salient stimulus parameters and delta sensitive to a variety of more complex elaborative processing.

## G36

### DECIPHERING INTERFERENCE CONTROL IN ADULTS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER

Laurence Casini[1], Isabel Suarez[1], Boris Burle[1], David Pineda[2], Carlos Tobon[2], Francisco Lopera[2], Thierry Hasbroucq[1]; [1]Aix-Marseille Université - CNRS, France, [2]University of Antioquia, Colombia — A deficit in "interference control" is commonly found in adults with Attention Deficit Hyperactivity Disorder (ADHD). This has mainly been interpreted as difficulties in inhibiting inappropriate responses. However, interference control involves processes other than simply the ability to inhibit. Consequently, we used sophisticated analysis to decipher the additional processes interference control in these patients. We compared interference control between 16 adults with ADHD and 15 control adults performing a Simon task. In most studies, performance is generally reported in terms of mean error rates and reaction times. However, here we used distribution analyses of behavioral data, complemented by analyses of electromyographic (EMG) activity. This allowed us to better quantify the control of interference, specifically the part that remains hidden when pure correct trials are not distinguished from partial errors. Partial errors correspond to subthreshold EMG bursts induced by incorrect responses that immediately precede a correct response. The main findings were that adults with ADHD were slower and showed a larger interference effect in comparison to controls. However, the data as a whole revealed that the larger interference effect was due neither to higher impulse expression, nor to a deficit in inhibition. But, interestingly, adults with ADHD exhibited a deficit in conflict adaptation, specifically after non-conflict trials. We propose and discuss the hypothesis that the interference control deficit found in adults with ADHD would be due to difficulties for controlling conflict after response facilitation induced by non-conflict trials.

## G37

### ATTENTIONAL INPUT GATING AS A MECHANISM OF PRO-ACTIVE RESPONSE SLOWING

Zachary Langford[1], Ruth M. Krebs[1], Durk Talsma[1], Marty G Woldorff[2], C.N. Boehler[1]; [1]Universiteit Gent, [2]Duke University — Efficiently avoiding inappropriate actions in a changing environment is central to cognitive control. One mechanism contributing to this ability is the deliberate slowing down of responses in contexts where the full cancellation of such a response might be sometimes required. In the present study electroencephalographic (EEG) recordings were performed to investigate the neural mechanisms of response time slowing in the context of potential inhibition. Subjects performed a Stop-signal task in two blocks; a standard (relevant) stop-signal block, and an irrelevant block, prompting the subjects to ignore the stop-signal. In such a setup pro-active response slowing usually occurs during the stop-signal relevant blocks, which we studied here by contrasting the go-trials of both blocks. Single-trial analysis (general linear model) was used to directly model the relationship between response time and the EEG data of the go-trials in both contexts within a multilevel framework. We found a relationship with response time already at the level of the sensory N1 component in relevant blocks, a characteristic fully absent in irrelevant blocks. Specifically, N1 amplitudes were lower the slower the response time was suggesting that attentional resources are being differentially deployed to control response speed. Response time and the probability of inhibition exhibit a monotonic increasing relationship, and thus successful inhibition is (partially) dependent on early attentional processing of the go-signal. One viable explanation is that the attenuation of N1 is an indicant of a pro-active mechanism that effectively distributes processing resources temporally by adjusting a sensory input gate and consequently governing inhibition performance.

## G38

### TIMING THE AVAILABILITY OF PREDICTIVE SIGNALS: A CEREBELLAR ASYMMETRY FOR REGULATING WORD ASSOCIATION PRIMING.

Therese M. Gilligan[1], Robert D. Rafal[1]; [1]Bangor University — The acquisition of language is underpinned by neural mechanisms that enable learning of associations between sounds that are likely to occur in close temporal relation. A stimulus that activates the meaning of a word will facilitate processing of a semantically related item- semantic priming. Thus, priming is a predictive process that facilitates efficient speech production, comprehension and reading. Since discourse is temporally dynamic, the benefits of priming depend on timing the availability of predictive signals. If a primed word is activated too soon, it can compete with the word activating it, delaying access to the priming word or causing naming errors. These errors are particularly conspicuous in some aphasic patients with anomia who make frequent semantic parraphasic errors. Thus priming must be modulated by brain mechanisms that facilitate and inhibit it with a temporal precision needed for efficient language performance. Cerebellar circuitry provides a precise neural clock and has been implicated in predicting not only the sensory consequences of action, but predictive sentence processing. We tested whether these cerebellar predictions were supported by inhibitory and facilitory processes. In a mixed group design (n=41), automatic word association priming was measured in a lexical decision task before and after 40 seconds of continuous theta burst stimulation of the left or right cerebellum (1cm below inion, 3cm lateral), or a vertex control site. Left cerebellar stimulation decreased priming, whereas right cerebellar stimulation increased priming. The results support the proposal that the cerebellum contributes to facilitory and inhibitory processes that dynamically regulate word priming.

## G39

### ENDOGENOUS VS. EXOGENOUS ACTION INHIBITION: A TMS-EEG STUDY

Stefania Ficarella[1,2], Lorella Battelli[2]; [1]Cimec-Center for Mind/Brain Sciences, Rovereto (TN), Italy, [2]Center for Neuroscience and Cognitive Systems@ UniTn, Fondazione Istituto Italiano di Tecnologia, Rovereto (TN), Italy — Inhibitory control, a crucial aspect of executive functions, is directly involved in the inhibition of unwanted responses. Action inhibition can be triggered by an exogenous stimulus in the environment, such as a red traffic light, or by endogenous decisions. While the first type has been extensively studied, less is known about the endogenous inhibition of actions. Specifically, it is still unclear whether separate circuits are responsible for the two types of inhibition. This study aims to test the causal role of two brain areas, namely the dorsal fronto-median cortex (dFMC) and the right Inferior Frontal Gyrus (rIFG), respectively considered to be involved in the endogenous and exogenous inhibition of actions, when implementing the inhibition of unwanted responses. We designed a novel cognitive task to directly compare a condition which induces participants to freely decide whether to perform an action or to inhibit it, with an exogenous inhibition condition. We tested 19 participants before and after 1 Hz repetitive transcranial magnetic stimulation (rTMS) over dFMC, rIFG and V1. Results show a significant reduction of action inhibition after stimulation of dFMC in the endogenous inhibition condition only. Since rTMS is known to inhibit the normal activity of the stimulated brain area, a reduction of action inhibition, after suppression of the dFMC activity, provides evidence for the causal role of this area in inhibiting endogenously-triggered actions. Furthermore, EEG data results corroborate a neurophysiological distinction between endogenous and exogenous action inhibition showing significant differences in the amplitude of stimulus-locked ERPs between the two conditions.

## G40

### EARLIER AND MORE DISTRIBUTED NEURAL NETWORKS FOR BILINGUALS THAN MONOLINGUALS DURING SWITCHING

Kalinka Timmer[1], John G. Grundy[1], Ellen Bialystok[1]; [1]York University — Bilinguals often outperform monolinguals on measures of task-switching, but this behavioral advantage is not always present. To explore the neuronal basis of these effects, we examined task-switching (color/shape) and language-switching (English/French) in English monolinguals and French-English bilinguals while EEG was recorded. Both tasks included single task and mixed task blocks. English monolinguals knew some French vocabulary from minimal school instruction. In the non-verbal task, the RT analysis showed effects of mixing cost (pure vs. mix) and switching cost (repeat vs. switch) but no language group differences. The accuracy analysis showed similar effects for mixing and switching costs, but bilinguals were more accurate in the mixed block than monolinguals. ERP analysis indicated more distributed electrophysiological networks for bilinguals (N1/N2/P3) in mixing costs and earlier latencies for bilinguals (N2/P3) in switching costs. In the language-switching task, the RT and accuracy analyses showed mixing costs and switching costs with no group differences for the English trials. ERP analysis showed a mixing cost for both monolinguals and bilinguals on the N2, but only monolinguals revealed a mixing cost in the later P3, indicating more need for executive control. The switching cost was present in the P3 for both groups, again with a more distributed network for bilinguals than monolinguals. Thus, even with similar behavioral outcomes, different electrophysiology was revealed for the two language groups. The more distributed and earlier activation of neural networks for bilinguals might reflect the integration of verbal and non-verbal control networks and underlie the bilingual advantage seen across the lifespan.

## G41

### EFFECTS OF ROSTRAL ANTERIOR CINGULATE CORTEX LESIONS ON PERFORMANCE MONITORING IN HUMANS: IMPAIRED ERROR-RELATED NEGATIVITY BUT INTACT ERROR AWARENESS

Martin E. Maier[1,2], Francesco Di Gregorio[1], Teresa Muricchio[2], Giuseppe Di Pellegrino[2,3]; [1]Catholic University of Eichstätt-Ingolstadt, [2]Centro Studi e Ricerche in Neuroscienze Cognitive Cesena, [3]University of Bologna — Detecting one's own errors and appropriately correcting behavior are crucial for efficient goal-directed performance. A correlate of rapid evaluation of behavioral outcomes is the error negativity/error-related negativity (Ne/ERN) that is seen already at the time of the erroneous response over frontal brain areas. However, whether the Ne/ERN is a necessary precondition for the subsequent emergence of error awareness remains unclear. The present study investigated this question by measuring the Ne/ERN and error signaling responses in seven human patients with lesions in the rostral anterior cingulate cortex located in the medial PFC performing a flanker task. The Ne/ERN was severely attenuated in these patients, but they showed no impairment in error signaling. Impairments of the Ne/ERN went along with a failure to increase response accuracy on trials following errors. These results demonstrate that while an intact Ne/ERN is crucial for adaptive post-error adjustments, it is not a necessary precondition for error awareness.

## G42

### COMMON NEURAL CORRELATES INVOLVED IN INHIBITORY REGULATION OF MEMORY AND EMOTION REVEALED BY DATA DRIVEN ANALYSES

Farah Naaz[1], Brendan Depue[1]; [1]University of Louisville, [2]University of Louisville — Self-regulation of memory and emotion are critical aspects of normal cognitive function. Difficulties in regulation of memory and emotion are ubiquitous in psychiatric disorders. Because of the entwined nature of memory and emotion, it is highly probable that their regulation involves common brain regions. In general, these inhibitory mechanisms involve up-regulation of the right lateral prefrontal cortex (rLPFC), which is putatively associated with down-regulation of task related effectors in posterior/sub-cortical regions. To investigate the common neural mechanisms between regulation of memory and emotion a data driven approach using Independent Component Analysis (ICA) was conducted. Twenty-three participants performed the Think/No-think (TNT) and Emotion Regulation (ER) tasks while undergoing fMRI. ICA components were selected on the basis of a priori hypotheses based on previous neuroimaging findings that suggest inhibitory regulation emanates predominantly from the rLPFC. Results yielded spatially overlapping ICA components that included up-regulation of right middle frontal gyrus (rMFG), right posterior cingulate cortex (rPCC), and right angular gyrus (rAG). These regions were associated with down-regulation of task related activity in posterior/sub-cortical task related regions. The overlapping activation of right hemispheric regions: MFG, PCC, and AG, suggest that these regions play a critical part in executing inhibitory regulation across the psychological domains of memory and emotion. This data is consistent with the idea that the rMFG is involved in implementing inhibitory regulation goals, while the role of rPCC and rAG may be related to self-awareness and reorienting attention during attempts to regulate memory and emotion.

## G43

### THE CORRECT-RESPONSE NEGATIVITY AS AN INDEX OF PERCEPTUAL UNCERTAINTY

Paul J. Beatty[1], George A. Buzzell[1], Daniel M. Roberts[1], Craig G. McDonald[1]; [1]George Mason University — Previous work investigating the neural basis of performance monitoring has identified event-related potential (ERP) components, such as the error-related negativity (ERN) and correct-response negativity (CRN), which have been linked to error detection and response conflict. However, recent work suggests that the CRN may selectively index response uncertainty when stimulus discrimination is difficult. Of note, previous reports inferred uncertainty by manipulating discrimination difficulty, as opposed to directly evaluating the certainty of participants' decisions. In the present experiment, EEG was recorded while participants performed a difficult visual discrimination task and reported their subjective certainty of responses on a trial-by-trial basis. Discrimination difficulty was titrated on an individual basis to produce performance accuracy of approximately 70%, ensuring that task difficulty was comparable across participants. We investigated the electrophysiological correlates of perceptual uncertainty by comparing CRN amplitude for subjectively-reported sure and unsure trials. Analysis of correct responses revealed a larger CRN deflection on trials in which individuals were uncertain of the stimulus identity, compared to trials in which individuals were certain of the stimulus identity. These findings provide additional evidence that the CRN indexes uncertainty associated with decisions in which sensory evidence is limiting.

### G44

**IMPULSE DYSREGULATION AND P300 AMPLITUDE REDUCTIONS (P3AR) FROM A 3-CATEGORY VISUAL ODDBALL TASK: DIFFERENTIAL SENSITIVITY OF THETA AND DELTA TIME-FREQUENCY MEASURES**

Jessica S. Ellis[1], Matthew D. Bachman[1], Anne V. Tootell[1], Adreanna T. Massey[1], Edward M. Bernat[1]; [1]University of Maryland College Park, Clinical and Cognitive Neuroscience Lab — Impulse dysregulation indicates a propensity for aggression and externalizing behaviors, which is associated with future psychopathology. Externalizing behaviors have been associated with reductions in amplitude of P300 event-related potential (ERP) measures from both target and novel conditions using common oddball tasks. Using time-frequency approaches, recent work suggests common ERP components such as P300 and the preceding N2 are accounted for by unique contributions of activity in the delta (0-3 Hz) and theta (3-7 Hz) ranges, and that P300 amplitude reduction (P3AR) is related to delta, but not theta. The current study assessed differences in delta and theta activity related to individual differences in impulse dysregulation. We assessed (P3AR) in the time-domain relative to time-frequency, including differential sensitivity of delta and theta activity. Subjects (N = 124) completed a three-stimulus visual oddball task, with IAPS pictures serving as novel stimuli. Results replicated significant P3AR relative to impulse dysregulation for both target ($r = -.215$, $p < .018$) and novel ($r = -.272$, $p < .003$) conditions. These effects were directly reflected in time-frequency delta measures (target, $r = -.189$, $p = 0.036$; novel, $r = -.253$, $p = 0.005$). Theta evidenced significant reductions during target processing ($r = -.197$, $p = .029$), but not novel ($r = -.033$, $p = .718$). This selective reduction suggests that medial-frontal novelty orienting processes in theta were not attenuated relative to impulse dysregulation, in contrast to delta activity which evidenced similar reductions in both conditions This finding is consistent with previous work, and suggests that functional attenuation of these aspects of brain function relative to impulse dysregulation is selective and not global.

### G45

**EXPECTANCY EFFECTS IN FEEDBACK PROCESSING ARE EXPLAINED PRIMARILY BY TIME-FREQUENCY DELTA NOT THETA**

Adreanna Massey[1], Matthew Bachman[1], Anne Tootell[1], Jessica Ellis[1], Srikant Kothur[2], Samuel Eckrich[3], Edward Bernat[1]; [1]University of Maryland College Park, [2]Florida State University, [3]University of Central Florida — The role of expectancy in feedback processing has been investigated as an important factor modulating event-related potential (ERP) measures including feedback negativity (FN) and P300. Previous work has demonstrated modulation of the P300 relative to expectancy, but results for the FN have been more inconsistent. Recent work from our group has shown that processes underlying the FN and P300 are better understood as separable processes in the theta (3-7 Hz) and delta (0-3 Hz) range using time-frequency analysis. This work suggests that theta activity is primarily modulated by the most salient stimulus features while activity in delta is sensitive to both primary salient features and a range of higher level processing related to secondary stimulus attributes (Bernat et al., in press). The current study assessed whether expectancy-related processing in a gambling feedback task could be more selectively indexed using time-frequency analysis than traditional time-domain FN and P300 measures. Participants (N=21) were instructed to choose between two monetary options, ranging from a higher probability of winning with a lower potential payout to a lower probability of winning with a higher potential payout, producing expected and unexpected gains and losses. Time-domain results replicated previous research: P300 amplitude was significantly modulated by expectancy ($F(2,19) = 10.83$, $p = .001$), while FN amplitude was not. Time-frequency analysis indicated that expectancy-related modulations were only observed in delta ($F(2,19) = 6.99$, $p = .005$), not theta. Further, regression analyses predicting time-domain ERPs with time-frequency measures revealed differences in expectancy among FN and P300 were explained primarily by delta for both gain and loss feedback.

## EXECUTIVE PROCESSES: Working memory

### G46

**NEURAL MECHANISMS OF INTENTIONAL AND INCIDENTAL BINDING IN WORKING MEMORY**

David Luck[1,2], Stéphanie Grot[1,2]; [1]Institut Universitaire en Santé Mentale de Montréal - Research Centre, Canada, [2]Department of Psychiatry, University of Montreal, Canada — Rationale: An important quality of human cognition is the ability to associate different aspects of an experience into personal events. This associative process is commonly referred to as binding, and is related to working memory (WM) capacity. When assessing WM binding, studying different encoding conditions could be useful. Hence, encoding processes can occur incidentally without conscious effort, or intentionally including to some extent conscious effort. Objectives: This fMRI study attempted to identify the neuronal correlates of intentional and incidental binding. We hypothesize that intentional binding relies on a fronto-temporal network, while the incidental form is mediated by the hippocampus, exclusively. Methods: Twenty participants were scanned while memorizing three coloured words and three coloured spatial locations. In the intentional binding condition, the three words were central and separated from the three ellipses. Participants had to mentally link the verbal and spatial information sharing the same color (e.g. the word in red must be associated with the position defined by a red ellipse). In the incidental binding condition, words were directly presented in ellipses. In the separate condition, the three words were central and separated from the three ellipses, and had to be memorized as is. Results: FMRI analyses revealed greater hippocampal activity for both forms of binding, relative to the separate condition. Conversely, greater prefrontal activity was observed for intentional, but not incidental, binding. Functional analyses revealed greater fronto-temporal connectivity for intentional, but not incidental, binding. Conclusions: The present results reveal that intentional and incidental binding relies on distinct neural substrates.

### G47

**INVESTIGATING THE LINKS BETWEEN WORKING MEMORY AND CHILDREN'S MATHEMATICS IN SIXTH GRADE: AN EVENT-RELATED POTENTIALS STUDY.**

Liu Pei Yi[1], Shen I Hsuan[1]; [1]Department of Occupational Therapy, Graduate Institute of Behavioral Sciences, Chang Gung University — Problem solving is recognized as an important life skill. It is a crucial and fundamental component of the school mathematics curriculum. Working memory (WM) plays a critical role in integrating information during problem solving. WM represents the ability to temporarily maintain and manipulate information in connection with cognitive tasks. Previous studies indicated that WM is related to and important for mathematical performance. The present study investigated the WM performance by using spatial and verbal n-back paradigms between children with high (n=22) and low (n=22) mathematic ability. On the same time, the underlying process was measured through event-related potentials (ERPs). Group with low mathematic ability showed delayed reaction time ($F(1,41) = 5.79$, $p = 0.0208$), delayed N1 peak latency ($F(1,42) = 13.557$, $p = 0.001$), and enhanced N1 mean amplitudes ($F(1,42) = 5.651$, $p = 0.022$) on verbal WM task. It seems that group with low mathematic ability processed slowly in basic verbal processes and needed more neuron activities. Delayed N2 peak latency ($F(1,42) = 6.678$, $p = 0.013$) on spatial WM task was also found in group with low mathematic ability, indicating slowed conflict-monitoring. Larger P3 mean amplitudes on both spatial ($F(1,42) = 4.637$, $p = 0.037$) and verbal ($F(1,42) = 6.976$, $p = 0.012$) WM tasks were observed in group with high mathematic ability relative to group with low mathematic ability showed that group with low mathematic ability could be less efficient on spatial and verbal WM processes.

### G48

**IMPLICIT WORKING MEMORY IS STILL WORKING DURING VISUAL SEARCH**

Eunhee Ji[1], Kyung-Min Lee[1], Suhyon Ahn[1], Yu-Jin Choi[1], Min-Shik Kim[1]; [1]Yonsei University — The current study investigated whether implicit working memory shared common cognitive resources with explicit working memory. We used a revised working memory paradigm (Hassin, Bargh, Engell, & McCulloch, 2009) where a moving and changing visual search display appears 5 times. For each display, participants had to find

a 'T' among three 'L's in a 2 x 2 array display as soon as possible. In the pattern set condition, the display movements followed a pre-determined pattern (e.g., zigzag); in the yoked broken pattern set condition, the movements of the first four displays followed that same pattern but the fifth display did not. A random half of the participants were in the explicit group, or told that some sets follow patterns, and that extracting these patterns may improve visual search performance. The implicit group was not told anything. We found that, as expected, response times for finding the 5thtarget were faster in the pattern set condition than in the broken pattern set condition. However, this was only true for the implicit group. There was no difference between the two conditions in the explicit group. This finding suggests that implicit working memory can improve visual search in the pattern set compared to the broken pattern set by extracting moving patterns of the search displays even when participants use the cognitive resource of spatial working memory during visual search. It could be inferred from this results that explicit working memory does not seem to share their limited discrete cognitive resources with implicit working memory.

## G49

### SENSORY PROCESSING PATTERNS PREDICT THE BIAS OF ENSEMBLE STATISTICS FOR ITEMS HELD IN VISUAL WORKING MEMORY

Matthew X. Lowe[1,2], Ryan A. Stevenson[1], Kristin E. Wilson[1], Natasha E. Ouslis[1], Marzyeh Azimi[1], Morgan D. Barense[1,3], Jonathan S. Cant[2], Susanne Ferber[1,3]; [1]University of Toronto, [2]University of Toronto Scarborough, [3]Rotman Research Institute, Baycrest — Given the limited resources of visual working memory, multiple items may be remembered as an averaged group or ensemble. While local information may be ill-defined, these ensemble representations provide accurate diagnostics of the environment by combining item-level information with gist information. Integrating information across multiple levels of abstraction rather than representing each item independently affords an increase in the accuracy of lower-level summary statistics for stored items. Recently, Brady & Alvarez (2011) reported evidence in favour of such hierarchical representations in visual working memory by demonstrating that the remembered size of an item was biased toward the mean size of items sharing the same common features. Here, we propose extending the study of ensemble processing by not only considering the statistics of the display, but also the statistics of the observers. In the study reported here, we utilize the Adult Sensory Profile to demonstrate that sensory threshold and responding strategy predict a directional memory bias for the integration of ensemble statistics with individual items held in visual working memory. Specifically, our findings suggest that individuals scoring higher in sensory processing traits reflecting greater sensory hypersensitivity and active avoidance strategies are more likely to be biased away from the mean size representation of a set of items, while individuals scoring lower in these traits are more likely to be biased toward the mean size representation. These findings indicate that stable traits in sensory processing may influence the encoding and retrieval of multiple items in visual working memory.

## G50

### THE EFFECT OF MATH ANXIETY ON BASIC MAGNITUDE PROCESSING AND CALCULATION WITH HIGH VS. LOW WORKING MEMORY LOAD

Kyungmin Lee[1], Soohyun Cho[1]; [1]Chung-Ang University — Mathematics anxiety (MA) refers to the experience of negative affect when engaged in mathematical activity. Individuals who experience more MA perform worse on various measures of mathematical problem solving. There are two opposing theories on the effect of MA in relation to working memory (WM) load. Ashcraft & Kirk (2001) suggest that MA compromises performance only when there is a significant WM load. In contrast, Maloney et al. (2010) propose that MA results from impairment in fundamental numerical processing and thus should affect mathematical cognition ubiquitously, regardless of WM demand. The present study tested these hypotheses by examining the effect of MA on magnitude comparison and calculation with high vs. low WM load. Participants' MA was measured along with performance on magnitude comparison (numerosity, area comparison) and calculation with high vs. low WM load (Carrying/Borrowing Required vs. Carrying/Borrowing Not-Required). Individuals with high MA showed worse calculation performance only in the high WM condition. In addition, MA scores were positively correlated with performance (RT) difference between the high vs. low WM conditions of calculation; i.e., higher the MA, greater the RT cost for high vs. low WM calculation. There was no difference between high vs. low MA groups in the low WM condition of calculation or any magnitude comparison task. MA scores did not correlate with accuracy on either magnitude comparison tasks. These results demonstrate that the negative effect of MA is selective for cognitive operations that are high in WM demand.

## G51

### CHANGES IN GLOBAL AND REGIONAL MODULARITY ASSOCIATED WITH INCREASING WORKING MEMORY LOAD

Matthew Stanley[1], Dale Dagenbach[1], Robert Lyday[1], Jonathan Burdette[1], Paul Laurienti[1]; [1]Wake Forest University — The recent use of graph theory measures in complex network analyses of neuroimaging data has allowed for the identification and classification of global and regional brain network properties as well as the ability to quantify changes in network properties across different task conditions. We investigated the effects of increasing working memory processing load on functional brain network modularity in a cohort of young adults. Measures of modularity in complex brain networks quantify how well a network is organized into densely interconnected communities. We investigated changes in both the large-scale modular organization of the functional brain network as a whole and regional changes in modular organization as demands on working memory increased from n = 1 to n = 2 on the standard n-back task. We further investigated the relationship between modular properties across working memory load conditions and behavioral performance. Our results showed that regional modular organization within the default mode and working memory circuits significantly changed from 1-back to 2-back task conditions. However, the regional modular organization was not associated with behavioral performance. Global measures of modular organization did not change with working memory load but were associated with individual variability in behavioral performance. These findings indicate that while regional changes in modular properties were highly sensitive to increases in external cognitive demands, only global changes in modular properties were sensitive to changes in behavioral performance across load conditions.

## G52

### DIFFERENT ELECTROPHYSIOLOGICAL CORRELATES UNDERLYING FRAGILE AND ROBUST VISUAL SHORT-TERM MEMORY.

Annelinde Vandenbroucke[1,2], Ilja Sligte[2,3], Jade de Vries[2], Mike X Cohen[2], Victor Lamme[2]; [1]UC Berkeley, [2]University of Amsterdam, [3]University of Birmingham — Recently, we have found evidence for a Visual Short-Term Memory (VSTM) stage that lies in between iconic memory and robust VSTM (Sligte et al., 2008; 2009). Classical VSTM experiments using a Change Detection paradigm show that items in VSTM are stored in a stable form, yet with a limited capacity of around four objects. Interestingly, when a partial-report paradigm is used, capacity is boosted to up to twice that amount, even when cue-timings outlast iconic memory traces. These additional items are however erased when new objects appear, hence we term this intermediate storage fragile VSTM. Although behaviorally, fragile and robust VSTM can be dissociated (Vandenbroucke et al., 2011; 2014), a neural distinction remains to be elucidated. Here, we investigated whether fragile and robust VSTM have different electrophysiological underpinnings using EEG time-frequency analyses. Twenty-four subjects performed a Change Detection task in which a cue was presented in between the memory and test display (gauging fragile VSTM) or during the test display (gauging robust VSTM). Memory displays contained 2, 4, 6 or 8 oriented rectangles. For robust VSTM, ceiling performance was reached at 4 objects, while fragile VSTM performance kept rising up to 8 objects. The capacity scores for fragile VSTM and robust VSTM correlated with different frequency bands, such as a relative decrease in parietal-occipital alpha power and increase in central and frontal gamma power for fragile VSTM compared to robust VSTM. This shows that fragile and robust VSTM rely on different mechanisms, and are possibly supported by different attentional strategies.

## G53

### THE EFFECT OF A VIRTUAL REALITY TSST ON FALSE MEMORY

Deidre O'Dell[1], David Fraser[1]; [1]Chatham University — Objective: The objective of this study was to test the hypothesis that increases in stress induced cortisol correlate to changes in false memory rates. A false memory is defined as

the generation of a new memory for an event that did not transpire. Methods: There were 32 participants (27 female, 5 male, mean age 22.5 years, range 18 -30). Stress was induced using a version of the Trier's Social Stress Test that was adapted to use a virtual reality audience (vrTSST). A visual analog scale (VAS) for anxiety was used to assess subjective stress levels. Cortisol was measured using saliva ELISA/EIA assay. False memory rates were measured using free recall and recognition tasks following a hybrid Deese-Roediger-McDermott (DRM) paradigm. Word lists included both semantic and phonological lures. Saliva samples were taken upon arrival (0 min), after the stress protocol (15 min), and after the memory tasks (45 min). Results: The vrTSST was successful in inducing a moderate increase in cortisol in a subset of the subject population. Subjects reported significant changes in subjective stress as a result of the vrTSST. Increases in cortisol correlated with greater accuracy on recall and recognition as well as fewer false memories. Conclusions: It is proposed that the moderate elevation of cortisol induced by the vrTSST is consistent with existing literature showing that the effect of cortisol on cognitive processes often follows an inverted U-shaped pattern. Mild to moderate increases in cortisol can have beneficial effects, but larger increases can be deleterious.

### G54

### USING THE CONTRALATERAL DELAY ACTIVITY TO PROBE THE NATURE OF TASK SETS REPRESENTATIONS

Atsushi Kikumoto[1], Lauren Williams[1], Selina Robson[1], Ulrich Mayr[1]; [1]University of Oregon — Selecting and preparing one action plan or task set among several competing plans is often considered an important working memory (WM) function. Yet, measures of WM capacity and task switching are usually not correlated, raising the question how these different aspects of cognitive control are functionally related. We used the EEG-derived contralateral delay activity (CDA; Vogel et al., 2004) to probe the content of WM while participants prepared for each trial a novel task-set of either two or four stimulus-response rules. Consistent with results with standard WM tasks, there was a greater CDA set-size effect (2 vs. 4 rules) for high than low WM capacity individuals. Also, both WM capacity and the set-size effect correlated with task-selection performance. In contrast, when we limited the number of constellations of task-sets throughout the experiment (similar to standard task-switching experiments), the CDA pattern suggested a sustained, yet set-size independent use of WM. A significant correlation between task-selection performance and individuals' WM capacity gradually disappeared as participants learned task-sets. These results suggest that task-selection does in fact require working memory. However, while novel task-sets are represented in WM in a detailed, load-dependent manner, familiar tasks are represented in a load-independent, compressed manner—likely in form of pointers to long-term memory representations.

### G55

### NEURAL DISSOCIATION FOR VISUAL AND SENSORIMOTOR WORKING MEMORY STORAGE: EVIDENCE FOR A MNEMONIC HOMUNCULUS.

Alejandro Galvez-Pol[1], Beatriz Calvo-Merino[1,2], Almudena Capilla[3], Bettina Forster[1]; [1]City University London, [2]Universidad Complutense de Madrid, [3]Universidad Autonoma de Madrid — The contralateral delay activity (CDA) is the electrophysiological signature of encoding and maintenance in human visual memory. The CDA is an enhanced amplitude (300–900ms post-stimulus onset) over the hemisphere contralateral to the presentation side of the remembered items, which is modulated by the number of items (load) held in visual working memory. However, recent behavioural work on working memory using body related stimuli has suggested an additional embodiment process necessary to encode sensorimotor information (e.g. bodies, actions). To test whether there is an independent sensorimotor memory storage similar to the one visually described, we directly measured participants' somatosensory-evoked activity by tactually probing (fingertips) the state of the somatosensory system during a working memory task using body related stimuli (hand postures) and matched visual stimuli (geometrical shapes) while controlling for visual effects. Visual evoked potentials (VEPs) showed a significant interaction between hemisphere and load in the geometrical shapes condition only, suggesting the presence of CDA over visual regions similar to what has been previously shown. Interestingly, a similar interaction was found for the same time window (300-900ms) in the somatosensory evoked potentials (SEPs) over central/posterior electrodes but for the hand condition only. Such activity suggests a sensorimotor CDA reflecting encoding and maintenance of visually processed body stimuli in an independent storage from the one used for non-body visual stimuli. These results provide evidence for a direct relationship between neural activity and specific sensorimotor working memory storage, suggesting a separate sensorimotor working memory storage from the classical visual memory system.

## LANGUAGE: Development & aging

### G56

### YEARS OF EDUCATION PREDICT ONLY A SUBSET OF LANGUAGE AND COGNITIVE TASKS AMONG OLDER ADULTS

Jet M. J. Vonk[1], Eve Higby[1,2,3], Dalia Cahana-Amitay[2,3], Loraine K. Obler[1,2,3]; [1]The Graduate Center of the City University of New York, [2]Boston University School of Medicine, [3]Boston VA Healthcare System — Level of education, as measured by Years of Education (YoE), has often been associated with cognitive vitality in aging. However, whether YoE also affects age-related language performance has not been explored. To address this question, we analyzed data from healthy older adults who performed multiple language and cognitive tasks. The analyses included between 109 and 261 participants, based on the number of participants who completed each task. Multiple regression analyses controlling for age and gender revealed that for tasks of lexical retrieval, YoE predicted object naming accuracy ($\beta$=.239, p<.001) and response times ($\beta$=-.143, p=.030), and action naming accuracy ($\beta$=.221, p<.001) but not response times. YoE also predicted phonemic ($\beta$=.205, p=.001) and semantic ($\beta$=.145, p=.024) fluency. For sentence-comprehension, YoE predicted accuracy for sentences containing negative markers ($\beta$=.238, p=.012) but not response times. YoE did not predict comprehension of embedded clauses. In terms of cognitive tasks, YoE predicted performance on all three working memory tasks: listening span ($\beta$=.230, p=.001), month ordering ($\beta$=.185, p=.004), and digit ordering ($\beta$=.172, p=.008). It also predicted Trail-making performance ($\beta$=-.140, p=.024), but did not predict performance on the Mini Mental State Examination, inhibition tasks (Stroop, Stop-signal), or cognitive speed tasks (choice reaction time, letter comparison, pattern comparison). These findings suggest that level of education plays an important role in older adults' lexical retrieval skills, and to some extent, in their sentence comprehension abilities, however its relation to cognitive performance is restricted to effects on working memory and set-shifting.

### G57

### SPATIAL SEPARATION OF CORTICAL ACTIVITY ASSOCIATED WITH FIRST AND SECOND LANGUAGE PROCESSING IN LATE SECOND LANGUAGE LEARNERS

Morgan B. Johnson[1], Therese M. Chevalier[1], Julia Fuchs[1], Shaun Boe[1], Aaron J. Newman[1]; [1]Dalhousie University — There is debate concerning whether languages learned in adulthood (L2s) engage the same brain regions as native languages (L1s). Previous studies have found equivocal results in this regard; the amount of exposure and proficiency in L2 may influence the findings. Here we controlled exposure by providing a fixed amount of training with new L2 vocabulary. The present study involved native English speakers who learned 48 words (nouns and verbs) in a language new to them (Spanish) over 2 training sessions (1 hour total). Training was delivered using prototype software employing video games and speech recognition (LANGA; Copernicus Studios, Halifax, NS). Immediately after the second training session, participants completed a picture naming task in English and Spanish during fMRI scanning. Data analysis focused on activation in the inferior frontal gyrus (IFG). While areas of activation for English and Spanish overlapped, we found a significant difference between the peaks for Spanish and English activation within the IFG. The number of suprathreshold voxels overlapping between L1 and L2 in the left IFG was equivalent to the number of voxels activated by each language alone. Although IFG activation was overall left-lateralized, in the right IFG we found more extensive activation for L1 than L2. These results suggest that even at early stages of L2 vocabulary learning, distinct but overlapping regions of the IFG are recruited for L2 as compared to L1 naming. Furthermore, contrary to some previous claims, we do not find evidence for greater right IFG involvement in L2 than L1 production.

## G58

### MORE BILATERAL, MORE ANTERIOR: ALTERATIONS OF BRAIN ORGANIZATION IN LARGE-SCALE STRUCTURAL NETWORK IN CHINESE DYSLEXIA

Ting Qi[1], Bin Gu[1], Guosheng Ding[1], Gaolang Gong[1], Chunming Lu[1], Li Liu*[1]; [1]Beijing Normal University, Beijing, China — Local structural abnormality has been frequently reported in dyslexia, however whether dyslexia is impaired in large-scale structural brain network remains unclear. Here, structural magnetic resonance imaging data of 17 Chinese reading disabled (RD) and 17 age-matched typically developing children (TD) were used to construct cortical thickness and surface area networks respectively. RD compared to TD showed reduced nodal centrality in the left hemisphere along with enhanced nodal centrality mainly in the right hemisphere brain regions in thickness network. As for surface area network, RD compared to TD demonstrated lower nodal centrality in the posterior brain regions but higher nodal centrality in the anterior brain regions. Such an anteverted tendency was further supported by the hub distribution pattern in both thickness and surface area networks. Specifically, hubs in RD were more distributed in frontal, less likely in parietal areas, whereas TD showed an opposite pattern. These findings indicated that the abnormal functional connectivity in dyslexia reported in previous studies might be rooted in the aberrant structural connectivity. These findings also indicated that the aberrant structural connectivity in the dyslexics was not only due to compensating for poor reading in the late development reflected by the altered thickness network, but may also be a congenital effect during the prenatal development reflected by the altered surface network.

## G59

### INTERACTION BETWEEN NATIVE AND SECOND LANGUAGE NETWORKS : A FUNCTIONAL MAGNETIC RESONANCE IMAGING STUDY OF CHINESE-ENGLISH BILINGUAL CHILDREN

Yue Gao[1], Guosheng Ding[1], Xiangzhi Meng[2], Li Liu[1]; [1]National Key laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, [2]Department of Psychology, Peking University — Do bilingual children recruit both native and second language neural networks in second language reading as adults do? Does second language and native tongue affect one another in bilingual children's brain? We used fMRI to test phonological and orthographical processing of Chinese-English bilingual children(n=28; mean age=9.9±0.7) in both languages, and defined regions of interest(ROI)based on meta-analysis of cross-language comparison. ROI analysis revealed that some Chinese-specific regions(bilateral inferior occipital gyrus, cingulate gyrus, and right fusiform gyrus)were significantly activated in English tasks. Similarly, some English-specific regions(left fusiform gyrus, inferior frontal gyrus, and medial frontal gyrus)were significantly activated in Chinese tasks. Among these regions, Increased activation of the Chinese-specific cingulate gyrus was negatively correlated with WRAT-3(Wide Range Achievement Test) letter test and English dictation test scores, suggesting that the higher the second language proficiency was, the less the native language network was involved. However, while increased activation in the English-specific left superior temporal gyrus was negatively correlated with Chinese reading fluency and character recognition test scores, activation in the English-specific left inferior frontal gyrus was positively associated with greater Chinese reading fluency scores - suggesting that second language processing may be affected by native language proficiency. Summarily, these results suggest that while bilingual children do develop a distinct neural network to process their second language, it is also partly supported by the brain's native language network. Additionally, this study indicates that the neural networks supporting native and second language in bilinguals' brain interact with one another.

## G60

### EFFECTS OF ACOUSTIC DEGRADATION ON NEURAL ACTIVITY FOR LANGUAGE COMPREHENSION OVER DEVELOPMENT

Saloni Krishnan[1,3], Robert Leech[2], Samuel Evans[1], Evelyne Mercure[1], Frederic Dick[3]; [1]University College London, [2]Imperial College London, [3]Birkbeck, University of London — The refinement of domain-general attentional abilities plays an important role in language comprehension throughout development. Attentional and perceptual "stress" (typically imposed by additional processing loads) is known to impair language comprehension in healthy adults, who show patterns of interference resembling those of adult aphasics. Such "stressors" also influence children's sentence comprehension accuracy, particularly worsening the comprehension of complex syntax. Despite this, we know almost nothing about how children's brains deal with increased processing loads in language tasks. For the first time, the influence of adverse listening conditions on children's neural activity for language comprehension was explored. We compared 19 adults and 32 7-to 13-year-old children listening to both clear and degraded (low-pass filtered+time-compressed) sentences in the scanner. The sentences varied in syntactic complexity, ranging from simple (active/subject clefts) to complex (passives/object clefts). Averaged over the two groups, listening to clear>degraded speech was associated with greater activation over bilateral lateral superior temporal gyri; listening to syntactically complex>simple sentences also elicited greater activity over inferior frontal gyri. In all four listening conditions, adults showed greater activity in bilateral superior temporal and subcentral gyri compared to children.Our results also suggest a complex interplay between age, language ability, and neural activity during sentence comprehension in children. In particular, we found greater left-lateralisation with increasing age and language ability in the planum temporale and the superior temporal gyrus. In tandem with language production findings from the same sample of children these results suggest long-tailed developmental changes in the brain networks underlying language learning and expertise.

## G61

### MONOLINGUAL AND BILINGUAL INFANTS SHOW DIFFERENT PATTERNS OF BRAIN ACTIVITY WHEN SEGMENTING SPEECH.

Elena Neophytou[1], Caroline Junge[2], Natalie Roch[1], Debra Mills[1]; [1]Bangor University, [2]University of Amsterdam — The ability to segment words from continuous speech in early language development is an important factor in later vocabulary size. Monolingual infants learning a stress-initial language, such as English, show segmentation abilities as young as 7.5 months. Little is known about how segmentation abilities develop in bilingual infants learning languages with different stress patterns. Event-related potential (ERP) studies with monolingual infants have identified a word familiarity effect as a marker for segmentation. From 200-900 ms familiarized words elicit a larger negativity than unfamiliar words at 10 months, and a positive effect at 7 months. We examined the developmental time course of segmentation abilities in infants learning two languages with similar but not identical stress-patterns, i.e., Welsh and British English. ERPs were recorded from 19 monolingual and 23 bilingual infants between 7-10 months in a familiarization-test paradigm. Infants heard 8 English sentences containing a stress-initial word during familiarization, followed by 4 test sentences, half of which contained the familiarized word. Monolingual and bilingual infants showed an ERP familiarization effect that manifested differently across development. Monolinguals exhibited a negative going effect that changed in lateral distribution from bilateral at 7 months, to a more focused left temporal effect at 10 months. In contrast, bilinguals showed an unclear pattern with a change from a bilateral positivity at 7 months to bilateral negativity at 10 months. The results suggest that although both populations develop segmentation abilities at a similar time, the underlying processes might differ.

## G62

### THE PEDIATRIC FUNCTIONAL NEUROIMAGING RESEARCH NETWORK (C-MIND): METHODS, PUBLIC DATABASE, AND PRELIMINARY RESULTS

Jennifer Vannest[1], Claire Sroka[1], Vincent Schmithorst[2], Gregory Lee[1], Wagner Michael[1], Rajagopal Akila[1], Scott Holland[1], C-MIND Authorship Consortium; [1]Cincinnati Children's Hospital Medical Center, [2]Children's Hospital of Pittsburgh — Goal: The goal of this project was to create standardized methods for acquisition and processing of pediatric neuroimaging data, combining BOLD functional magnetic resonance imaging (fMRI) with arterial spin labeling (ASL) perfusion (Schmithorst et al., 2014a). We focused on developmental changes in neural substrates of receptive language function from infancy to age 18 (Schmithorst et al., 2014b), making all data available in a publicly-accessible database. Methods: 257 children ages 0-18 years participated in the study. Infants and toddlers under age 3 were scanned during natural sleep; older children participated in two imaging sessions; one to collect structural and baseline perfusion data; the second included ASL/BOLD fMRI scans using a passive-listening story processing task in

all participants, and a sentence-picture matching task in children older than 7 (Vannest et al., 2014). Comprehensive neuropsychological assessments were completed in all participants. Results: The public database including de-identified data from 206 participants who completed all study sessions is available online (research.cchmc.org/c-mind/). An initial sub-analysis (Sroka et al., submitted) examined the relationship between activation during the story processing task and standardized vocabulary scores in (n=30) children ages 3 to 5. Adjusting for age, children with higher vocabulary scores showed increased left-lateralization and greater activation in thalamus, hippocampus and left angular gyrus. Conclusion: It is feasible to collect high-quality neuroimaging data in sleeping infants and awake children as young as age 3; and to make this data publicly available. This dataset can be used to explore brain-behavior relationships in a wider age range than previously studied.

### G63

### RAPID AUDITORY PROCESSING IN ITALIAN INFANTS AT RISK FOR LANGUAGE AND LEARNING IMPAIRMENT

Chiara Cantiani[1], Valentina Riva[1], Caterina Piazza[1,2], Roberta Bettoni[1], Massimo Molteni[1], Naseem Choudhury[3,4], Cecilia Marino[5,6], April A Benasich[3]; [1]Scientific Institute, IRCCS Eugenio Medea, Bosisio Parini, Lecco, Italy, [2]Politecnico di Milano, Italy, [3]Rutgers University, Newark, USA, [4]Ramapo College of New Jersey, Mahwah, USA, [5]Centre de Recherche de l'Institut Universitaire en Santé Mental de Québec, Canada, [6]Université Laval, Québec, Canada — Infants' ability to discriminate between auditory stimuli differing in fundamental frequency and presented in rapid succession (i.e. rapid auditory processing abilities [RAP]) has been shown to reliably predict later language outcomes and also to be anomalous in infants at familial risk for Language and Learning Impairment (LLI). This study represents the first attempt to investigate RAP for two acoustic features (fundamental frequency and duration) in Italian infants at familial risk for LLI (FH+). RAP skills of 23 FH+ Italian 6-month-olds and 32 control infants (FH−) were characterized via EEG/ERP using a double-deviant oddball paradigm. Pairs of tones were presented at a rapid rate (70ms inter-stimulus interval); the deviant stimuli differed in either frequency or duration. For a subset of the participants outcome measures of expressive vocabulary were collected at 20-months-of-age via a parental questionnaire. Overall, the morphology of ERP responses differed for frequency vs. duration deviants. Group differences favoring FH- infants were identified: in FH+ infants, the latency of the N250 peak was delayed and the mean amplitude of the positive mismatch response was reduced, primarily for the frequency condition and within the right hemisphere. Moreover, both EEG measures differentiating FH+ and FH- groups at 6-months-of-age were correlated with expressive language scores at 20 months. Results suggest that Italian infants with a first-degree relative affected by LLI show atypical auditory processing. During rapid-rate presentation, discrimination of frequency change appears more difficult for FH+ infants. Preliminary data suggests that early RAP abilities in Italian infants predict to later language skills.

### G64

### PREFRONTAL CORTEX AS A PROTECTIVE FACTOR IN READING: HOW THE BRAIN ENABLES READING COMPREHENSION DESPITE LESS PROFICIENT DECODING

Smadar Patael[1], Emily Farris[1,2], Jessica Black[3], Roeland Hancock[1], John D.E. Gabrieli[4], Laurie Cutting[5,6], Fumiko Hoeft[1,6,7]; [1]University of California, San Francisco, [2]University of Texas of the Permian Basin, [3]Boston College, [4]Massachusetts Institute of Technology, [5]Vanderbilt University, [6]Haskins Laboratories, [7]Keio University, Japan — Understanding text is the ultimate goal of learning to read. To master reading comprehension, children have to first acquire decoding skills, the ability to translate printed words into sounds. Surprisingly, some children struggle to read (decode), but yet can comprehend text well (referred to as resilient dyslexics in the current study), but its brain basis is virtually unknown. Further, it is unknown whether this brain mechanism allows the development of comprehension-decoding discrepancy, or the brain pattern is a secondary consequence of the enhanced use of compensatory strategies. Therefore, the goal of our study was to examine the mechanism underlying this discrepancy. We found that increased regional grey matter volume (GMV) in the left dorsolateral prefrontal cortex (LtDLPFC) was specifically and positively-associated with greater discrepancy in a cross-sectional sample of school-age children with a wide range of reading ability (N=55; Experiment-1a). Interestingly, a subsample of resilient dyslexics had increased LtDLPFC GMV not only when compared to poor but also to good readers without discrepancy (N=36; Experiment-1b). Further, increased LtDLPFC GMV in pre-readers predicted greater discrepancy three years later (N=43; Experiment-2). Finally, the role of this anatomical region was found to be associated with cognitive control using large-scale reverse inference (Experiment-3). These findings point to a causal relationship between LtDLPFC critical for working memory and planning, and superior comprehension relative the child's decoding skills. Studies such as ours may offer clues as to how best support children with dyslexia and maximize their ability to understand text despite decoding challenges.

### G65

### MULTIPLE CHANNELS OF COMMUNICATION AND CO-OCCURRENCES IN ADULTS WITH WILLIAMS SYNDROME

Talent V. Dang[1], Philip Lai[1,2,3], Judy Reilly[3], Ursula Bellugi[1]; [1]The Salk Institute for Biological Studies, [2]University of California, San Diego, [3]San Diego State University — Williams Syndrome (WS) is a genetic disorder, characterized by hyper-sociability and gregariousness. The goal of this study is to better define the social phenotype of adults with WS by analyzing multiple channels of communication and their co-occurrences during a dyadic interaction. Participants included 14 individuals with WS and 11 typically developing (TD) individuals. Language, facial expression, eye contact, and their co-occurrences were analyzed. Using facial expression in conjunction with speech, a negative correlation between age and smiles was observed in the TD group (P=.048) while the WS group continue to smile regardless of age. The frequency of eye contact was significantly higher in the TD group (p=.004), while the average duration of eye contact was significantly longer in the WS group (p=.015). Co-occurrences of eye contact and facial expression resulted in significant differences as the TD group produces more of these two channels concurrently than the WS group. Although less frequent, the co-occurrences observed in the WS group was significantly longer than the TD group. We are beginning to observe different communication patterns in which the WS group is more open to meeting new people, express frequent smiles, and engages in longer eye contact; the TD group has shorter, yet more frequent eye contact and fewer smiles. These results are somewhat consistent with previous studies in children with WS, suggesting aspects of their social phenotype persist into adulthood. Taken together, these multiple channels of communication and their temporal dynamics can better help define the adult WS social profile.

## LANGUAGE: Syntax

### G66

### THE INFLUENCE OF L1 PROFICIENCY ON ERP INDICES OF SENTENCE PROCESSING

Ella Dubinsky[1], Lisa Beck[1], Antoine Tremblay[1], Aaron J Newman[1]; [1]Dalhousie University — We characterized individual differences in event-related potential (ERP) responses to semantic and syntactic violations in sentences, and investigated whether there are systematic relationships between such differences and behavioural measures of cognitive-linguistic abilities. We recorded ERPs from native English speakers in response to written English sentences containing lexical-semantic, morphosyntactic, or phrase structure violations, as well as control sentences. Language proficiency scores were obtained from the TOAL-3; other cognitive measures including working memory and executive function were also obtained. Mean amplitudes in the 300-500 (N400) and 600-800 (P600) ms windows were analyzed using linear mixed effects modelling, with proficiency measures included as continuous fixed effects terms. At the group level, biphasic early negativity-late positivity patterns were observed for all three violation types, although the scalp distribution varied with violation type. In particular, the early negativity for morphosyntactic and phrase structure violations was more left-lateralized than for lexical-semantic violations. However, closer investigation revealed systematic differences in the magnitude and scalp distribution of these components as a function of language proficiency. These findings contribute to a growing appreciation of the role that individual differences play in modulating ERP responses to sentence

processing. These results will be discussed in the context of characterizing individual strategies to parsing and how other cognitive factors (e.g., working memory) may contribute.

## G67

### SLEEP FACILITATES LEARNING A NEW LINGUISTIC RULE

Laura Batterink[1], Delphine Oudiette[1], Paul J. Reber[1], Ken A. Paller[1]; [1]Northwestern University — Natural languages contain countless regularities. Extraction of these patterns is an essential component of language acquisition. Here we examined the hypothesis that memory processing during sleep contributes to this learning. We exposed participants to a hidden linguistic rule by presenting a large number of two-word phrases, each including a noun preceded by one of four novel words that functioned as an article (e.g., gi rabbit). These novel articles were presented as obeying an explicit rule: two articles signified that the noun referent was relatively near, and two that it was relatively far. Undisclosed to participants was the fact that the novel articles also predicted noun animacy, with two of the articles preceding animate referents and the other two preceding inanimate referents. Rule acquisition was tested implicitly using a task in which participants responded to each phrase according to whether the noun was animate or inanimate. Learning of the hidden rule was evident in slower responses to phrases that violated the rule. Responses were delayed regardless of whether rule-knowledge was consciously accessible. Brain potentials provided additional confirmation of implicit and explicit rule-knowledge. An afternoon nap was interposed between two 20-min learning sessions. Participants who obtained greater amounts of both slow-wave and rapid-eye-movement sleep showed increased sensitivity to the hidden linguistic rule in the second session. We conclude that during sleep, reactivation of linguistic information linked with the rule was instrumental for stabilizing learning. The combination of slow-wave and rapid-eye-movement sleep may synergistically facilitate the abstraction of complex patterns in linguistic input.

## G68

### HOW RIGHT IS LEFT? AN ERP STUDY ON THE EFFECTS OF HANDEDNESS ON GRAMMATICAL PROCESSING

Sarah Grey[1], Darren Tanner[2], Janet G. Van Hell[1,3]; [1]Pennsylvania State University, [2]University of Illinois Urbana Champaign, [3]Radboud University Nijmegen — We examined the effects of handedness on grammatical processing. Research shows that right-handed participants with a left-handed blood relative (familial sinistrals) process language differently from right-handers with no left-handed blood relative (familial dextrals; Tanner & Van Hell, 2014; Townsend & Bever, 2001). Sinistrality is thought to be related to increased reliance on lexical/semantic information whereas dextrals rely more on grammatical information (Townsend & Bever, 2001; Ullman, 2005), but how do left-handers process grammar? Because brain-based studies typically exclude left-handers (Willems et al., 2014) little is known about the effects of handedness on language processing. We tested left-handed individuals on grammatical processing using ERPs, and compared their neural patterns to two groups of right-handed participants: dextrals with a sinistral blood relative and dextrals with no familial sinistrality. Participants read sentences that were either correct or contained an error in English subject-verb agreement or verb tense. For agreement, the right handers with a left-handed relative showed a biphasic N400-P600 response whereas the left-handers and the right-handers without a left-handed relative showed a P600. For tense, the three groups showed different patterns: the dextrals with a left-handed blood relative again had a biphasic N400-P600 response, the left-handers group showed an N400, and the dextrals with no left-handed relatives showed a P600. Overall, the results reveal similarities and differences in reliance on lexical/semantic or structural information as a function of handedness. In general, the right-handers with a left-handed relative showed a biphasic N400-P600 whereas the other two groups showed an N400 or a P600.

## G69

### THE ROLE OF THE BASAL GANGLIA IN LANGUAGE COMPREHENSION: AN ERP STUDY OF SYNTACTIC PROCESSING IN PARKINSON'S DISEASE (PD)

Mieko Ueno[1], Laura Kemmer[2], Christopher Barkley[1], Marta Kutas[1], Shugo Suwazono[3], Vincent Filoteo[1], Irene Litvan[1]; [1]University of California, San Diego, [2]Pacific Lutheran University, [3]National Hospital Organization Okinawa National Hospital — Recent work has demonstrated language abnormalities in PD. Friederici et al. (2003), for example, reported reduced P600 amplitudes -- an event related brain potential (ERP) component used as an index of syntactic processing -- to word category violations in speech in PD, and concluded that basal ganglia circuitry is crucial for late/integrative syntactic processes. We assess the generality of this conclusion by examining the processing of grammatical number violations during reading combined with performance on an extensive neuropsychological battery. EEG was recorded while individuals with PD (Mean Hoehn and Yahr stage=2.1; Mean MoCA=26.3) and age-matched controls read sentences containing grammatical number violations with subject-verb and reflexive pronoun-antecedent agreement (and grammatical controls). P600 effect (violations minus controls) amplitudes and latencies were correlated with various neuropsychological measures. Statistically indistinguishable centro-posterior P600 effects were observed in both groups. P600 parameters were significantly correlated with Executive Function/Working Memory (EF/WM) scores: higher scores were associated with earlier and larger P600 effects for both groups (PD: r=.8~.9; controls: r=.6~.7). We found no evidence for P600 effect amplitude reductions in individuals with PD with severity approximately equal to that in previous reports. Preliminary analyses suggest that syntactic P600 amplitude and latency are better predicted by scores on tests of EF/WM than grammaticality judgment accuracy in PD. This suggests that the link between the basal ganglia and syntactic processing is more complicated than presumed to date.

## G70

### NATIVE WORD ORDER PROCESSING IS NOT UNIFORM: AN ERP STUDY OF VERB-SECOND WORD ORDER

Annika Andersson[1], Susan Sayehli[1], Marianne Gullberg[1]; [1]Lund University — Most Germanic languages share verb-second (V2) word order: the finite verb occurs in second position in a main clause regardless of whether it starts with a subject (e.g., she; SVO), or an adverbial (e.g., today; AdvVSO). Swedish allows for certain exceptions to V2 resulting in clauses with V3 word order (AdvSVO) (Bohnacker, 2006). Despite the general acknowledgment that V3 occurs, little is known about the factors that license it and about how these structures are processed. This study therefore investigated V2-/V3-processing in 20 adult native Swedish speakers, manipulating initial semantic adverbial type (idag 'today', hemma 'at home', and kanske 'maybe'), and subject type (lexical noun, 'the boy', vs. pronoun, 'he') in a sentence completion task and in acceptability judgments made after event-related potentials were recorded. The results showed effects of adverbial- and subject-type across tasks and measures. Behavioral results showed positive effects of pronominal subjects; moreover, idag-sentences were the most accurate, and kanske-sentences the least accurate. Neurocognitively, there was a main effect of V2 reflected in a medial negativity in the N400 time window, a left anterior positivity, and a late posterior negativity. Importantly, the negativities were strongest in amplitude with kanske, while the left anterior positivity was only elicited with hemma and idag. The results thus suggest that V2-violations in Swedish are more acceptable with some adverbials (here kanske 'maybe'), and that such sentences are also processed differently from sentences starting with other adverbials. Native word order processing is thus not uniform.

## G71

### THE NEUROBIOLOGY OF AGRAMMATIC SENTENCE COMPREHENSION: A LESION STUDY

Arianna La Croix[1], Corianne Rogalsky[1], Kuan-Hua Chen[2], Gretchen Hays[1], Steven W. Anderson[2], Hanna Damasio[3], Tracy Love[4], Gregory Hickok[5]; [1]Arizona State University, [2]University of Iowa, [3]University of Southern California, [4]San Diego State University, [5]University of California - Irvine — Broca's area has long been implicated in sentence comprehension. In particular, damage to this region is thought to be the central cause of "agrammatic comprehension" in which performance is substantially worse (and near chance) on sentences with noncanonical word orders compared to canonical word order sentences (in English). The present study investigated this claim in 66 patients with chronic focal left hemisphere cerebral damage. Patients completed two sentence comprehension measures, the SOAP syntactic test (Love & Oster, 2003) and a plausibility judgment task. Patients with damage to Broca's area (and surrounding areas but excluding the temporal lobe; n=11) on average did not exhibit the expected agram-

matic comprehension pattern, e.g. their performance was > 80% on non-canonical sentences in the SOAP syntactic test. These findings are contrary to the well-documented agrammatic performance of patients with Broca's aphasia. Across our entire patient sample, agrammatic comprehension is associated with damage within a large left hemisphere network, in particular inferior frontal, anterior temporal and temporoparietal regions. To further characterize the networks involved in noncanonical versus canonical sentence comprehension, we then performed voxel-based lesion symptom mapping (VLSM) for each sentence type in each task across all 66 patients. Coinciding with previous studies, the VLSMs identified a significant association between sentence comprehension and a large left temporal-inferior parietal network for all sentences (peak t values were in posterior temporal and inferior parietal voxels); no significant frontal regions were found for any sentence type/task. Our findings suggest that a large left hemisphere network supports sentence comprehension.

## G72

### NEURAL RESPONSES SHOW EFFECTS OF QUANTIFICATION DURING PROCESSING OF AGREEMENT DEPENDENCIES

Nyssa Z. Bulkes[1], Darren Tanner[1]; [1]University of Illinois at Urbana-Champaign — Successful language comprehension requires the integration of grammatical information across words, and in languages like English, this includes processing subject-verb agreement. A goal for psycholinguistic theories of agreement is to specify the range cues used during the formation of agreement dependencies, the mechanisms that establish these dependencies, and the overlap (or divergence) in mechanisms responsible for processing agreement in language comprehension and production. Research on language production using the attraction interference paradigm has shown that plurally-quantified noun phrases (NPs; e.g., "most students") do not elicit a greater number of speech errors than noun phrases with non-number-marked determiners (e.g., "the students"), suggesting that overt quantification provides no stronger cue to plurality than morphological marking on the noun itself. Here we used ERPs to study how quantification impacts comprehension of agreement at the neural level. Native English speakers read sentences that were grammatical or contained a violation of subject-verb agreement, where the subject NP was either overtly quantified or contained an unmarked determiner (e.g., The/most students arrive/*arrives…). Results show a significantly larger P600 effect for ungrammatical verbs following NPs with plural quantifiers versus unmarked determiners. This suggests that, unlike in language production, quantification serves as an additional cue for the encoding and processing of agreement information in comprehension, over and above plural marking on the noun. Our results support recent theories of agreement comprehension that entail both prediction and cue-based retrieval mechanisms, and which argue that agreement processing mechanisms are non-identical in comprehension and production (Tanner et al., 2014).

## G73

### INFLUENCE OF L1-L2 SIMILARITY, AOA, PROFICIENCY, IMMERSION ON L2 SYNTACTIC PROCESSING: AN EMPIRICAL REVIEW ON AVAILABLE ERP RESULTS

Sendy Caffarra[1], Nicola Molinaro[1,2], Doug Davidson[1], Manuel Carreiras[1,2]; [1]BCBL, Basque Center on Cognition, Brain and Language, Donostia, Spain, [2]Ikerbasque, Basque Foundation for Science, Bilbao, Spain — Several factors have been considered influential on how the brain acquires and computes second language grammar (i.e., L2 factors): L1-L2 similarity, age of acquisition (AoA), proficiency, and immersion duration in a L2-speaking community. So far, ERP studies have investigated the impact of each single factor on the time course of L2 parsing without taking into account the relative contribution of all the others. The present work attempts to provide a unified view on this topic by including all the L2 factors in a single empirical review. Forty-one ERP studies on L2 syntactic processing were analyzed in order to establish whether functional specializations of distinct aspects of syntactic processing (i.e., eLAN, LAN, N400, P600) would be equally influenced by the L2 factors or not. Logistic regression was performed on the published ERP results elicited by syntactic violations in L2, including the L2 factors as independent categorical variables. In this way, we identified the relative contribution of each L2 factor on the percentage of published ERP effects. Results showed that a higher number of LAN effects has been reported when immersion in the L2 country lasted more than 5 years, and more P600 effects has been reported at a high level of L2 proficiency. Thus, distinct aspects of syntactic processing are differently influenced by the L2 factors: duration of immersion is particularly influential on early automatic syntactic processes, and proficiency level plays an important role on late controlled processes.

## G74

### MORPHO-SYNTACTIC PROCESSING IN LATE BILINGUALS: CONVERGING EVIDENCE FROM ERPS AND TIME-FREQUENCY REPRESENTATIONS (TFRS)

Yanina Prystauka[1,2], Eleonora Rossi[2]; [1]Center for Mind/Brain Sciences Trento University, [2]Penn State University — One important debate in the bilingualism literature is how grammatical similarity between the native (L1) and second language (L2) impacts the neurophysiological bases of L2 processing. Here, we utilize a novel approach by converging Event Related Potentials (ERPs) and Time-Frequency Representations analyses, to reveal changes of oscillatory neuronal activity over time during morpho-syntactic processing. Specifically, we investigate clitic pronouns processing in native Spanish (n=20) and advanced English-Spanish bilinguals (n=22). Importantly, clitics are a unique Spanish grammatical structure which encodes grammatical gender (a unique L2 feature), and number (shared instead between the two languages). EEGs were recorded while participants read Spanish sentences containing gender and number violations on the clitic. Previous ERPs studies have reported that morpho-syntactic violations elicit a P600 component, while TFR research has related morpho-syntactic processing to oscillatory neuronal activity in the alpha (7-14Hz) and beta frequency (15-30Hz) ranges. Our time-domain results reveal that both groups are sensitive to number violations (as shown by an increased P600), while only a subset of native-like L2 speakers show sensitivity to gender violations. Additionally, the time-frequency analysis reveal that both L1 and L2 Spanish speakers show a decrease in the alpha and beta bands as a response to gender and number violations. However, the magnitude of this decrease is smaller in L2 speakers. Altogether, we provide converging evidence that adult L2 speakers are sensitive to grammatical structures that are not encoded in their native language. Additional analyses will aim to investigate the existence of the inverse relationship between ERPs and TFRs.

## G75

### P600 EFFECTS IN LANGUAGE AND MUSIC

Nicole E. Calma[1], Laura Staum-Casasanto[2], Dan Finer[1], Robbin Miranda[3], Michael T. Ullman[4], John E. Drury[1]; [1]Stony Brook University, [2]University of Chicago, [3]Infinimetrics Corporation, [4]Georgetown University — Whether language/music involve shared/distinct neurocognitive mechanisms remains a topic of debate (Patel 2003, Peretz & Coltheart 2003). In ERP interference studies, interaction patterns involving anterior negativities (LAN/RAN effects) have been found when linguistic/musical syntax are simultaneously disrupted (Koelsch et al 2005), consistent with shared resources. However, whether the mechanisms underlying other ERP components (e.g., N400/P600) may be shared across domains remains undetermined. Our previous work tested familiar and unfamiliar melodies (from Miranda & Ullman 2007) containing musical syntactic violations (out-of-key notes) with simultaneous presentation of sentences containing linguistic-semantic violations ("…the ball John will KICK/#BAKE…"). In that study, P600 effects elicited by simultaneous music-syntactic and linguistic-semantic violations were subadditive when the melody was familiar/known (consistent with shared/overlapping generators). In contrast, unfamiliar/novel melodies in double violations yielded additive P600 effects (consistent with distinct underlying generators). Using the same set of familiar/unfamiliar melodies and correct target sentences, the present study asked whether the same influence of melody familiarity on language/music P600 interactions would arise with linguistic-syntactic violations (e.g., "…the ball John will KICK/*KICKED…"). Strikingly, the same pattern of the influence of familiarity emerged as in our first experiment, showing language/music P600 interactions for familiar melodies only. In light of these data, current models of shared/distinct neural resources for language/music require refinement regarding precisely what is claimed to be shared/distinct between domains.

### G76

**NEURAL ACTIVATION IN CHILDREN WITH AND WITHOUT SPECIFIC LANGUAGE IMPAIRMENTS DURING COMPLEX SENTENCE PROCESSING** Ronald Gillam[1], Nick Wan[1], Sandra Gillam[1], Allison Hancock[1]; [1]Utah State University — Children with and without specific language impairment (SLI) were imaged with Near Infrared Spectroscopy (fNIRS) as they performed complex sentence comprehension tasks. The research question was, "Do children with SLI recruit the same brain areas with the same extent, variability and speed as typically developing, age-matched controls during syntactic processing tasks." Fifteen children with SLI (ages 8;9 to 11;11) and 15 age-matched, typically-developing controls were asked to point to a picture representing the agent in on of 4 types of sentences: SVO, SR, PAS, and OR. Sixty sentences (15 per condition) were pseudo-randomized into 3 blocks of 20 sentences each with an 8 sec presentation and response interval. For the behavioral data, there was a Group main effect, a Condition Main Effect, and a Significant Condition x Group interaction, $F(3,66) = 3.45$, $p < .05$. Children with SLI were much less accurate than the age-matched controls on the noncanonical (PAS and OR) tasks, but they were not reliably slower. For the NIRS data, children in both groups had significantly greater activation in the left inferior parietal lobule for canonical sentences as compared to noncanonical sentences. In addition, children with SLI had significantly greater activation in the left inferior parietal lobule than their typically-developing peers for all sentence types. Children with SLI may be making up for syntactic deficits by activating cortex that is usually associated with controlled attention and procedural memory. These results are consistent with Chomsky's theory of syntactic comprehension and neural inefficiency explanations of SLI.

### G77

**NEURAL CORRELATES OF SYNTACTIC MOVEMENT** Eduardo Europa[1], Cynthia K. Thompson[1]; [1]Northwestern University — Syntactic movement is a psycholinguistic concept referring to the displacement of sentence constituents to argument (NP-movement) or non-argument positions (Wh-movement) within sentences (Chomsky, 1981, 1986, 1995). Previous research has shown that comprehension of complex sentences with Wh-movement (e.g., object-cleft sentences) and NP-movement (e.g., passive sentences) elicits activation in overlapping, but distinct left-lateralized networks that include the inferior frontal gyrus (IFG) and temporoparietal junction (TPJ) (Thompson et al., 2010; Mack et al., 2013). The purpose of this study was to directly compare the neural correlates of these two movement types. Functional MRI data were acquired from 13 healthy adults (mean age=27.7 years, SD=3.3) during comprehension of noncanonical (e.g., passive and object-cleft) and canonical sentences (e.g., active and subject-cleft) via an auditory sentence-picture verification task. Similar to previous studies, a main effect of canonicity was found for noncanonical sentences in bilateral frontal cortex and left TPJ. Wh-movement (object-cleft>subject-cleft) over NP-movement (passive>active) resulted in activation in bilateral IFG and insula and left MFG, however no activation was found for NP-movement over Wh-movement. These results suggest that processing Wh-movement requires greater neural resources than processing NP-movement. These findings are in line with both representational and processing accounts of the two sentence types in that Wh-, but not NP-, movement structures cross clausal boundaries, with moved constituents occupying a non-argument, rather than an argument, position. Wh-movement structures also engage greater working memory demands. Further research is required to clarify the differences between the movement types.

## LONG-TERM MEMORY: Episodic

### G78

**STRATEGIC RETRIEVAL PROCESSES INVOLVED IN ENCODING NEW INFORMATION** David Amadeus Vogelsang[1,2], Zara M. Bergström[3], Charan Ranganath[4,5], Jon S. Simons[1,2]; [1]Department of Psychology, University of Cambridge, Downing Street, Cambridge CB2 3EB, UK, [2]Behavioural and Clinical Neuroscience Institute, University of Cambridge, [3]School of Psychology, Keynes College, University of Kent, [4]Center for Neuroscience, University of California, Davis, [5]Department of Psychology, University of California, Davis — Optimal retrieval of studied information requires goal-directed retrieval orientation to increase retrieval success. However, it is unresolved how orienting retrieval towards different types of information affects the processing of new information that might also be encountered during a memory test phase. We applied subsequent memory analysis to EEG and fMRI data to study how different retrieval orientations influence incidental encoding of new information. Participants encoded information in both a deep semantic and shallow phonological task and were tested in a subsequent blocked memory test to examine how orienting retrieval towards these different types of information influences encoding of new words that were presented as foils during the memory test phase. Despite the fact that the only difference between the foils was the type of information that was targeted during retrieval, recognition memory for foils, assessed in a later second memory test phase, revealed that attempting to retrieve semantic rather than phonological information led to better encoding of new words, resulting in better subsequent recognition of semantic foils than phonological foils. Subsequent memory analysis of EEG data demonstrated that semantic and phonological foils elicited distinct parietal effects during the first memory test. Different patterns of fMRI activity were also observed, enabling a comparison across imaging modalities regarding the spatiotemporal characteristics of the foil recognition effect. The behavioural results converge with the novel neuroimaging data providing further support for the hypothesis that strategically orienting retrieval towards new semantic versus phonological information leads to different neural representations that are predictive of subsequent memory.

### G79

**INTER-INDIVIDUAL DIFFERENCES IN NEURAL CORRELATES OF LONG-TERM MEMORY FORMATION DURING WORKING MEMORY MAINTENANCE** Axel Mecklinger[1], Florian Beier[1], Emma Bridger[1]; [1]Saarland University; Germany — Maintaining information in working memory (WM) can support long-term memory (LTM) formation, particularly during the initial stage of WM maintenance relative to later stages. Disrupting initial stages of WM thus disproportionally impairs subsequent LTM performance (Ranganath et al., 2005). Here we investigated whether this pattern and corresponding event-related potentials (ERPs) interact with individual differences in working memory capacity (WMC), given that individuals with higher WMC should have more resources for LTM formation during WM tasks (Unsworth & Engle, 2007). Brain potentials were recorded from high (n=15) and low (n=13) WMC individuals processing a visual delayed-match-to-sample task, with an interference task which disrupted either the early or late delay phase. In a subsequent surprise recognition task, both groups showed enhanced LTM performance for the late compared to the early interference condition, as well as a centrally-distributed late ERP old/new effect, the putative neural correlate of recollection. During WM maintenance, the high WMC group revealed sustained occipitally-distributed positive slow wave activity which was larger for items subsequently remembered in the recognition task than forgotten items. For the high WMC group this effect was present in the early but not in the late interference condition. For low WMC individuals it was absent in both interference conditions. These results provide general support for dual stage models of WM maintenance. They also indicate that different processes supporting LTM formation are engaged in individuals with high relative to low WMC particularly during early stages of WM maintenance which are of high relevance for successful LTM formation.

### G80

**MOOD INFLUENCES THE SELECTIVITY OF SLEEP-DEPENDENT MEMORY CONSOLIDATION** Aaron L. Grady[1], Christopher A. Hawkins[1], Haleigh Winfrey[1], Maria Czyzewska[1], Carmen E. Westerberg[1]; [1]Texas State University — Long-term memory is selective. Whereas some memories appear to last a lifetime, others are soon forgotten. It is hypothesized that covert reactivation of specific memories during sleep facilitates consolidation of these memories and contributes to this selectivity. Here, we tested whether mood could influence the selectivity of sleep-dependent consolidation. Half of the participants were assigned to the sad group and the other half to the happy group. After listening to a short story that included both happy and sad events in a neutral mood, participants then listened to music while imagining themselves in various scenarios to induce either a happy or a sad mood. Mood assessments obtained before and after the induction proce-

dure confirmed its effectiveness. Participants then took a 90-min nap while mood-consistent music was played to reactivate the previously induced mood state (happy or sad). Upon waking, free recall for story events was tested, and a final mood assessment indicated that mood had returned to a neutral level for both groups at recall. Participants in the sad group recalled significantly more sad events than happy events, whereas the happy group recalled an equivalent number of happy and sad events. Furthermore, in the sad group, multiple aspects of sleep physiology predicted the extent of sad events recalled upon waking, implicating sleep-dependent consolidation in the memory facilitation for sad events. These results suggest that mood state can influence which memories gain access to sleep-dependent consolidation processes, and could have implications for understanding and treating mood disorders.

## G81

### CHRONIC MEDIA MULTITASKING AND DISTRACTION: NEURAL SUBSTRATES AND MNEMONIC CONSEQUENCES

Melina Uncapher[1], Monica Thieu[1], Anthony D Wagner[1,2]; [1]Dept of Psychology, Stanford University, [2]Neurosciences Program, Stanford University — Chronic multitasking with media has been associated with various cognitive differences, including poor distractor filtering and reduced use of top-down goal information. Recent data further indicate that heavy media multitaskers' (HMMs) deficits in working memory (WM) extend to long-term memory (LTM). At present, the neural bases of media multitasking-related cognitive differences is not yet known. Here we investigated media multitasking-related differences during perceptual filtering, and whether these differences influence neural encoding of LTMs. We tested the hypothesis that HMMs, relative to light MMs (LMMs), are more heavily biased toward bottom-up attention capture of irrelevant information, reducing the fidelity of relevant information in WM and LTM. FMRI data were collected while 40 participants (HMMs=20, LMMs=20) performed a semantic decision task on visually presented words in the presence of occasional distracting images. Participants were later given a surprise recognition memory test for target words and distractor images. Univariate analyses revealed that the ventral frontoparietal network associated with the bottom-up capture of attention was more reactive in HMMs; specifically, left temporoparietal junction (TPJ) was more active in the presence of distractors in HMMs relative to LMMs. Furthermore, HMMs' susceptibility to distraction had carry-forward consequences for long-term memory (LTM): HMMs showed reduced memory for the target information encountered during the semantic decision task. Together these findings suggest that heavy media multitaskers' susceptibility to distraction may derive from a more reactive ventral attention network, thus yielding lower fidelity perceptual representations of relevant information, which in turn lead to lower fidelity LTM representations.

## G82

### HIPPOCAMPAL AND MEDIAL PREFRONTAL CONTRIBUTIONS TO ITEM AND CONTEXT MEMORY OVER TIME

Maureen Ritchey[1], Andrew P. Yonelinas[1], Charan Ranganath[1]; [1]University of California, Davis — A contentious issue in memory research is whether hippocampal and neocortical contributions to episodic retrieval change as memories age. Some models predict that hippocampal involvement will decrease over time whereas neocortical contributions (such as in medial prefrontal cortex, or mPFC) will remain stable or even increase over time. However, it is unclear whether delay effects might be related to differences in the retention of context information in memory. In this study, we used fMRI to compare hippocampal and mPFC contributions to immediate and one-day delayed retrieval, measuring responses during item recognition and the discrimination of intact and recombined context associations. The results showed that both the anterior hippocampus and mPFC were involved in item recognition immediately and after a delay, whereas the posterior hippocampus was involved only immediately. The anterior hippocampus additionally showed activity that discriminated between intact and recombined associations during both tests, whereas the medial PFC discriminated among context associations only after a delay. These findings suggest that the anterior and posterior hippocampus play different roles in item recognition over time. In addition, delay-dependent changes in mPFC involvement are not common across all forms of memory, but rather, context retrieval in particular may become increasingly dependent on mPFC representations over time.

## G83

### PERSONAL SEMANTICS ARE DISTINCT FROM EPISODIC AND SEMANTIC MEMORY: AN ELECTROPHYSIOLOGICAL STUDY OF MEMORY FOR REPEATED EVENTS AND AUTOBIOGRAPHICAL FACTS.

Louis Renoult[1], Annick Tanguay[2], Myriam Beaudry[2], Paniz Tavakoli[2], Sheida Rabipour[2], Kenneth Campbell[2], Morris Moscovitch[3], Brian Levine[3], Patrick S.R. Davidson[2]; [1]University of East Anglia, UK, [2]University of Ottawa, Ontario, Canada, [3]Rotman Research Institute, Baycrest, Toronto, Ontario, Canada — Declarative memory consists of two independent systems: episodic and semantic memory. Episodic memory represents memories of personal and contextually unique events, while semantic memory represents culturally-shared and acontextual factual information. Intermediate forms of memory such as memories of repeated personal events (RE) and of personal facts (PF) are commonly referred to as personal semantics but have been studied little and rarely compared to both semantic and episodic memory. Event-related potentials (ERPs) were recorded in 27 participants while they verified the veracity of sentences probing the 4 types of memory: general (semantic) facts, PF, RE, and unique (episodic) events. Behavioral results showed equivalent reaction times in all 4 conditions. True sentences were verified faster than false sentences, except for unique events for which no significant difference was observed. Electrophysiological results showed that the N400, associated with retrieval from semantic memory, was maximal for general facts, intermediate for PF and RE, and minimal for unique events. A mirrored pattern was observed for the LPC, associated with retrieval from episodic memory: it was maximal for unique events, intermediate for personal facts and repeated events, and minimal for general facts. RE and PF did not differ significantly from each other but their corresponding scalp distribution differed from those of general facts and unique events. Our results show that the neural correlates of AF and RE can be dissociated from those of semantic and episodic memory but that these two forms of personal semantics generate similar patterns of brain activity in a sentence verification task.

## G84

### HOW THE MTL REPRESENTS SPATIAL AND TEMPORAL CONTEXTS: A HIGH-RESOLUTION MRI INVESTIGATION

Halle Zucker[1], Maureen Ritchey[1], Arne D. Ekstrom[1], Andy P. Yonelinas[1], Charan Ranganath[1]; [1]University of California, Davis — Theories of medial temporal lobe (MTL) function suggest that the hippocampus supports memory for item-context associations, but the roles of different hippocampal subfields remain controversial. It is debated whether subfields support memory via pattern completion and separation processes involving differential coding for spatial versus temporal contexts in CA3 and CA1 or if both subfields participate similarly in spatial and temporal contextual representation. In this study, we used high-resolution imaging to investigate how MTL subregions code for spatial and temporal information during episodic memory retrieval. Participants engaged in a virtual reality encoding task where they learned 200 unique objects in one of two spatial contexts. At encoding, trials were divided into 20 lists (temporal contexts). We then used high-resolution (1.5 mm isotropic voxels) fMRI during an object recognition test to assess activity related to recollection of the context associated with each studied object. Additionally, participants completed a spatial source memory task to validate subjective recollection decisions. Object-recognition accuracy approached 75%, and objects rated as recollected were associated with higher source accuracy. Preliminary fMRI analyses revealed enhanced activation throughout the MTL for correctly recognized items. Further analyses will use a multivariate pattern similarity approach to reveal the extent to which spatial versus temporal context is associated with specific subfields or shared patterns across subfields.Thus, we will test the prediction that both CA3/DG and CA1 carry information about spatial and temporal contexts versus that CA3/DG codes for information about spatial context and CA1 temporal context.

## G85

### INVESTIGATING THE ARCHITECTURE OF SHORT-TERM MEMORY IN SEVERELY AMNESIC PATIENTS WITH HIPPOCAMPAL DAMAGE

David E. Warren[1], Melissa C. Duff[1], Daniel Tranel[1]; [1]University of Iowa — Hippocampal damage is widely believed to produce focal long-term memory

deficits, but recent investigations indicate that hippocampal damage can also impair performance on tasks that do not explicitly require long term memory. In particular, hippocampal damage may reduce the probability that information can be retained even across very short delays (Warren et al., 2014). To investigate this further, we tested the performance of hippocampal amnesic patients (N=4), patients with left temporal lobectomies affecting hippocampus (LTL; N=3), brain-damaged comparison participants (BDC; N=10), and healthy normal comparison participants (NC; N=10) using a short-term memory task. The task was adapted from previous work (Nee & Jonides, 2011), and tested memory for short word lists (6 words/list) presented serially and rapidly (500 ms/word). Recognition memory for a probe word was tested 300 ms after the final word. We analyzed recognition performance as a function of the probe's serial position, and found that severely amnesic participants with bilateral hippocampal damage had reduced recognition performance (measured with d') whether all serial positions were considered (p=0.01) or only the most recent three (p=0.02). Intriguingly, left temporal lobectomy including hippocampus did not reduce performance to the same extent. These results are consistent with the proposition that bilateral hippocampal damage reduces the probability that recently studied information is available at later test, even when memory loads are low and study-test intervals are very short. If upheld, these findings would suggest that hippocampus contributes to on-line task performance, which has implications for theories of memory, aging, and neurological disease.

## G86

### ADAPTIVE TASK DIFFICULTY INFLUENCES FUNCTIONAL NEUROPLASTICITY IN COGNITIVE TRAINING

Kristin Flegal[1], J. Daniel Ragland[1], Charan Ranganath[1]; [1]University of California, Davis — Progress in cognitive training research requires a mechanistic understanding of the factors that promote transfer of training gains, and their relationship to cognitive and neural plasticity. Adaptive task difficulty is a potential mediator of training and transfer effects, as adaptivity is predicted to facilitate more efficient processing by creating a prolonged mismatch between the supply of, and the demand upon, available neural resources. This hypothesis was tested in a study consisting of 3 weeks of computerized working memory updating (WMU) training, with pre-, early-, and post-training fMRI sessions including untrained WMU (near transfer) and episodic memory (far transfer) tasks. Participants were assigned either to an Adaptive training condition, in which practiced WMU tasks dynamically increased in difficulty, or to a Non-Adaptive active control condition. Participants additionally completed a battery of untrained transfer tasks pre- and post-training. Behavioral data showed that participants in both conditions improved on untrained WMU tasks, but transfer effects were significantly larger on an episodic memory task following adaptive than non-adaptive training. Furthermore, training gains within the Adaptive condition were significantly associated with larger transfer effects to unpracticed WMU tasks. fMRI analyses indicated that striatal activation decreases in a trained WMU task were significantly larger for adaptive than non-adaptive training, and training gains within the Adaptive condition were significantly associated with hippocampal activation changes in untrained transfer tasks. Results from this study relate adaptive task difficulty to broader transfer of training gains—including far transfer to episodic memory—and greater functional neuroplasticity.

## G87

### BASAL CORTISOL LEVELS AND STRESS-INDUCED CORTISOL RESPONSES ARE DIFFERENTIALLY RELATED TO PROCESSES UNDERLYING RECOGNITION MEMORY

Andrew M. McCullough[1], Maureen Ritchey[1], Charan Ranganath[1], Andrew P. Yonelinas[1]; [1]University of California, Davis — It is well established that stress can affect memory processing, and these effects are mediated in part by cortisol levels. Yet very different relationships have been observed between cortisol and memory across studies. Understanding exactly how cortisol levels and stress influence memory-related processes has broad implications for research domains including post-traumatic and chronic stress, as well as age-related memory deficits. Previous work suggests that recognition memory performance is supported by recollection and familiarity, processes that have distinct neural substrates, and thus which may be differentially influenced by stress and cortisol. We examined the effects of post-encoding stress on recognition memory using a cold-pressor task, and measured cortisol levels before and after the encoding and stress tasks. Memory was tested 24 hours after encoding. Hierarchical regression analyses revealed that basal cortisol levels were negatively related to estimates of recollection (r2 = .14) and familiarity (r2 = .07). In contrast, the magnitude of cortisol response to stress was differentially related to recollection and familiarity estimates, such that recollection had an inverted-U relationship with the magnitude of cortisol response (r2 = .19), while familiarity estimates increased linearly with the cortisol responses (r2 = .07). This dissociation of the effects of cortisol on recollection and familiarity is likely related to different properties of the brain regions underlying those processes, and it suggests that one source of mixed evidence in the literature is the varying degree to which different memory tests are supported by recollection and familiarity.

## G88

### FUNCTIONAL CONNECTIVITY-BASED PARCELLATION OF THE HUMAN MEDIAL TEMPORAL LOBE

Shao-Fang Wang[1], Maureen Ritchey[1], Laura A Libby[1], Charan Ranganath[1]; [1]University of California at Davis, Davis, CA 95618, USA — Regional differences in large-scale connectivity have been proposed to underlie functional specialization along the anterior-posterior axis of the hippocampus and parahippocampal gyrus (PHG). However, it is unknown whether functional connectivity can be used reliably to parcellate the hippocampus and PHG into discrete functional units. The current study aimed to differentiate subregions of the hippocampus and PHG based on whole-brain resting-state functional connectivity. Functional connectivity maps were calculated for each slice along the longitudinal axis of the PHG and hippocampus. A hierarchical clustering algorithm was then applied to these data in order to group slices according to the similarity of their functional connectivity profiles. In the PHG, three discrete clusters were identified. Two of the clusters corresponded to parahippocampal and perirhinal cortex, and these regions showed preferential connectivity with previously described posterior-medial and anterior-temporal networks, respectively. The third cluster corresponded to an anterior perirhinal region that exhibited preferential connectivity with auditory cortical areas and also with a network involved in visceral processing. In the hippocampus, three clusters approximately corresponding to hippocampal head, body, and tail were identified, but differences in whole-brain connectivity between these clusters were more graded than differences observed between PHG clusters. These results indicate that connectivity-based methods can be used to parcellate regions within the MTL. Further analyses will test for task-related functional differences among these regions.

## G89

### TEMPORAL CHARACTERISTICS OF EPISODIC MEMORY FORMATION INVESTIGATED THROUGH REPETITIVE TRANSCRANIAL MAGNETIC STIMULATION.

Giulia Galli[1,2], Matteo Feurra[2,3], Enea Francesco Pavone[2,4], Simone Rossi[2]; [1]Kingston University (UK), [2]Azienda Ospedaliera Universitaria Senese (Italy), [3]Moscow Higher School of Economics (Russia), [4]Fondazione Santa Lucia, IRCCS (Italy) — Successful memory formation relies on brain activity set in train immediately before and during the encoding of an information or event. However, the impact of post-stimulus processing on successful encoding is still largely unknown. In this study, we used an interference approach with repetitive Transcranial Magnetic Stimulation (r-TMS) to assess whether post-stimulus processing is relevant for the formation of a long lasting, episodic memory trace. During memory encoding, we delivered r-TMS at different time intervals after stimulus presentation, and assessed memory performance in a subsequent memory test. In a between subjects design, r-TMS at different time intervals was delivered either to the dorsolateral (DLPFC) or to the ventrolateral (VLPFC) prefrontal cortex, which have both been implicated in memory formation as shown by fMRI studies. In addition, in order to vary the strength of the memory trace, we used a Levels of Processing approach. The results showed that when r-TMS was applied immediately after stimulus offset, subsequent memory performance was significantly impaired. This finding was evident for stimuli learnt under deep encoding conditions, and when the brain stimulation was delivered to the VLPFC. These findings suggest that, at least for strong memory traces, post-stimulus processing in the VLPFC is crucial for memory formation, perhaps even more than online processing. Post-stimulus processing may involve unintentional rehearsal that occurs

immediately after stimulus offset and affects the likelihood that the stimulus is later remembered, as suggested by an influential model of memory formation.

## G90

### VISUALS MAKE NARRATIVES MORE MEMORABLE AND EFFECTIVELY DRIVE BRAIN RESPONSES

Samantha Cohen[1], Jason J. Ki[2], Lucas C. Parra[2]; [1]The Graduate Center at the City University of New York, [2]The City College of New York — In our media dominated culture narratives are increasingly communicated with images that illustrate their contents. We wondered to what extent do audiovisual presentations facilitate memory for the contents of a story. We hypothesized that visual context added to an auditory narrative will more effectively drive brain responses and therefore result in improved recall. To test this we presented autobiographical narratives with and without accompanying animations and measured electro-encephalographic responses, and subsequently tested recall of factual information 3 weeks later. We found that audiovisual narratives were recalled more effectively than the identical story presented as audio alone for all 10 stories tested. Surprisingly, this benefit was equally strong when the animations were scrambled in time. As predicted, these benefits correlated strongly with the reliability of brain responses across subjects. Indeed, those subjects, among the 43 we recorded, who showed more reliable responses also recalled story elements better. A possible explanation for these results is that audiovisual stimuli effectively engage attention making the story more memorable, even when the visuals do not contribute any factual information.

## G91

### THE ENCODING–RETRIEVAL MATCH PRINCIPLE AND THE DIAGNOSTIC VALUE OF THE RETRIEVAL CUE: AN EVENT-RELATED POTENTIAL (ERP) STUDY

Inês Bramão[1], Mikael Johansson[1]; [1]Department of Psychology, Lund University, Sweden — The present study investigated conditions yielding beneficial effects of context on episodic memory retrieval. An influential idea in the literature is that memory performance benefits when a retrieval cue matches contextual features of the originally encoded episode. However, recent studies suggest that what improves memory performance is not the encoding-retrieval match per se, but instead the presence of diagnostic features in the retrieval context that help to discriminate the target memory from competing memories. To test this prediction, we constructed a novel paradigm where the diagnostic value of the context and the encoding-retrieval match were manipulated in an associative recognition memory task. Participants were asked to memorize pairs of words presented together with a unique or a non-unique background photograph of outdoor scenes (i.e. diagnostic versus non-diagnostic contexts). At test, participants were asked to recognize the word pairs in the presence or absence of the previously encoded contexts. Behavioral data showed that memory performance improved in the presence of the original context, but importantly, only when the contextual cues were diagnostic of the target memory trace. The electrophysiological data mirrored this finding and showed an encoding-retrieval match effect in ERPs associated with diagnostic contextual cues, but not in the ERPs associated with non-diagnostic contextual cues. Taken together, the present results underscore the importance of the diagnostic value of the retrieval cue, and further suggest that the typically observed beneficial effects of an encoding-retrieval match may be impeded due to interference from competing episodic memories.

## G92

### STATES OF CURIOSITY BENEFIT LATER RECOLLECTION OF INCIDENTAL INFORMATION

Matthias Gruber[1], Yonelinas Andrew[2], Ranganath Charan[1]; [1]Center for Neuroscience, UC Davis, USA, [2]Department of Psychology, UC Davis, USA — In everyday life, learning is often driven by curiosity, but the neurocognitive mechanisms of how curiosity affects learning are poorly understood. In a recent study (Gruber et al., 2014, Neuron), participants showed improved recall of information that they were curious about, and also enhanced recognition accuracy for incidental, unrelated faces learned during states of high curiosity. The findings suggest that high-curiosity states might be conducive to learning of even neutral information. Additional fMRI findings indicated that the SN/VTA and hippocampus support such incidental memory benefits. However, the previous study could not address which specific type of memory underlies curiosity-related recognition benefits for incidental information. Here, in a series of behavioral experiments, we ask how recollection and familiarity contribute to such curiosity-driven memory enhancements. First, participants rated their curiosity on a series of trivia questions. Then, participants learned the answers to selected trivia questions. A trial started with the presentation of a trivia question and participants anticipated the associated answer during a delay. Critically, an unrelated face stimulus was presented during this anticipation period. In this way, participants incidentally encoded faces during high- and low-curiosity states. Then, memory for the faces was tested by using a modified Remember/Know recognition memory test allowing us to dissociate between recollection- and familiarity-based recognition memory. Preliminary analyses revealed that curiosity-driven memory benefits are supported by recollection rather than familiarity. Further analyses will investigate the content and temporal characteristics of curiosity-driven memory benefits for incidental information.

## G93

### ENCODING AND RETRIEVAL CONTRIBUTIONS TO MEMORY ERRORS

Lisa A. Solinger[1], Elizabeth F. Chua[1,2]; [1]Brooklyn College of the City University of New York, [2]The Graduate Center of the City University of New York — We used eye tracking and functional magnetic resonance imaging (fMRI) to test the hypothesis that irrelevant binding at encoding is associated with hippocampal activity and subsequent memory errors, and retrieval monitoring and decision processes are needed to avoid these errors. Using a paradigm that resembles the board game, Memory, participants studied pairs of objects presented in a 4x5 grid of 20 "cards" and, like the board game, were instructed to remember where matching cards were located and, unlike the board game, to remember which cards were turned over at the same time. At test participants were shown a probe card and were asked either, to find the "matching card", or to find the card that they had studied at the "same time" as the probe. Preliminary analyses of same time trials show that correctly choosing the same time card and incorrectly choosing the matching card showed greater activity in the right medial temporal lobe (MTL) compared to choosing a distractor card, indicating similar encoding activity for trials that later led to hits and lures but not for misses. At retrieval, correctly choosing the same time card showed greater activity in posterior parietal cortex compared to incorrectly choosing the matching card, indicating task appropriate retrieval processes that are important for avoiding memory errors.

## G94

### AN ERP INVESTIGATION OF THE NEUROCOGNITIVE MECHANISMS UNDERLYING THE SPACING EFFECT

Alice S.N. Kim[1,2], Audrey M.B. Wong Kee You[1], Binh Tam Le[2], Melody Wiseheart[1], Sylvain Moreno[2], Shayna Rosenbaum[1,2]; [1]York University, [2]Baycrest Hospital — In healthy and patient populations, episodic memory benefits from the spacing effect, where longer intervals (intervening items) between study repetitions enhances long-term retention compared to massed repetition. However, few studies have investigated the mechanisms underlying this effect. In this study, two groups of 15 healthy, young adults were tested in an ERP experiment, during which participants were instructed to learn pairs of words for a subsequent memory test. Each group performed one of two encoding tasks, which either required study-phase retrieval or not. During the study phase, repeated pairs were separated by 0, 4, or 12 intervening pairs, corresponding to a massed condition and two levels of spacing, respectively. During the test phase, participants were tested on paired-associate recall. Between-group analyses indicated no differences in memory performance or ERP data for the two encoding task groups. Data from the two groups were thus collapsed for all subsequent analyses. A repeated-measures ANOVA demonstrated a significant effect of spacing on memory performance. Post-hoc analyses showed significant improvement in memory performance as spacing levels increased from 0 to 4, as well as 0 to 12, intervening pairs. For the ERP data, the results of a partial least square analysis revealed a significant effect of spacing that was most salient over the right frontal scalp region. Larger spacing intervals (spacing levels 4 and 12) resulted in ERP patterns that were more similar to ERPs elicited by the original presentation of a pair compared to its immediate repetition, suggesting a potential role of neural fatigue.

### G95

**EYE MOVEMENTS TO NOTHING SUPPORT MEMORY RETRIEVAL IN THE BRAIN.** Richard Dewhurst[1], Roger Johansson[1], Ines Bramão[1], Mikael Johansson[1]; [1]Lund University, Sweden — A combined Event-Related Potential and Eye Tracking experiment is described, with the aims of elucidating the neural components subserving so called "looking at nothing" effects on memory retrieval (e.g. Richardson, Altmann, Spivey, Hoover, 2009, Johansson & Johansson, 2014). Participants performed a visual encoding task designed to establish a deep episodic memory trace. They inspected an array of 24 objects and were asked to remember as much as possible about their spatial arrangement. In a subsequent retrieval phase participants were auditorily probed regarding the locations of the memorised objects. Critically, they fixated within a now blank region of the display, either congruent to the objects' original location, or spatially dislocated and incongruent. The results demonstrate that the facilitatory behavioural effects of eye movement congurency, can be mapped onto the modulation of posterior ERP slow waves, previously suggested to be associated with re-construction and monitoring of episodic memory representations (e.g. Johansson & Mecklinger, 2003). We argue that episodic memory retrieval is an aspect of cognition embodied by eye-movements, not merely in an epiphenomenal sense. Looking at the right location gives rise to a greater overlap between encoding-, and retrieval-related neural activity, consequently boosting memory performance in line with the encoding-retrieval match principle (cf. Rugg, Park, & Uncapher, 2008) . To our knowledge, this if the first demonstration of the neural profile of memory enhancement driven solely by fixation location, in the absence of visual input.

### G96

**ERP CORRELATES OF EPISODIC CONTEXTUAL RETRIEVAL** Marty Fiati[1], Peter Bright[1]; [1]Anglia Ruskin University — Increasingly a small number of regions within the parietal lobe referred to as the posterior parietal cortex (PPC) have been implicated in episodic recollection. Involvement of the PPC has been closely associated with successful memory recognition, and it has been found to further support retrieval of fine multi-sensory features within an episode. Late positive-going Event-Related Potentials (ERPs) arising from similar posterior parietal sites have typically been associated with successful memory recollection, and the magnitude of these has also been suggested to reflect binding of contextual information specified within an episode. In the current study, ERPs were recorded while participants performed an episodic retrieval task in which they first identified previously studied (Old) faces, and subsequently made binary context-based source judgements denoting the location (left/right), voice (male/female), and study task (pleasantness rating/celebrity judgement) that they had associated with each face at study. The ERPs for presentations of Old faces were separated according to the accuracy of source judgements for the different contexts, and were compared to ERPs of new faces. Source recollection was associated with a late positivity (450ms-800ms) maximal over centro-parietal sites. The prediction that the magnitude of the parietal positivity reflected source binding at retrieval was tested by comparing ERPs according to the number of accurate source memory judgments for each face. Findings suggested that the differences between parietal ERPs co-varied with number of source retrievals, supporting predictions, and furthermore they did not vary with sensory modality of the retrieved contexts.

### G97

**CUED-RECALL PERFORMANCE AND RESTING-STATE FUNCTIONAL CONNECTIVITY** Tanya Jonker[1], Jonathan Smallwood[2]; [1]University of Waterloo, [2]University of York — In the present study, we examined the functional connectivity underlying correct responding on a cued-recall test using category-exemplar word pairs. We related individual differences in correct memory to resting-state functional connectivity maps, using the default mode network hubs as seed regions. We found that accuracy on the cued-recall test was related to (1) decoupling between the hippocampal formation and the parietal cortex, and (2) stronger connectivity between the hippocampal formation and the medial prefrontal cortex. These results illustrate the functional architecture that supports effective episodic retrieval and implicate the default mode network as a core neural system that supports this basic aspect of human cognition.

## METHODS: Electrophysiology

### G98

**FACILITATION OF VISUAL SEARCH RESPONSE TIMES THROUGH ANODAL AND CATHODAL TRANSCRANIAL DIRECT CURRENT STIMULATION IS DEPENDENT ON THE VISUAL QUALITY OF THE STIMULUS** Kyongje Sung[1], Laura Bosley[1], Barry Gordon[1]; [1]The Johns Hopkins University School of Medicine — Transcranial direct current stimulation (tDCS) has been shown to modulate neuronal activity. The effect of tDCS in the visual domain has been conceptualized as either amplification (with anodal current) or attenuation (with cathodal current) of the neuronal representations of stimuli. Given this construct, we tested the hypothesis that tDCS during visual search would interact with target presence, task difficulty, or visual quality of stimulus, which all modulate sub-processes of visual search and resulting RTs. In experiment 1, in three sessions, healthy adults (n=12) performed two identical search tests with target presence and task difficulty factors. In each session, the first test was a baseline sham and the second test was either anodal, cathodal, or another sham stimulation. The effect of tDCS was measured by the RT difference between the two tests. Only the anodal tDCS significantly reduced mean search RTs in experiment 1. There was no interaction between anodal stimulation and other task factors. In experiment 2 (n=16), we introduced visual quality manipulation (dim vs bright) and tried to replicate the finding of experiment 1. Experiment 2 produced the same result with bright stimuli. However, when the stimulus quality was poor, cathodal stimulation also improved search RTs, indicating a significant interaction between type of tDCS and stimulus quality. These findings suggest that the notion that anodal/cathodal tDCS leads to amplification/attenuation of representations is an oversimplified one. The electrophysiological mechanisms associated with reverse polarities of stimulation may be more similar than has been assumed.

### G99

**CORTICAL RESPONSES TO TRANSCRANIAL MAGNETIC STIMULATION DURING NON-RAPID EYE MOVEMENT SLEEP** Olivia Gosseries[1], Jaakko O. Nieminen[1], Francesca Siclari[2], Melanie Boly[1], Adenauer Casali[3], Bradley R. Postle[1], Marcello Massimini[3], Giulio Tononi[1]; [1]University of Wisconsin-Madison, [2]University Hospital of Lausanne, [3]University of Milan — Transcranial magnetic stimulation coupled to electroencephalography (TMS-EEG) allows for directly and non-invasively stimulating the brain and recording the subsequent cortical response. Previous TMS-EEG studies have shown clear-cut differences between conscious and unconscious conditions. When subjects are unconscious, as in non-rapid eye movement (NREM) sleep early in the night (stage N3), anesthesia or coma, TMS typically triggers a stereotypical and local slow-wave response. When they are conscious, as in normal wakefulness and rapid eye movement sleep (REM) sleep, brain responses to TMS are long-lasting, widespread, complex, and differentiated. In this study, we performed TMS-EEG during NREM sleep in stage 2 (N2) and N3 on 7 healthy participants. Brain activity was recorded using a 60-channel TMS-compatible EEG and single-pulse TMS was applied (up to 285 pulses per session) on the superior parietal cortex. After each TMS session (5 to 15 sessions per night), subjects were awakened to ask for a dream report. TMS-EEG responses were analyzed using the global mean field amplitude (GMFA), the perturbational complexity index (PCI), as well as time-frequency measures. Our results show that the TMS-EEG response during N3 is larger and slower than during N2 sleep. The GMFA is higher and PCI is lower in N3 as compared to N2 sleep. Moreover, N3 recordings showed activation at lower frequency bands after TMS as compared to N2 sleep. Additionally, TMS-EEG responses vary depending on whether subjects do or do not report a dream. TMS-EEG might provide valuable information for characterizing neurophysiological fluctuations and levels of consciousness within NREM sleep.

### G100

**EVALUATION OF A BRIEF NEUROMETRIC ASSESSMENT FOR THE GENERATION OF ELECTROPHYSIOLOGICAL PROFILES IN A SAMPLE OF OLDER ADULTS WITH MILD COGNITIVE IMPAIRMENTS** Emily Cunningham[1], Paul Kieffaber[1]; [1]College of William and Mary — The amount of time necessary to assess an individual along multiple elec-

trophysiological dimensions poses a significant limitation to the utility of event-related-potential- (ERP-) based assessments in clinical settings. Kappenman and Luck (2011) have posited a solution to this problem, demonstrating the feasibility of assessing multiple independent ERP components in parallel within a single task. Building on this work, we have developed a tool for brief, extensive electrophysiological assessment. The primary aim of the current study was to evaluate the feasibility and utility of this task in the assessment of a sample of older adults with mild to moderate levels of cognitive impairment (N = 30). Participants completed a simple computerized task, approximately 25 minutes in duration, which was designed to elicit up to 9 ERPs (frequency MMN, gap MMN, P50 suppression, C1, N2pc, visual MMN, P3, ERN, and LRP), and included measurement of eyes-open and eyes-closed resting state activity. This task was well-tolerated in the older adult sample, and allowed successful generation of multidimensional profiles of electrophysiological activity. Results demonstrate that these profiles may be used to successfully differentiate between individuals at different levels of cognitive impairment, and preliminary analyses of these profiles in conjunction with neuropsychological and volumetric data support the potential utility of this design in the identification/characterization of groups or individuals.

## G101

### SPECTRAL WHITENING INFLUENCES OSCILLATORY DYNAMICS AND BEHAVIOR IN HUMANS

Torben Noto[1], Bradley Voytek[2]; [1]UCSD, [2]UCSD

— Neural oscillations play a critical role in many brain functions, including perception, memory, executive functioning, and emotion. The scale over which neural oscillations operate spans the microscale local field potential (LFP) of a local neuronal population to the macroscale electrocorticogram (ECoG) and electroencephalogram (EEG). Oscillations have proved to be a fundamental component of neural communication and network coordination, putatively through their interactions with local population spiking activity via spike/field or phase/amplitude coupling (PAC). Importantly, population spiking and the oscillatory frequency of a neuronal population can be different from the spiking frequency of individual neurons in the neural region generating the oscillation, however the interrelationship between oscillatory coupling and PAC remains unclear. Across several datasets, collected from multiple investigators—ranging from whole-cell patch clamp with concurrent LFP to human subdural ECoG—we find that temporally de-correlated spiking activity: 1) Is associated with a "flattening" (whitening) of the LFP and ECoG power spectral density; 2) Reduces phase amplitude coupling; and, 3) Biases perceptual behaviors such that ongoing shifts in the spectral shape predict trial-by-trial response times. These results are supported by computational modeling and single-unit in vivo patch-clamp and LFP data. Thus, we have outlined a pathway by which spiking connects the biology of oscillatory mechanics to complex behaviors in humans.

## G102

### SLEEP OSCILLATIONS AND THEIR RELATIONSHIP TO COGNITION IN 3.5 AND 6.5 MONTH OLD NAPPING INFANTS

Sue Peters[1], Silvia Ortiz-Mantilla[1], April A. Benasich[1]; [1]Center for Molecular and Behavioral Neuroscience, Rutgers University - Newark

— Sleep rhythms are thought to play an integral role in infant brain development. Variability in sleep patterns may serve as early biomarkers for several neurodevelopmental disorders. Two promising potential predictors are the spectral microstructure components of spindles and slow wave activity (SWA). These components have been proposed as electrophysiological measures of brain maturation, and have been linked to cognitive measures in school-aged children, adolescents, and adults. The present study aims to characterize the microstructure of non-REM daytime sleep, including slow wave and spindle neurophysiology and topography, using both cross-sectional and longitudinal groups of typically developing infants at 3.5 and 6.5 months. Infant sleep dEEG data (124 channels) were collected and analyzed using Matlab toolboxes (i.e. SPM, FASST, EEGLAB). Concurrent standardized tests designed to measure infant cognitive and language development were administered. Twenty-eight sleep sessions were scored for NREM sleep stages using EEG and behavioral data. Spectral analysis of NREM 2/3 sleep stages was completed on eight topographical regions, using spectral decomposition. The occipital SWA power was higher than the frontal power at both ages. There was a significant maturational increase in temporal theta power, which may be representative of the auditory cortical acoustic mapping that occurs during the first year of life. A significant positive correlation between the temporal theta amplitude and the cognitive score was seen at 3.5 months, and may represent hippocampal activity. This research may lead to more detailed studies of sleep microstructure including temporally-bounded sensory information processing and possible links to emerging language and cognitive abilities.

## G103

### FRONTAL LOBE EEG ASYMMETRY AND GENERALIZED ANXIETY DISORDER

Amanda Ng[1], Mark Geisler[1]; [1]San Francisco State University

— Previous research has shown that individuals with depression exhibit a frontal lobe asymmetry when performing non-stimulating tasks (Schaffer, Davidson, & Saron, 1983; Henriques & Davidson, 1991; Davidson, Marshall, Tomarken, & Henriques, 2000). The left frontal lobe may specialize in the expression of positive emotions and the propensity to engage in approach behaviors, while the right frontal lobe may specialize in negative emotions and withdrawal behaviors (Davidson, 1998). The current study examined whether this frontal asymmetry was apparent for individuals with high or low Generalized Anxiety Disorder (GAD) symptoms when they performed tasks that induce anxiety versus relaxation. We predicted there would be reduced alpha power resulting in greater activation of the right frontal lobe after completing an anxiety inducing task compared to a relaxation task. Anxiety was induced with the Paced Auditory Serial Addition Task (PASAT) while relaxation was induced with a meditation task. Participants also completed 2 minutes of Eyes Open (EO) and 2 minutes of Eyes Closed (EC) three times during the experiment. The conditions were counterbalanced among the participants. Participants performed these five tasks while EEG (F3, F4, and eye movement artifact) was recorded continuously. Analysis included ten 1-second epochs from each condition. Preliminary results showed greater activation of the right frontal lobe compared to the left frontal lobe during the EC, Post-Anxiety condition. The Baseline and Post-Relaxation conditions did not show cortical asymmetry for either the EO or the EC condition.

## G104

### TDCS INCREASES CORTICAL EXCITABILITY: DIRECT EVIDENCE FROM TMS-EEG

Leonor Josefina Romero Lauro[1], Mario Rosanova[2], Giulia Mattavelli[1], Alberto Pisoni[1], Nadia Bolognini[1], Giuseppe Vallar[1]; [1]Department of Psychology, University of Milano-Bicocca, Italy, [2]Department of Biomedical and Clinical Sciences "L. Sacco", University of Milano, Italy

— Despite transcranial direct current stimulation (tDCS) is increasingly used in experimental and clinical settings, the neurophysiological underpinnings of its immediate and delayed effects, and to what extent the stimulation of a given cerebral region may affect the activity of anatomically connected regions, still remain unclear. In the present study, we used an integrated system of Transcranial Magnetic Stimulation and Electroencephalography (TMS-EEG) to explore local and global cortical excitability modulation during and after active and sham tDCS. Single pulse TMS was delivered over the left posterior parietal cortex (PPC), before, during, and after 15 min of anodal tDCS over the right PPC. EEG was concurrently recorded from 60 channels. For each session, indexes of global and local cerebral excitability were obtained, computed as global and local mean field power (Global Mean Field Power, GMFP and Local Mean Field Power, LMFP) on mean TMS-evoked potentials (TEPs). The global index was computed on all 60 channels. The local indexes were computed in six clusters of electrodes: left and right in frontal, parietal and temporal regions. Source analysis was also run on a subset of subjects to better refine the spatial resolution of the observed local effects. GMFP increased, compared to baseline, both during and after active tDCS. LMFP increased after the end of stimulation in parietal and frontal clusters bilaterally, while no difference was found in the temporal clusters. The results suggest that anodal tDCS induces a widespread rise of cortical excitability, both during and after the end of the stimulation

## G105

### EEG TIME-FREQUENCY DYNAMIC FUNCTIONAL CONNECTIVITY WITH MEDIAL-FRONTAL REGIONS: INDEXING EXECUTIVE FUNCTION AND MOTOR CONTROL DURING A GO/NO-GO TASK

Anne V. Tootell[1], Adreanna T. Massey[1], Matthew D. Bachman[1], Jessica S. Ellis[1], Selin

Aviyente[2], Edward M. Bernat[1]; [1]University of Maryland College Park, Clinical and Cognitive Neuroscience, [2]Michigan State University, Department of Electrical and Computer Engineering — There is growing interest in measures indexing dynamic functional connectivity underlying cognitive and behavioral processes. In the context of a go/no-go task, the present study assesses dynamic functional connectivity with medial-frontal regions during the N2 component using time-frequency phase-locking value (PLV) measures in the theta band (Aviyente et al., 2011; Mutlu et al., 2012). Connectivity with motor areas was assessed during response execution and inhibition, and dorsolateral prefrontal regions were assessed relative to inhibition and a working memory manipulation. A normative sample (N=76) participated in two go/no-go tasks: a simple version in which separate letters indicated go vs. no-go, and a 1-back working memory version in which repeated letters were no-go and non-repeated were go. As predicted, significant increases in functional connectivity were observed between lateral and medial prefrontal (PFC) areas for no-go relative to go trials, consistent with engagement of dlPFC during inhibition. Importantly, significant increases in medial-lateral PFC functional connectivity was observed in the working memory go/no-go task relative to the simple go/no-go task ($t(75) = 5.98$; $p = .001$), offering new high time-resolution information supporting the view that medial-lateral PFC functional integration is a mechanism underlying working memory. Lastly, functional connectivity during motor execution, between medial PFC and contralateral versus ipsilateral motor cortices, demonstrated sensitivity of the PLV measure to motor processes ($t(75) = 3.94$; $p = .001$). Results provide validation for the sensitivity of the proposed time-frequency PLV measures to hypothesized dynamic functional connectivity with medial-frontal areas underlying inhibition, motor control, and working memory.

### G106

### CAPTURING AND DRIVING NEURAL OSCILLATIONS WITH A PHASE-LOCKED-LOOP MODEL-DRIVEN CONTROLLER

Kevin Horecka[1], Patrick Watson[1], Rama Ratnam[1], Neal Cohen[1]; [1]University of Illinois at Urbana-Champaign — Emerging research on characteristic in vivo neural oscillations suggests that precise timing information, including phase-domain information, is critical for coordinating multiple networks to perform complex information processing (Buzsaki et al. 2004). In addition, neural network models encoding memory items in patterns of oscillatory interference possess advantages over models that use static weights (Burwick 2006). In this work, we explore the relationship between memory-driven neural oscillations and oscillations present in pathological epileptiform activity, to examine if they share common oscillatory structures. We present a phase-locked-loop-based neural model using a complex Hebbian learning rule to encode oscillatory interference patterns as trajectories in phase space such that they can be recovered from partial cue inputs (Itzkevitch & Hopenstadt, 2001). We demonstrate that phase trajectories can encode and reconstruct remembered neural states and provide feedback control of neural oscillatory activity to drive networks into precise patterns of oscillatory synchrony. Using electrocorticography data recorded during epileptiform activity in a canine epilepsy model (Davis et al. 2011), we explore 1) the features of ictal (i.e., seizure), and interictal phase trajectories, 2) optimal control parameters for maintaining interictal rhythms, and 3) critical points in oscillating phases that could be used to predict and interrupt seizure activity. We then discuss the implications of using a memory model to predict seizure activity and the possible relationships between memory-driven oscillations and pathology.

## PERCEPTION & ACTION: Motor control

### G107

### NEURAL NETWORK FOR TOOL USE UNVEILED BY FMRI IN HEALTHY SUBJECTS AND LESION ANALYSIS IN APRAXIC PATIENTS

Elvira Salazar-López[1], Marie Luise Brandi[1,2], Afra Wohlschläger[2], Benedikt J. Schwaiger[2], Georg Goldenberg[3], Joachim Hermsdörfer[1]; [1]Technische Universität München, [2]Klinikum rechts der Isar. Technische Universität München, [3]Klinikum Bogenhausen — This project investigates the neural networks involved in tool use, a daily task frequently impaired in patients suffering from apraxia. It collects evidence from two brain-imaging paradigms: event-related fMRI in elderly controls and lesion analysis in patients with damage of the medial cerebral artery following stroke. Both experiments use a tool carousel for controlled tool presentation (12 tools from daily life). FMRI-data is analyzed with SPM8 in a factorial design (object and task) during the planning- and action-phase. In the lesion study Voxel Lesion Symptom Mapping is applied to behavioral execution of patients and lesions detected, analyzing the factors: score parameter, damaged side (left, right) and tool used; in addition a ROI analysis specifies the findings. Results yield a left lateralized network that includes the superior and inferior parietal lobe and the intraparietal sulcus, the dorsal and ventral premotor cortex and the middle frontal gyrus, the temporal cortex and the lateral occipital complex, that is similar in both studies. Despite moderate performance errors in patients with right brain damage these pathways were not detected, suggesting a more spread distribution of responsible networks and different sources for failures. The correspondence of the areas revealed by fMRI in healthy subjects and the left-sided areas damaged in the patient´s group demonstrates the role of dorsal and ventral pathways in complex actions like tool use, with an especial importance of frontal and parietal areas. Methodological benefits of employing the tool carousel and the two different populations strengthen the findings of the project.

### G108

### SENSORIMOTOR CONTROL OF VOCAL PITCH AND FORMANT TRAJECTORIES IN PARKINSON'S DISEASE

Fatemeh Mollaei[1,2], Douglas M. Shiller[1,3], Shari R. Baum[1,2], Vincent L. Gracco[1,2]; [1]Centre for Research on Brain, Language and Music, McGill University, [2]School of Communication Sciences and Disorders, McGill University, [3]École d'orthophonie et d'audiologie, Université de Montréal — Auditory feedback provides information on multiple speech output parameters including pitch (fundamental frequency, or F0) and formant properties. Each of these parameters underlies different linguistic dimensions in English, with F0 encoding primarily prosodic properties and formant frequencies encoding the vocal tract area functions that underlie phonological units. Inducing auditory errors in one or the other of these acoustic parameters has been used to examine the manner in which auditory feedback is integrated with ongoing speech motor processes. The capability of individuals to adapt to induced sensory errors may be used to evaluate the control problems associated with speech motor disorders. Parkinson's disease (PD) is one such disorder in which patients exhibit difficulty in learning new sensory-motor correspondences. An issue that has not been addressed is whether this impairment applies to all aspects of speech or whether fundamental frequency and formant parameters of speech might be differentially affected. Here we employed a sensorimotor compensation paradigm to investigate the mechanisms underlying the control of vocal pitch and formant parameters using a within subject design. PD and age-matched control participants produced speech while their auditory feedback corresponding to F0 and first formant frequency (F1) was altered unexpectedly and on random trials. PD participants exhibited a larger compensatory response to F0, however they showed a reduced compensation to F1 perturbations compared to age-matched controls. The results suggest that the sensory-based control of pitch and formant frequency might be differentially impaired in PD.

### G109

### AUGMENTED AUDITORY FEEDBACK TO LEARN A NOVEL UPPER LIMB JOINT COORDINATION REACHING PATTERN

Shinya Fujii[1,2], Tea Lulic[1,3], Joyce L. Chen[1,4]; [1]Sunnybrook Research Institute, [2]Japan Society for the Promotion of Science, [3]McMaster University, [4]University of Toronto — Studies show motor learning is more effective when practice occurs with a reduced frequency of augmented feedback compared to feedback on every trial. The aim of this study is to test what frequency of augmented auditory feedback facilitates the learning of a novel upper limb movement. Fourteen healthy volunteers learned to perform a novel reaching pattern using their arm across 4 blocks of 25 trials. Participants either received auditory feedback on every other practice trial, i.e. 50% feedback (N=7), or on every trial i.e. 100% feedback (N=7). The auditory feedback was a pure-tone sound that changes in amplitude, proportional to the amount of error in joint coordination relative to the target pattern. After training, participants performed 25 no-feedback trials, and an additional 25 no-feedback trials the next day to test retention. A two-way ANOVA with factors training block and feedback condition on the mean error of joint coordination showed a significant main

effect of training block ($p < 0.05$). Auditory feedback guided the joint coordination to be closer to the target pattern over the course of training. There was no significant difference in the mean error between feedback conditions at post-training and retention. However, Levene's tests for equality of variances showed significantly smaller inter-individual variability in the group that practices with 100% compared to 50% feedback ($p < 0.05$). The results suggest augmented auditory feedback can guide the learning of a novel joint coordination pattern, and auditory feedback on every trial may result in more consistent learning across individuals.

### G111

### MODULATION OF INTERHEMISPHERIC INHIBITION AFTER TRANSCRANIAL DIRECT CURRENT STIMULATION OF PRIMARY MOTOR CORTEX

Michael Vesia[1,2], Tea Lulic[3], Roberta Pellicciari[1,2], Reina Isayama[1,2], Robert Chen[1,2], Joyce L Chen[3,4]; [1]Toronto Western Research Institute, [2]Department of Medicine (Neurology), University of Toronto, [3]Sunnybrook Research Institute, [4]Department of Physical Therapy and Graduate Department of Rehabilitation Sciences, University of Toronto — Transcranial direct current stimulation (tDCS) is a non-invasive approach to modulate cortical excitability and brain function in humans. It has the potential to facilitate motor learning in healthy individuals, and enhance motor recovery after stroke. Anodal tDCS increases, while cathodal tDCS decreases excitability of the motor system. The aim of this study is to examine neurophysiological mechanisms that underlie tDCS-induced changes in motor excitability in healthy volunteers (n=7). We hypothesized that modulation of motor excitability is mediated in part by changes in interhemispheric inhibition (IHI) from the homologous primary motor cortex (M1) in the opposite hemisphere. We measured motor excitability with single- and paired-pulse transcranial magnetic stimulation (TMS) in both hemispheres before and after anodal, cathodal, or sham tDCs to left M1 (1.5 mA, 20 min). TMS measures included: motor evoked potential (MEP) amplitude; intracortical excitability within M1; and IHI between motor cortices. Anodal tDCS resulted in (1) increased left M1 excitability (MEP amplitudes), (2) decreased right M1 excitability, and (3) increased IHI from the left to right hemisphere. In contrast, cathodal tDCS resulted in (1) no changes in left M1 excitability, (2) increased right M1 excitability, and (3) decreased IHI from the left to right hemisphere. Together, these findings suggest that tDCS not only changes the excitability of the stimulated area, but also modulates the contralateral hemisphere through changes in interhemispheric connections. They also are consistent with interhemispheric competition models suggesting pathophysiological changes of excitatory and inhibitory interactions between hemispheres after stroke, and they may be modulated by tDCS.

### G112

### INVESTIGATING THE ROLE OF CEREBELLUM IN SENSORY PROCESSING DURING VOCAL BEHAVIOR

Zarinah Agnew[1], Gill Jeevit[1], Srikantan Nagarajan[1], Richard Ivry[2], John Houde[1]; [1]UCSF Dept of Otolaryngology, University of California, San Francisco, [2]Action & Cognition Lab, University of California, Berkeley — It has been proposed that the cerebellum serves to generate predictions about the sensory consequences of future movements. Complete or over reliance on sensory feedback is thought to result in unstable movements. Patients with cerebellar ataxia are known for their deficits in visually guided movement and it is suggested that this group are less able to make accurate predictions about the sensory consequences of movements and have to rely on reafferent information which ultimately leads to unstable movements. The present study aimed to investigate the nature of auditory feedback processing in patients with cerebellar degeneration by measuring various aspects of vocal behavior. Patients were tested on a battery of vocal assessments designed to probe different aspects of vocalization: we investigated ability to produce spontaneous voicing, pitch tracking of a moving pitch target and pitch perturbation. We investigated the hypothesis that reducing auditory feedback during vocalization would improve vocal stability. In order to investigate this idea further, a third experiment was carried out where we investigated how patients responded to perturbations in pitch production whereby auditory feedback is pitch shifted during vocalization. As predicted, patients with cerebellar damage displayed significantly altered responses to the pitch shift compared to healthy age matched controls indicating an alteration in the way reafferent information is utilized.Together, these three experiments provide compelling evidence in favor of the idea of the cerebellum as a prediction system, the dysfunction of which leads to over reliance on sensory feedback and hence unstable auditorily guided vocal movements.

### G113

### REVIEW OF GAIT IMPROVEMENT BY SENSORY FEEDBACK IN PARKINSON'S DISEASE PATIENTS

Yoram Baram[1]; [1]Technion - Israel Institute of Technology — A treatment modality for movement disorders by visual feedback is reviewed. The natural closed-loop sensory-motor feedback system is imitated and enhanced by a wearable virtual reality apparatus which, employing body-mounted inertial sensors, responds dynamically to patient's own motion, displaying an earth-stationary image of a checkerboard-like tiled floor. Clinical and at-home studies performed on different cohorts at different locations, and published in recent years have shown significant gait improvement in patients with Parkinson's disease using the apparatus. In contrast to open-loop devices, which impose constant-velocity visual cues in a "treadmill" fashion, or rhythmic auditory cues in a "metronome" fashion, requiring constant vigilance and attention strategies, and, in some cases, instigating freezing in Parkinson's patients, the closed-loop device increased walking speed and stride length, eliminating freezing of gait in most patients, without side effects. Clinical measurements have shown an average improvement of 25.7% ($p=0.001$) in walking speed and 30.8% ($p=0.0085$) in stride length achieved by closed-loop visual feedback, compared to 13.8% ($p=0.230$) in walking speed and 15.0% ($p=0.056$) in stride length, obtained by open loop visual input. Following two-week at-home training, residual improvement in walking without the device was 17.1% ($p=0.0004$) in walking speed and 12.4% ($p=0.003$) in stride length. Visual feedback was found to reduce gait initiation time by 6.2%. Preliminary EEG results show increased information flow from occipital to parietal and motor lobes in the beta range while walking with visual feedback, and residually, without the device, immediately following device use.

### G114

### SHARED MECHANISMS FOR SPEECH ERROR CORRECTION AND SENSORIMOTOR LEARNING

Caroline Niziolek[1], Srikantan Nagarajan[1], John Houde[1]; [1]University of California, San Francisco — When we speak, we monitor the sound of our own voice--our auditory feedback--and adjust our speech to counteract deviations from what we intend to say. Evidence for this monitoring and adjustment comes primarily from two types of experimental paradigms: the first, unexpected feedback alteration, probes rapid error correction by employing sudden changes to auditory feedback that are sparse and random, such that they cannot be learned. The second, sensorimotor adaptation, probes speech learning by applying consistent manipulations to auditory feedback, causing a temporarily remapping of articulatory commands that persists after feedback is returned to normal. In two complementary experiments, we used magnetoencephalography (MEG) and real-time auditory feedback alteration to examine how these two mechanisms, adaptation and error correction, interact. Results show that auditory cortical responses to altered feedback were increased relative to baseline trials in Experiment 1, when they could not be predicted, but not in Experiment 2, when the feedback alteration was learned. Furthermore, compensatory "error correction" responses, in which subjects changed their vocal output within 200 ms to counteract the imposed changes in feedback, were larger in Experiment 1 than in Experiment 2, despite comparable magnitudes of unexpected change. These results suggest that the learned remapping of vowel articulatory movements interacts with rapid error correction; these two processes may therefore be governed by shared neural mechanisms.

## PERCEPTION & ACTION: Other

### G115

### ASSESSING THE ROLE OF SPONTANEOUS EEG ALPHA PHASE IN THE ESTIMATION OF INTERVAL DURATIONS

Alex Milton[1], Christopher Pleydell-Pearce[1]; [1]University of Bristol, School of Experimental Psychology — Although the phase of ongoing EEG alpha band activity (7-13Hz) has been shown to modulate the detection of sensory input, it is less clear if it also influences its temporal encoding. While some suggest that phase changes in low-frequency rhythms might correspond to the demarcation

of discrete temporal intervals of perception, efforts to establish this link have so far provided only indirect evidence. This study draws upon developments in the time perception literature to address this question. Here, evidence suggests that temporal encoding is inherent in the time-course of neural activity involved in stimulus processing, and need not require a separable mechanism. This implies that alpha phase could modulate estimations of time via its influence on the excitability of neural populations engaged in sensory processing. Accordingly, we assessed whether variations in the estimation of millisecond intervals were related to variations in the phase of alpha. 14 participants performed a two-interval discrimination task where they indicated the relative duration (Longer/Shorter) of a comparison versus a standard interval. The phase of alpha activity preceding duration onset was retrospectively calculated and its effect on the subsequent time estimation was investigated using a cluster-based permutation analysis. The results revealed that differing estimations of relative interval length were associated with differing phase distributions at left posterior electrodes in the period immediately preceding and including onset of the first interval. Analysis also demonstrated that negative phases at stimulus onset predicted Longer responses, and the findings support a possible mechanism by which phase relates to temporal encoding.

## G116

### SPEAKING TOGETHER: AN INVESTIGATION OF JOINT, SYNCHRONIZED SPEECH PRODUCTION.

Kyle M. Jasmin[1,2], Carolyn McGettigan[3], Zarinah K. Agnew[4], Nadine Lavan[3], Oliver Josephs[1], Fred Cummins[5], Sophie K. Scott[1]; [1]University College London, [2]National Institute of Mental Health, [3]Royal Holloway University of London, [4]University of California San Francisco, [5]University College Dublin — Synchronized behavior —chanting, singing, praying, dancing— is found in all human cultures, and is central to religious, military and political activities that require people to get along and work together; however, we have yet to determine the neural profiles of synchronous behavior or understand how these activities improve group cohesion. We scanned participants with functional magnetic resonance imaging while they spoke and listened to sentences alone, and also when they spoke simultaneously with an experimenter. On trials when subjects spoke with the experimenter, we manipulated whether the subject heard the experimenter speak the same sentence (allowing synchrony) or different sentences (preventing synchrony), and also whether the voice they heard was live or pre-recorded. Subjects were unaware that recordings were used during the experiment, and their ability to distinguish live and recorded trials was confirmed behaviorally. We found that, compared to basic speech perception and production baselines, synchronous speaking activated bilateral auditory fields in superior temporal gyrus, extending into anterior and posterior STG, ventral right parietal fields and right Broca's area. We also found that when subjects spoke synchronously with a live (but not recorded) partner who could perform the task jointly and cooperatively, a well-established neural correlate of speech production—suppression of auditory regions—did not occur; instead, auditory cortex responded as though the subject were listening but not speaking. These results suggest that synchrony's social benefits may relate to an altered ability to distinguish who is speaking—a blurring of self and other that occurs outside conscious awareness.

## G117

### EFFECTS OF PLEASANT AND UNPLEASANT ODOURS ON EVALUATIONS OF NEUTRAL MALE AND FEMALE FACES: AN EEG STUDY

Stephanie Cook[1], Nicholas Fallon[1], Hazel Wright[1], Anna Thomas[2], Timo Giesbrecht[2], Matt Field[1], Andrej Stancak[1]; [1]University of Liverpool, [2]Unilever Research and Development — Odours influence affective behaviour and exert cross-modal effects on other stimuli, often modulating our preferences for objects in other modalities. Behavioural research has demonstrated changes in evaluations of faces presented in the presence of pleasant or unpleasant odours. Evaluative context of the event-related potential (ERP) response to faces is known to be reflected during the late positive potential (LPP). The present study aimed to observe the effects of pleasant and unpleasant odours on evaluations of a large set of neutral male and female faces by both males and females, using ERP analysis. Participants (N=20) rated neutral faces following administration of pleasant (jasmine) and unpleasant (methylmercaptan) odours, plus a no-odour control. EEG was recorded continuously using a 129-channel system. Neutral faces presented after administration of the pleasant odour were rated significantly more pleasant than the same faces presented after administration of the unpleasant odour, statistically. Analysis of ERPs in response to faces revealed three clusters of electrodes which showed statistically significant effects of odours on scalp potentials in six time points during the late ERP latency period (600-950 ms). Topographic maps indicated increased negativity in occipital and posterior temporal-parietal electrodes in response to faces in the pleasant odour condition. The findings further support existing research showing that positively- and negatively-valenced odours can shift hedonic evaluations of faces such that they are more or less favourable, respectively. Moreover, results suggest that late ERP components (>600 ms) may be responsible for disentangling the effects of odours on hedonic evaluations of faces.

## G118

### NEURAL UNDERPINNINGS OF THE PERCEIVED LINKAGE BETWEEN VOLUNTARY ACTIONS AND SENSORY EFFECTS: A TRANSCRANIAL DIRECT CURRENT STIMULATION STUDY.

Annachiara Cavazzana[1], Barbara Penolazzi[1], Chiara Begliomini[1], Patrizia Silvia Bisiacchi[1]; [1]University of Padua (Italy) — Intentional Binding (IB) - the temporal attraction between a voluntary action and its sensory effect (Haggard et al., 2002) – is considered as a valid implicit measure of sense of agency (SoA), i.e., the capacity of controlling one's own actions. IB has been thoroughly studied from a behavioral point of view; however, its neural underpinnings remain to discover. Although providing evidence that supplementary motor complex is involved, the available research findings are still too scarce to draw definitive conclusions. In addition, always the same two well-validated paradigms were used to collect data on IB. Here, for the first time, transcranial direct current stimulation (tDCS), together with a new paradigm (Cavazzana et al., 2014), was used to investigate a possible causal relationship between the pre-SMA, in virtue of its involvement in the planning of action, and IB. Fifteen participants (mean age in years: 22.93±1.98; 4 males) underwent testing after submitting to anodal, cathodal, and sham-control stimulations during three separate sessions (Experiment I). Subsequently the same stimulation protocol was administered by involving the right primary auditory cortex (PAC) as a control region, given its role in processing the sensory auditory effects of voluntary action (Experiment II). Results showed a significant reduction of IB only after perturbing pre-SMA ($p<.05$). No involvement of the PAC was found. Overcoming a correlational approach, the present study supports a causal involvement of pre-SMA in our experience as agents of our own actions, thus suggesting an essential contribution of this prefrontal region to SoA.

## G119

### DOES INDUCING DISBELIEF IN FREE WILL ALTER BRAIN CORRELATES OF PRECONSCIOUS MOTOR PREPARATION?: A REPLICATION STUDY

Fenner Macrae[1], Michael Pitts[1]; [1]Reed College, Portland, Oregon — The current study is a direct replication of a recent experiment (Rigoni et al., 2011, Psychological Science) which found that inducing disbelief in free will was associated with an amplitude reduction of the readiness potential (RP) ERP component more than 1 second prior to a voluntary response. This finding was surprising because an abstract belief appeared to have affected preconscious neural activity prior to the execution of voluntary actions. With assistance from the original authors, all procedural and EEG/ERP methods were reproduced as closely as possible. Participants in the "anti-free-will" group read an essay which argued against the existence of free will while control participants read a matched essay that did not mention free will. Both groups were then tested using the classic Libet paradigm (Libet, 1983) and RPs were measured and quantified. The effectiveness of the belief manipulation was assayed using the FWD scale. Contrary to Rigoni et al. (2011), we found no differences in RP amplitude between the anti-free-will and control groups. However, we also found no differences in the FWD scores between groups, suggesting that the belief manipulation may have been ineffective. To test whether RP amplitude is at all sensitive to beliefs in free will we examined whether there were any correlations between FWD scores and RP amplitudes (N=28). We found no significant correlations suggesting again that RP amplitude is unaffected by free will beliefs. The current study suggests that more evidence is required before the original findings are accepted as reliable and reproducible effects.

## G120

### PARACINGULATE SULCUS MORPHOLOGY PREDICTS HALLUCINATIONS IN SCHIZOPHRENIA

Jane Garrison[1], Charles Fernyhough[2], Mark Haggard[1], Simon McCarthy-Jones[3], Jon Simons[1]; [1]University of Cambridge, UK, [2]University of Durham, UK, [3]Macquarie University, NSW, Australia — Hallucinations are often regarded as a cardinal feature of schizophrenia but around 30% of patients never experience such symptoms, and research has yet to identify the brain mechanisms that distinguish patients who experience hallucinations from those who do not. In this study, we demonstrate that morphological variation in a specific medial prefrontal brain structure, the paracingulate sulcus (PCS), predicts the occurrence of hallucinations in patients with schizophrenia. Structural MRI scans from 113 patients and 40 healthy controls were examined, and the length of the PCS measured across both hemispheres using a newly validated technique, carried out blind to diagnosis. PCS length in patients with hallucinations was significantly reduced compared to patients without hallucinations and healthy controls. There was no difference in sulcal length between patients who experienced auditory hallucinations and those who experienced them in other sensory modalities, supporting a domain-general reality-monitoring account of hallucinations. A logistic regression analysis established the reliability of the observed results in the context of a range of potentially confounding demographic and symptom variables, revealing that left hemisphere PCS length was the only significant predictor of hallucinations in schizophrenia, with a 1cm reduction in sulcal length increasing the likelihood of a patient experiencing hallucinatory symptoms by 19.9%. These results provide a direct link between hallucinations in schizophrenia and morphological variation in a specific structural feature of the brain.

## G121

### HAPTIC HALLUCINATIONS: EVIDENCE FROM EVENT-RELATED POTENTIALS

Will Rizer[1], Daniel Wilbern[1], Sonja Prychitko[1], Andrea Savord[1], Mounia Ziat[1]; [1]Northern Michigan University — Haptic hallucinations, commonly known as formication, consist of the feeling of insects crawling on or beneath the skin. To further understand this phenomenon, we examined event-related potentials (ERPs) during trials in which participants wore a sleeve that delivers sensations similar to bugs crawling on the skin. The main goal was to identify which moving stimulus speed is closest to that of a crawling insect. We tested three different speeds (low, medium, high) travelling distally (elbow to wrist) or proximally (wrist to elbow) along the left forearm. Results show that for early somatosensory ERPs, N80 was observed over contralateral parietal electrode sites (P4), with amplitudes larger for higher speeds in both proximal and distal conditions. The same trend has been observed for the later somatosensory component N140, over midline (Fz, Pz), ipsilateral frontal (F3), and bilateral parietal (P3/4) electrode sites. For the positive component P1, larger amplitude has been observed for lower speeds over midline (Fz, Pz), frontal (F3/4, F5/6), frontal-central (FC5/6), and parietal (P3/4) bilateral electrode sites. P2 was only observed over the midline (Fz, Pz) and ipsilateral frontal (F3) electrode sites. Based on participants' survey answers, the slowest speed felt more like an insect crawling on the skin, which suggests that insect-like stimulus generates higher amplitudes for positive components and lower amplitudes for negative components.

## G122

### A FIRST LOOK USING FMRI AT HOW THE BRAINS' OF CHILDREN WITH AND AUTISM ACTIVELY TIME SUPRA-SECOND DURATIONS

Jonathan T Huck[1], Warren H Meck[2], Martha B Denckla[3], Melissa J Allman[1]; [1]Michigan State University, [2]Duke University, [3]Kennedy Krieger Institute/Johns Hopkins Medicine — Specific goals: Pathophysiological differences in the primordial interval timing system (in the milliseconds to minutes range) are beginning to be revealed in autism and related psychological disorders. The timing of supra-second durations is well known to recruit cortico-striatal timing mechanisms in adults. To-date, there are no fMRI studies of interval timing in typical childhood, or in those affected with autism. Methods: Children with and without autism completed a time perception task inside the magnet. On each trial, a standard (S) and comparison (C) stimulus duration were presented in quick succession, and children were asked to judge whether C was 'shorter' or 'longer' than S. S was either (consistently) 2.2-s or 8.2-s. In both versions, the six C durations were deviants of S (+/-12, 24, 36%). Our a-priori ROI mask included regions typically recruited during adult time perception tasks (e.g., supplementary motor cortex, striatum, cerebellum). Results: Of particular note, we observed an apparent over-engagement of striatal timing mechanisms when children with autism were timing relatively shorter S and C durations—for instance unlike unaffected children, they revealed striatal activity during the 2.2-s but not 8.2-s standard duration; and tended to recruit the striatum across the comparison durations in the 2.2-s version of the task (ranging between 1-3-s). Conclusion: Children with and without autism show different patterns of activity in several brain regions typically involved in temporal processing, notably the striatum. This pattern may suggest autistics experience a subjective lengthening of relatively short durations, and/or, a proclivity to engage beat-based timing mechanisms.

## G123

### ACTION PREDICTION WITHOUT MOTOR EXPERIENCE IN 8-MONTH-OLD INFANTS: EVIDENCE FROM LOOKING TIME AND ELECTROPHYSIOLOGICAL MEASURES

Carina de Klerk[1], Victoria Southgate[1], Gergely Csibra[1,2]; [1]Centre for Brain and Cognitive Development, Birkbeck College, University of London, [2]Cognitive Development Centre, Central European University — A popular idea in cognitive neuroscience is that in order to predict others' actions observers need to map those actions onto their own motor repertoire. If this is true, infants should be unable to predict actions for which they have no previous motor experience. However, recently it has been suggested that observational experience might facilitate prediction and shape the sensorimotor regions of the brain in a similar manner as physical experience does (Cross et al., 2009). We investigated this idea using a looking time paradigm in which pre-walking infants were presented with videos of visually familiar, upright and visually unfamiliar, inverted walking actions which were briefly occluded from view followed by either a correct (time-coherent) or an incorrect (time-incoherent) continuation of the action. Infants looked significantly longer at the incorrect compared to the correct continuations of the upright, but not the inverted walking actions. In a follow-up study we investigated sensorimotor cortex activation, as measured by electroencephalography, as a neural indication of action prediction in another group of pre-walking infants. Infants showed significantly more sensorimotor cortex activation during the occlusion of the upright walking actions that we know they can predict, than during the occlusion of the inverted walking actions that they cannot predict. Taken together, these findings are inconsistent with the idea that motor experience is crucial for action prediction and instead they suggest that infants may be able to use their extensive experience with observing other peoples' actions to generate action predictions.

## G124

### BEHAVIORAL AND NEURAL CORRELATES OF CO-SPEECH GESTURE UNDERSTANDING ARE MODULATED BY THE SEMIOTIC CONCEPT OF PEIRCE'S UNIVERSAL CATEGORIES OF PERCEPTION.

Dhana Wolf[1,2], Linn-Marlen Rekittke[1], Irene Mittelberg[1], Klaus Mathiak[1]; [1]RWTH Aachen University, Germany, [2]JARA Translational Brain Medicine, Aachen/Jülich, Germany — Co-speech gestures are intrinsically ambiguous and become meaningful only within a given speech context. Their low codification proved challenging for comprehensive classification approaches for empiric analysis (review: Andric et al., 2012) We utilized the concept of the Universal Categories of Perception (UC; Charles Sanders Peirce, 1960), as a semiotic foundation to characterize co-speech gestures with a focus on the interpreting mind. Their neuro-cognitive representation was investigated with behavioral and neuroimaging experiments. Eighteen healthy German subjects watched video recordings of freely narrated stories during a behavioral experiment (button press responses) and a subsequent functional magnetic resonance imaging (fMRI) measurement. Subject's gesture perception was modulated with three tasks corresponding to the three UCs in a top-down manner: UC1 (potentiality of meaning) is predominant in the hand movements itself; UC2 (contextualized meaning) in the disambiguation of a gesture by the accompanying speech; and UC3 (patterns) in gestures with learned meaning (e.g. thumbs up). Task-induced modulation of gesture interpretation was confirmed by significant differences in response patterns and increased within-task correlations. Intersubject-correlation analysis of fMRI data confirmed corresponding modulation of neural

recruitment patterns for the three tasks. These involved orbitofrontal cortex (task 1), precuneus (Task 2) and right lateral occipital, superior temporal, and left inferior frontal gyri (task 3). Our findings support the notion that well-established semiotic principles such as the UCs are suitable to investigate multimodal perception processes in the context of social cognition.

# THINKING: Decision making

## G125

### STRATEGIC CONTROL OF GENERALIZATION DURING CATEGORIZATION

Carol Seger[1], Kurt Braunlich[1]; [1]Colorado State University — To investigate decision making during a task requiring strategic control of generalization, we collected fMRI data while participants performed a prototype-distortion categorization task using two different rules. To categorize according to the "Lax" rule, participants had to allow all similar exemplars into the category, while excluding unrelated (random) exemplars. To categorize according to the "Strict" rule, participants had to allow only the prototype into the category, while excluding random exemplars. Both tasks were associated with a largely overlapping set of frontoparietal regions. Using model-based analyses, we investigated effects associated with categorical uncertainty and stimulus entropy. Across both rules, we observed effects associated with increasing distance from the bound in somatomotor (left precuneus), frontoparietal (right inferior parietal lobe), and default mode (right angular gyrus, posterior cingulate) networks. Conversely we observed an effect of decreasing distance from the decision bound in regions associated with the dorsal attention (bilateral inferior opercularum and bilateral intraparietal sulcus) and salience (bilateral anterior insula and medial frontal cortex) networks. While activity within visual regions was sensitive to increasing stimulus entropy, only the right inferior operularum (dorsal attention network) showed greater activity in response to stimuli with lower stimulus-entropy. Categorical analyses between the two rules provided evidence that regions in the left superior and inferior parietal lobes were sensitive to the increased generalization demands of the Lax condition.

## G126

### HIGHER LANDING ACCURACY IN EXPERT PILOTS IS ASSOCIATED WITH LOWER ACTIVITY IN THE CAUDATE NUCLEUS

Maheen Adamson[1,2], Joy Taylor[1,2], Daniel Heraldez[2], Allen Khorasani[2], Art Noda[2], Beatriz Hernandez[2], Jerome Yesavage[1,2]; [1]Veterans Affairs, Palo Alto Health Care, [2]Stanford School of Medicine — The most common lethal accidents in General Aviation are caused by improperly executed landing approaches in which a pilot descends below the minimum safe altitude without proper visual references. We examined relevant neural processes in pilots performing a simulated landing approach inside a functional MRI scanner. Pilots (20 – 66 yrs) were asked to "fly" a series of simulated "cockpit view" instrument landing scenarios in an MRI scanner. The scenarios were either high risk (heavy fog) or low risk (medium fog). Pilots with two levels of expertise participated: Moderate Expertise (Instrument Flight Rules pilots, n = 8) or High Expertise (Certified Instrument Flight Instructors, n = 12). High Expertise pilots were more accurate than Moderate Expertise pilots in making a "land" versus "do not land" decision ($p < .01$). Brain activity in bilateral caudate nucleus was examined for main effects of expertise during a "land" versus "do not land" decision with the no-decision control condition modeled as baseline. In making landing decisions, High Expertise pilots showed lower activation in the bilateral caudate nucleus compared to Moderate Expertise pilots ($p < .05$). During the approach the pilot is engaged in detailed examination of flight instruments while monitoring certain visual references for making landing decisions. The caudate nucleus regulates saccade eye control of gaze and its role in expertise demonstrated in this study provides evidence for increased "neural efficiency" in High Expertise pilots relative to Moderate Expertise pilots.

## G127

### ACCOUNTING FOR TASTE: TEMPORAL DYNAMICS OF DECISION-MAKING FOR ONESELF VERSUS OTHERS

Alison Harris[1], Cendri Hutcherson[2], Antonio Rangel[2]; [1]Claremont McKenna College, [2]California Institute of Technology — Although decision-making research usually focuses on choosing for oneself, we are often faced with selecting options for others: for example, when preparing a meal for a child or buying lunch for a friend. In these cases, we must take into account another's preferences, even though they may differ markedly from our own. Yet, it is unclear when such attributions of others' preferences emerge in the time course of choice. Here we measured participants' brain activity with event-related potentials (ERP) while they made food choices for themselves and two partners, one with similar tastes and one with markedly different (i.e., "health-conscious") preferences. As seen previously, neural value signals were visible from 500 to 650 ms after stimulus onset, and were localized to ventromedial prefrontal cortex (vmPFC), a brain region implicated in valuation. However, neural activity differentiating decisions for oneself versus others emerged even earlier, from approximately 300-500 ms post-stimulus, localized to social cognition regions including posterior superior temporal cortex (pSTC). These results suggest that representation of the recipient precedes the onset of value computations, potentially influencing the relative value assigned to attributes like taste and health. Consistent with this idea, value-related brain activity showed a significant interaction of the weighting of taste and health information by the intended recipient. Whereas taste contributed most strongly to ERPs for oneself, health information was weighted increasingly with increasing partner distance (Self < Similar < Different). Together, these results provide novel insights into the time course of decision-making when others' preferences are taken into account.

## G128

### THINKING FAST, THINKING SLOW, THINKING ALPHA?

Olave Krigolson[1], Cameron Hassall[1]; [1]Neuroeconomics Laboratory, University of Victoria — Throughout our daily lives we make a myriad of decisions –ranging from what to eat to whom to date. Scientific evidence suggests that human decisions are the product of two distinct systems within the human brain (Kahneman, 2011). The first, or "fast" system, relies on well known or reflexive answers – for example answering "two plus two is…". The second, or "slow" system, supplies more deliberative answers such as the response to "the square root of three hundred and twelve is…". Here we used electroencephalography (EEG) in an attempt to find a neural marker that identified whether or not a participant was making a System I or System II decision during performance of a perceptual learning task. Over the course of an hour, participants learned to classify "blobs" – pseudo-randomly generated shapes into four distinct families. At the mid-point of the experiment, when participants could accurately classify blobs, we removed two of the familiar blob families and introduced two new families. Thus at the mid-point of the experiment participants faced decisions we hoped would either engage System I - identifying familiar blobs, or System II – identifying the recently introduced novel blobs. Interestingly, we observed increased alpha activity over parietal electrode sites when participants classified familiar relative to unfamiliar blobs – a result that we believe suggests participants were using System I decision processes when classifying familiar relative to unfamiliar blobs. Importantly, our results provide a novel methodology and marker for examining System I and System II in humans.

## G129

### OCCIPITAL ALPHA-SUPPRESSION DURING REWARD-ANTICIPATION AND FRONTAL-MIDLINE THETA DURING REWARD-OUTCOME CORRELATE WITH DELAY-DISCOUNTING

Narun Pornpattananangkul[1], Robin Nusslock[1]; [1]Northwestern University — In a delay-discounting situation, one has to choose between 1) smaller-but-immediate reward and 2) larger-but-more-delayed reward. Higher preference toward the smaller-but-immediate option corresponds to more delay-discounting, while the opposite corresponds to less delay-discounting. People vary in delay-discounting, and it is unclear how such individual-differences are related to reward-processing. From the "impulsivity" viewpoint, one's impulse to obtain reward hijacks one's self-control to wait for a larger amount. Accordingly, more delay-discounting individuals should be more sensitive to reward-information. On the contrary, from the "delayed-gratification" viewpoint, willing to wait for a larger amount is seen as individuals being susceptible to a larger reward, so much that they decide to forgo their immediate-but-smaller option. Hence, less delay-discounting individuals should be more sensitive to reward-information. Here we tested these two competing hypotheses. Thirty-seven undergraduates completed a delay-discounting task, from which their hyperbolic delay-discounting index, k, was computed. To investigate neural-activity during

reward-anticipation and reward-outcome, the EEG time-estimation task was employed. Participants were instructed to estimate a duration and were later provided with feedback on their performance. They received monetary-reward for accurate-performance on Reward trials, but not on No-Reward trials. Compared to No-Reward trials, Reward trials elicited stronger Occipital Alpha-Suppression prior to the feedback and stronger Frontal-Midline-Theta (FMT) after the feedback. More importantly, these increases in Alpha-Suppression ($r = .40$, $p = .01$) and FMT ($r = -.32$, $p = .05$) were more pronounced among less delay-discounting individuals. Because less delay-discounting corresponds to enhanced reward-processing during both reward-anticipation and reward-outcome, our results support the "delayed-gratification" viewpoint.

## G130

### REWARD POSITIVITIES REFLECT PREDICTION ERRORS IN A FOUR-ARMED BANDIT TASK

Cameron Hassall[1], Amy Silver[2], Olave Krigolson[1]; [1]Neuroeconomics Laboratory, University of Victoria, [2]Neuroscience, Carleton University — Previous studies on feedback processing in humans contrast the brain's response to rewards with the brain's response to punishments. In electroencephalographic (EEG) experiments, this difference is typically shown as a negative deflection in the human event-related brain potential (ERP) called the feedback related negativity (FRN). Recent evidence suggests, however, that the observed ERP difference between rewards and punishments is better explained as a positive deflection that is absent in response to punishments. Termed the reward positivity (RP), this positive deflection is thought to reflect a positive reward prediction error signifying that an outcome is better than expected, although this idea has yet to be fully investigated. To affirm if, like the FRN, the reward positivity reflects a reinforcement learning prediction error, we had participants play a four-armed bandit game that only featured rewards. We then compared our participants' ERP results (reward positivities) and behavioral results (bandit choices) to the output of a computational reinforcement learning (RL) model. The pattern of results for our RL model's choices mirrored our participants' choices, and the magnitude of the prediction errors generated by the model predicted the amplitude of our participants' reward positivities. Importantly, these results suggest that the reward positivity indexes a positive RL prediction error that is absent following punishment.

## G131

### INFORMATION SEEKING IN CONSUMER BEHAVIOR: AN ANALYSIS OF PURCHASE HISTORY DATA

Ikuya Nomura[1], Kazuyuki Samejima[2], Ichiro Moda[3], Naoki Kato[3], Kazuhiro Ueda[1]; [1]The University of Tokyo, [2]Tamagawa University, [3]Asahi Breweries, LTD. — Choice between known goods and unknown goods is repeated in everyday life as new products go on the market one after another. Such choice is thus one of the key factors of consumer behavior. We experimentally examined, using 4-armed bandit task, the underlying neural mechanism of choice between novel and known goods. We found that participants who tended to seek for information had a stronger tendency to choose unknown goods and their right frontal pole was activated when choosing unknown goods. However the previous experiment was conducted in a laboratory setting: participants were not asked to purchase goods. So we conducted a similar experiment using 4-armed bandit task for persons whose history of buying beers from June 2013 to May 2014 were recorded. We elicited each person's tendency for information seeking from the result of bandit task. Moreover we identified, using entropy, the diversity of goods purchased throughout the period and, using JS divergence, the change of goods purchased between the first and the second halves. This revealed correlations between tendency for information seeking and diversity of goods as well as change of goods. This result indicates that choosing unknown goods means gaining new information even in the real world.

## G132

### LOOKING FOR THE HEART IN THE BRAIN: NEUROIMAGING ANALYSES OF LIFE-SPAN DIFFERENCES IN CHARITABLE GIVING

Jason Hubbard[1], William T. Harbaugh[1], Ulrich Mayr[1]; [1]University of Oregon — Economists distinguish "pure altruism" (i.e., a giver is motived by an increase in the utility of the recipient) from "impure altruism" (i.e., a giver is motivated by an increase in utility to him/herself, such as through an increase in reputation). Based on earlier work examining the neural correlates of charitable behavior (e.g., Harbaugh, Mayr, & Burghart, 2007) we explored whether well-documented life-span increases in giving can be attributed to either pure or impure altruism. Participants (N=80, age 18–67, M = 44.2) performed a charitable giving task while undergoing fMRI, where giving was either private or—to elicit impure motives—observed by others. In separate runs, participants also passively witnessed transactions involving money to either themselves or charities. We found an increase in giving with age ($r=.40$, $p <.001$) and when observed (17% increase, $p < .001$). However there was no trace of an interaction between these two variables—a finding that is inconsistent with an increased impure motive across the life span. In line with our previous result regarding neural correlates of pure altruism, activity in reward- and decision-related regions, including anterior cingulate, ventral striatum (vSTR), ventromedial prefrontal cortex (vmPFC), and posterior cingulate during mandatory transfers predicted subsequent voluntary giving. Furthermore, giving-related brain activity correlated with age in overlapping regions of vmPFC and vSTR. These results suggest that, (a) consistent with the pure altruism motive, neural valuation responses can reflect the utility of others, and (b) life-span changes in charitable giving are due to the strengthening of this pure altruistic motive.

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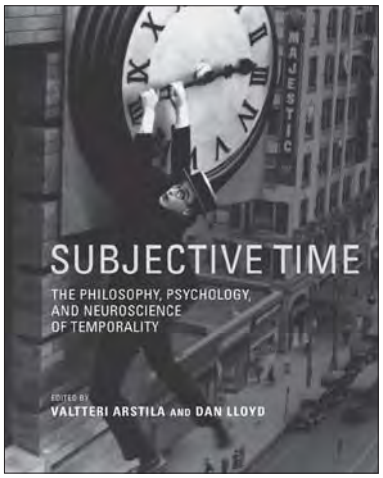


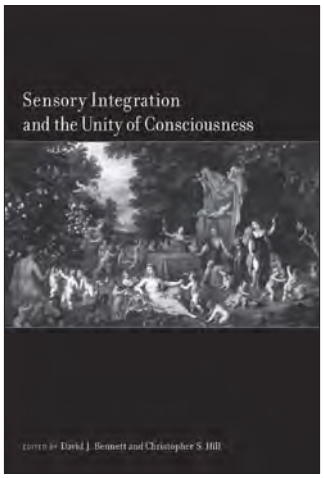


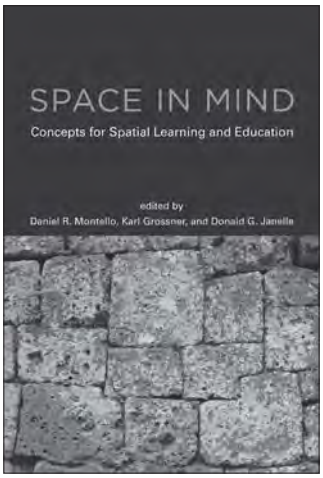


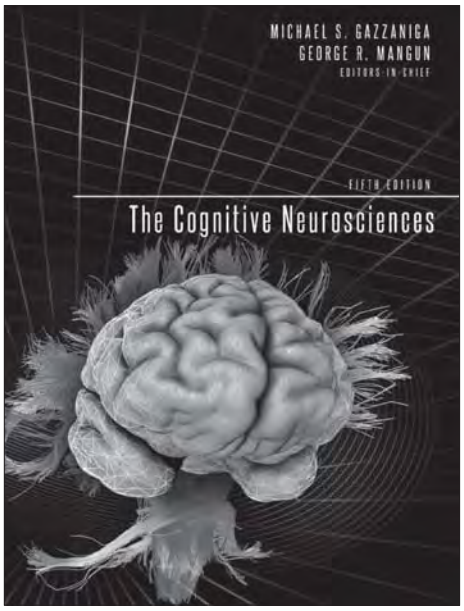


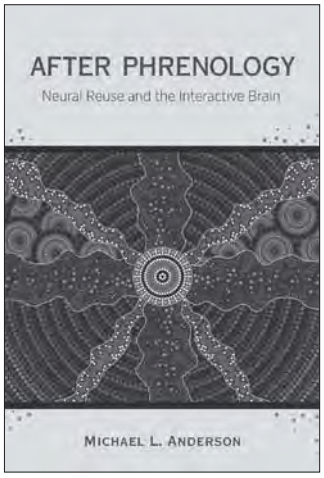


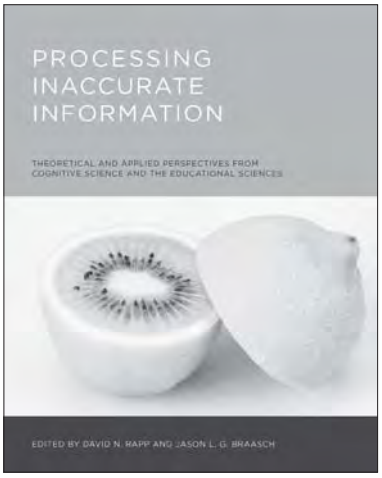


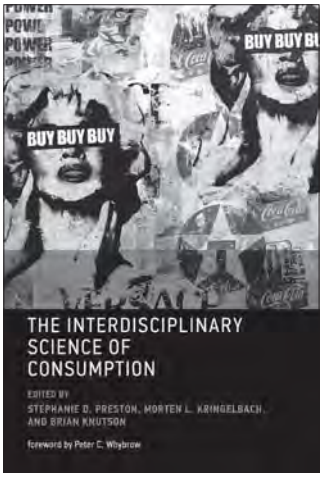


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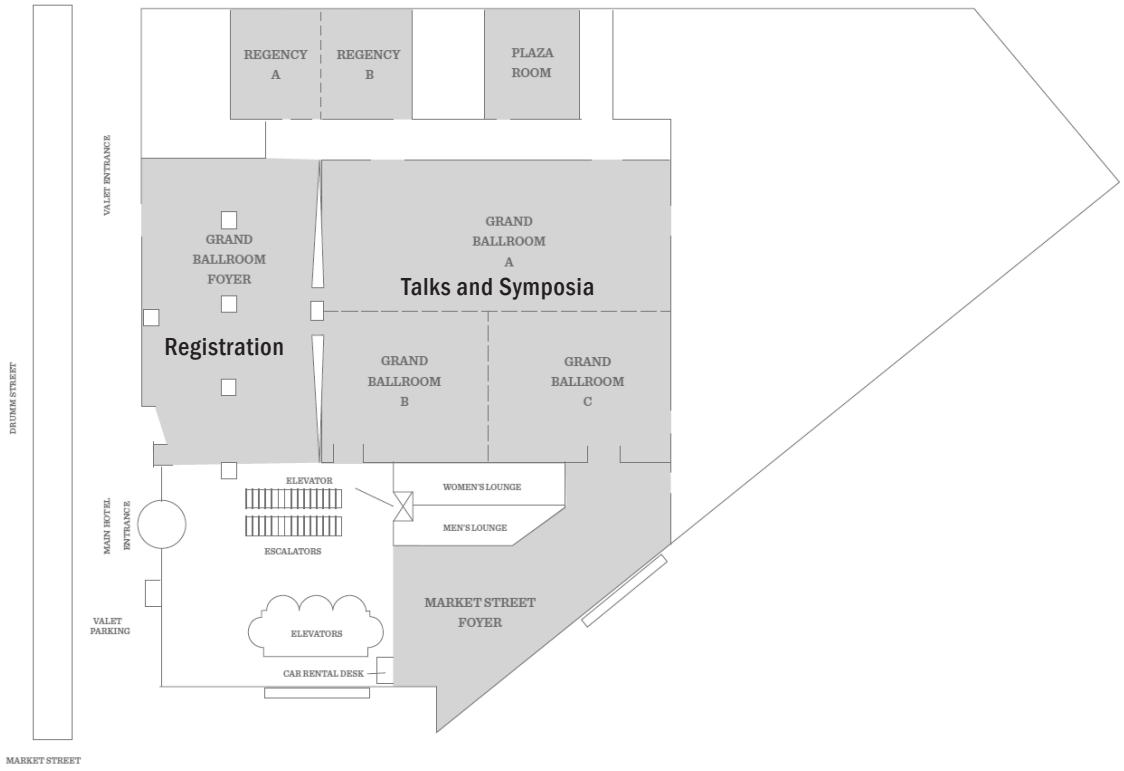


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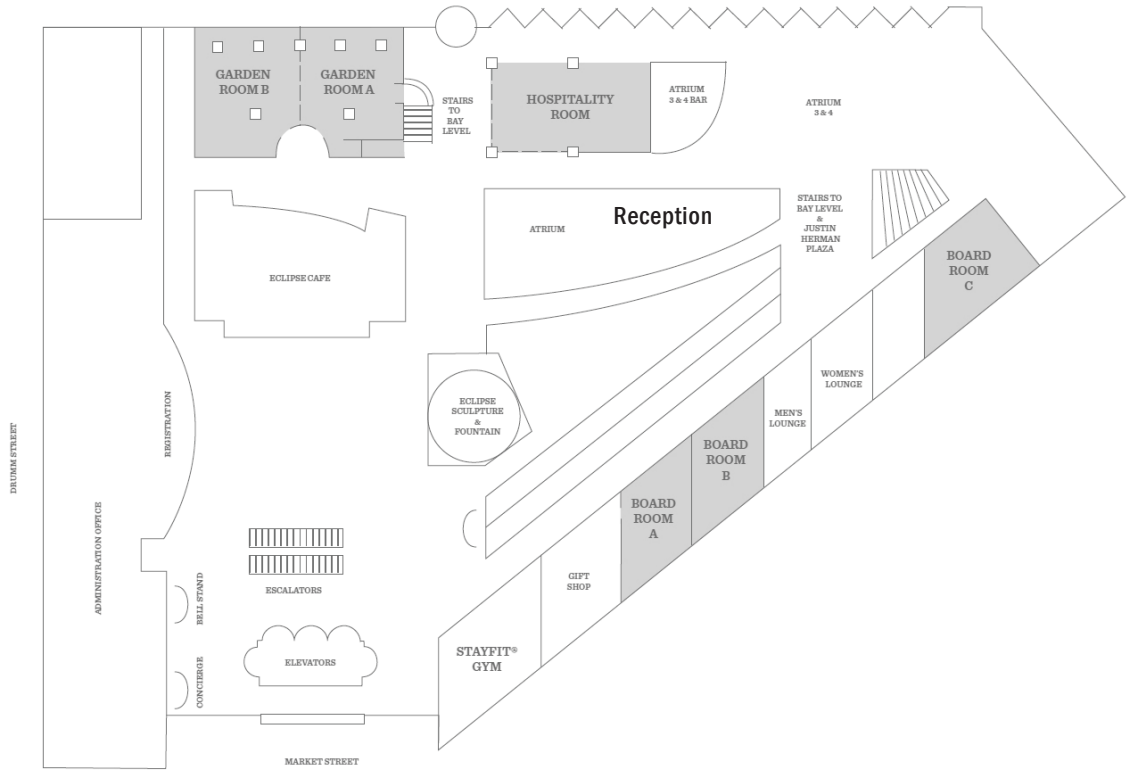

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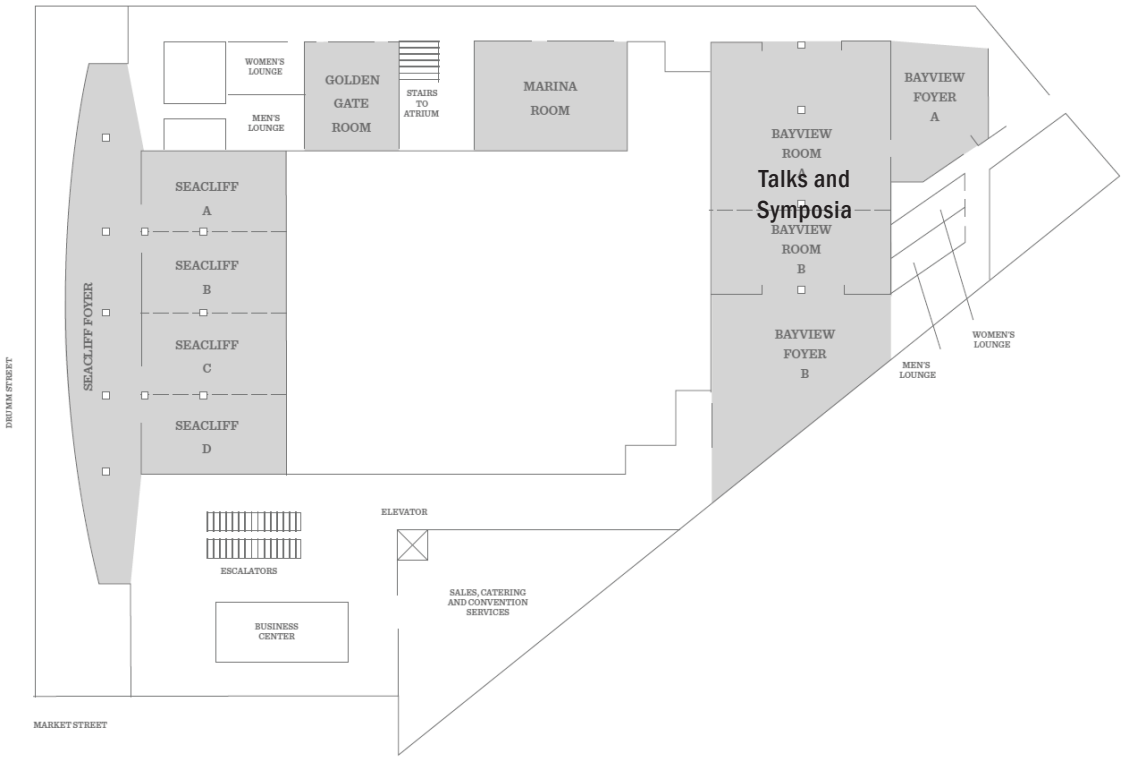


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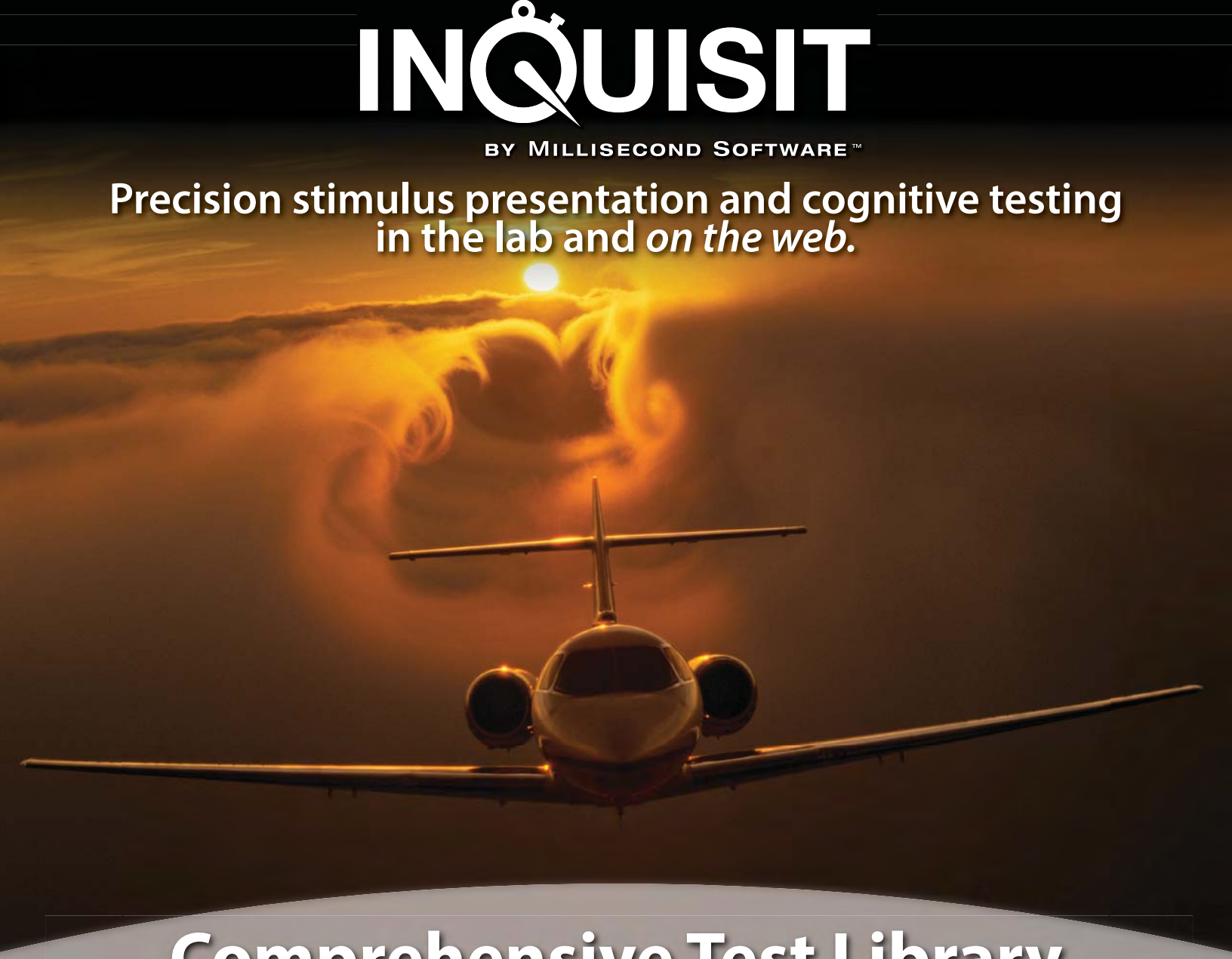

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