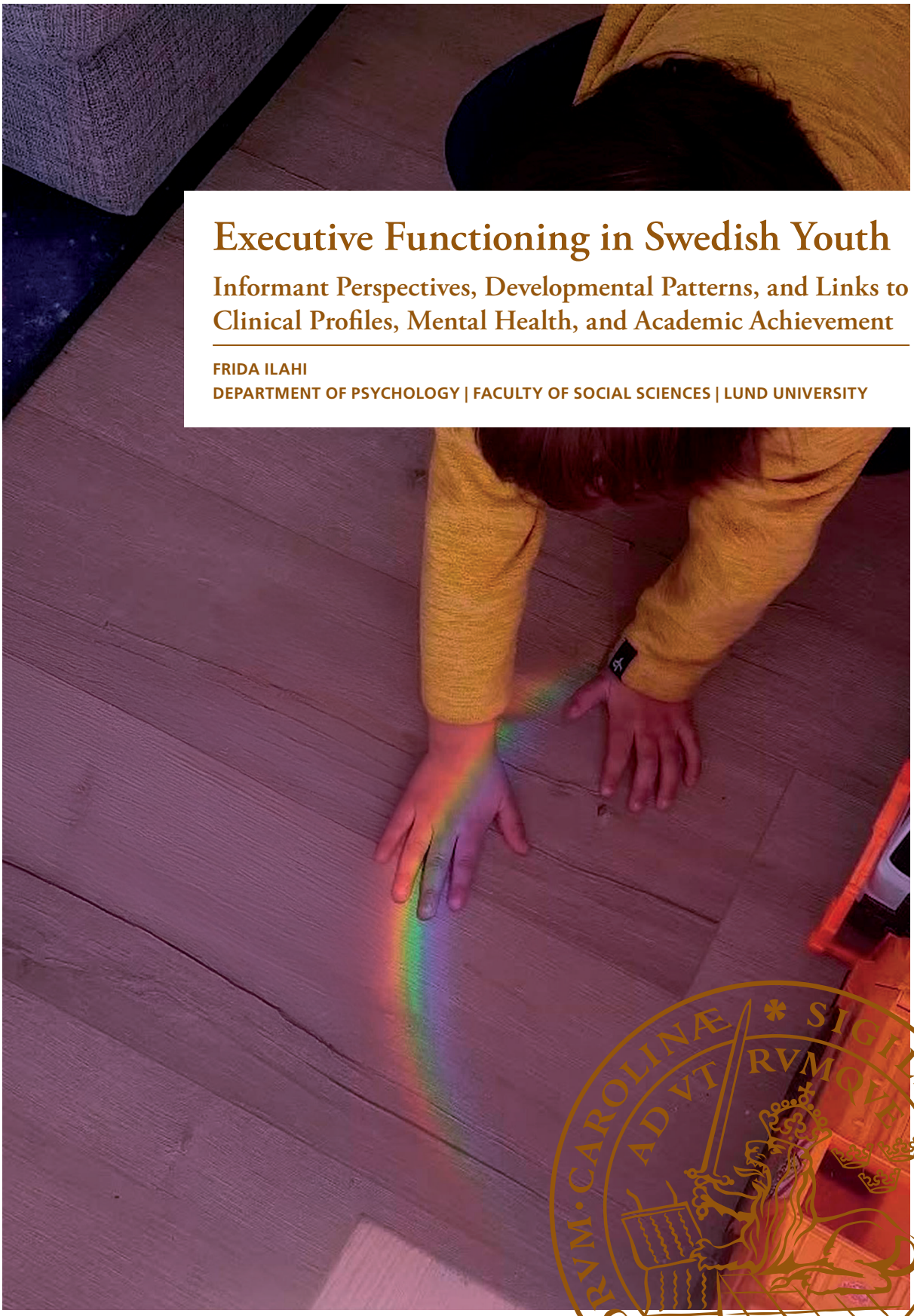
LUND UNIVERSITY

Executive Functioning in Swedish Youth: Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

Ilahi, Frida

2025

Document Version:
Publisher's PDF, also known as Version of record



Executive Functioning in Swedish Youth

Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

FRIDA ILAHI
DEPARTMENT OF PSYCHOLOGY | FACULTY OF SOCIAL SCIENCES | LUND UNIVERSITY

About the Author

Frida Ilahi is a clinical psychologist with research interests in executive functioning and its role in youth mental health and academic achievement. In her doctoral thesis, she examined everyday executive functioning among Swedish youth, using multi-informant perspectives across both community and clinical samples. In the future, she hopes to contribute to the development of school-based interventions that strengthen executive functions among youth.

Printed by Media-Tryck, Lund 2025 NORDIC SWAN ECOLABEL 3041 0903

Faculty of Social Sciences
Department of Psychology

ISBN 978-91-8104-612-0

Executive Functioning in Swedish Youth: Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

Executive Functioning in Swedish Youth

Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

Frida Ilahi

LUND
UNIVERSITY

DOCTORAL DISSERTATION

Doctoral dissertation for the degree of Doctor of Philosophy (PhD) at the Faculty of Social Sciences at Lund University to be publicly defended on 17th of October at 13.00 in Spoletorp Hörsal, Spolegatan 1R, Lund

Faculty opponent
Associate Professor Mariëtte Huizinga, Vrije Universiteit Amsterdam, Netherlands

Dissertation advisors
Associate Professor Daiva Daukantaitė, Lund University
Associate Professor Eva Hoff, Lund University

Organization: LUND UNIVERSITY

Document name: DOCTORAL DISSERTATION **Date of issue: October 17, 2025**

Author(s): Frida Ilahi

Title and subtitle: Executive Functioning in Swedish Youth: Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

Abstract: This thesis examines executive functioning (EF) among Swedish youth. EF is defined as a set of neurocognitive processes regulating cognitive, emotional, and behavioral activities essential for goal-directed behavior. I assessed EF using the self-, parent-, and teacher-report forms from the original and second editions of the *Behavior Rating Inventory of Executive Function* (BRIEF and BRIEF2). A primary aim of this thesis was to evaluate the psychometric properties of the Swedish BRIEF2 in a gender- and age-balanced community sample (Study I). In addition, I explored EF across clinical groups, including youth with neurodevelopmental disorders (NDDs) and psychiatric conditions such as obsessive-compulsive disorder (OCD), anxiety, and depression (Studies II and III). Finally, I investigated the associations between EF, mental health, and academic achievement in an adolescent community sample (Study IV). Study I supported the BRIEF2's original three-factor structure (Behavioral, Emotional, and Cognitive Regulation) across informants, with internal consistency ranging from moderate to excellent. The model fit was weaker for teacher ratings. Age and gender differences varied by informant: adolescents reported greater EF difficulties with age, while parents and teachers reported fewer. Girls self-reported greater EF difficulties than did boys, although parents and teachers generally reported the opposite, except in emotional control. All of these differences had small effect sizes. Study II revealed that youth with OCD or anxiety disorders exhibited moderately elevated EF difficulties compared to community peers, but did not differ significantly from each other. EF was not associated with OCD symptom dimensions, severity, or treatment outcome. In Study III, youth with NDDs showed substantial EF impairments across all domains, regardless of comorbidity, compared to both non-NDD (i.e., anxiety disorders) and control groups. The non-NDD and control groups also differed significantly on six of the nine EF domains, with moderate effect sizes. No significant differences were found between the NDD-only and NDD plus comorbidity groups, although youth with dual NDDs exhibited more EF difficulties than did those with a single NDD. Study IV indicated that adolescents with self-reported NDDs reported significantly more EF difficulties, especially among younger students. Self-rated EF was strongly linked to internalizing symptoms, while teacher EF ratings showed weaker associations, suggesting that such difficulties may be less visible in classroom settings. Girls self-reported having more EF difficulties, whereas teachers rated more difficulties in boys. Teacher-rated EF was the strongest predictor of academic performance. Among girls, internalizing symptoms strengthened the link between EF and achievement, possibly reflecting compensatory strategies. Together, these findings contribute to an understudied area of everyday EF in adolescents as assessed by multiple informants. The key takeaways include the importance of considering both informant and gender perspectives, as well as specific EF domains (e.g., shifting, emotional control, organization) for mental health and academic success. I discuss the methodological and conceptual challenges, encouraging future researchers to refine EF assessments and continue investigating EF, particularly among adolescent girls, to inform school-based interventions.

Key words: executive function; executive functioning; adolescents; informant perspectives; BRIEF; BRIEF2; neurodevelopmental disorders; mental health; academic achievement

Language: English **Number of pages**: 1-96

ISBN: 978-91-8104-612-0

Executive Functioning in Swedish Youth

Informant Perspectives, Developmental Patterns, and Links to Clinical Profiles, Mental Health, and Academic Achievement

Frida Ilahi

LUND
UNIVERSITY

Cover image by Frida Ilahi

Published by:

Department of Psychology

Faculty of Social Sciences

Lund University

Lund 2025

ISBN 978-91-8104-612-0 (print)

ISBN 978-91-8104-613-7 (digital)

Printed in Sweden by Media-Tryck, Lund University,
Lund, 2025

A tree thrives not just by its own strength but through the richness of the soil and the care it receives. I have grown because of the people around me. I hope to continue cultivating that same spirit of support, helping others flourish in their own pursuits.

Table of Contents

Acknowledgements 11
Abstract 13
Populärvetenskaplig sammanfattning 15
List of Articles 17
Author's Contribution to The Articles 18
Abbreviations 19

Introduction 20
Definition of Executive Functioning 20
The Conceptual Complexity of Executive Functioning 21
Assessment of EF: Performance tasks vs. Rating scales 22
EF Rating Scales: Ecological Validity and Context-Specific Assessment 23
What Are We Really Measuring? Distinctions and Overlaps with Related Constructs 25
EF and Self-Regulation 25
EF and IQ 26
EF, Grit & Agency 26
EF and Motivation 27
Development of Executive Functioning during Adolescence 27
EF Development and Gender Differences Through the Lens of the BRIEF2 29
EF and Mental Health: A Risk and Resilience Perspective 30
Definition of Mental Health 30
NDDs: National Prevalence and Gender Differences in ADHD and ASD 30
Anxiety and Depression: National Prevalence and Gender Differences 32
EF and Mental Health 33
EF in ADHD and ASD 34
EF & Internalizing Symptoms: Anxiety and Depression 34
EF in Youth with Comorbidity and Complex Clinical Profiles 35
EF and Academic Achievement 36

EF, Academic Challenges, and the Swedish Context 37
Knowledge Gaps, Rationale, Aims 39
Aims and Research Objectives 40

Methods 41

Participants 41
Community Sample 41
Clinical Samples 42
Procedure 43
Materials 44
Assessment of EF: BRIEF and BRIEF2 44
The three versions of the BRIEF2 45
BRIEF2 Scales and Scoring 46
The BRIEF2 Clinical Scales and Examples of Items 47
BRIEF2 Validity Scales 50
Clinical Assessment and Diagnostic Measures 51
Clinical Assessments of NDDs: ADHD and ASD 51
Clinical Assessment of OCD Severity and General Functioning 52
Measures of Mental Health 53
Academic Achievement 53
Data Analysis 54

Summary of studies 56

Study I 56
Study II 57
Study III 58
Study IV 59

Discussion 60

Confirmation of the Psychometric Soundness of the Swedish BRIEF2 60
Age- and Gender Differences in Behavioral EF 61
EF in Clinical Populations: Associations to NDDs and Psychopathology 63
EF, Mental Health and Academic Achievement 65
Practical Implications 67
Utility of The Swedish BRIEF2 in Everyday Contexts 67
Importance of Multi-Informant and Gender-Sensitive EF Assessment 67
Behavioral EF in Clinical Profiles and Complex Presentations 67
EF and Academic Outcomes 68
Methodological Considerations 68
Strengths of the Thesis 70

Limitations of the Thesis 72
Ethical Considerations 73
Directions for Future Research 73
Concluding remarks 75
Declaration of conflicts of interests 77
References 78

Acknowledgements

As I approach the end of my PhD journey, I must reflect on these past five years. Many people assume that a PhD is merely an extended period of study; for me, it has felt more like an intensive, years-long intellectual and personal retreat, a time of profound self-discovery and growth. This journey has taught me so much about myself, both professionally and personally. While I would love to say it has been a smooth and effortless experience, that would be far from the truth. I began my PhD studies in March 2020, just as the COVID-19 pandemic was upending the world. At that time, I was a relatively newly licensed clinical psychologist, transitioning from a role in adult psychiatry, where I had worked with therapy and neuropsychiatric assessments. I had also recently stepped into the new and transformative role of motherhood, having welcomed my firstborn, Orion, in 2018. Navigating the demands of motherhood and research, while maintaining a work-life balance was sometimes challenging. However, the intellectual freedom I was given to shape my PhD project served as a huge motivation. Being able to design my part of the project and explore my own interests in executive functioning and mental health has been incredibly rewarding. I would therefore like to express my sincere gratitude to the Department of Psychology at Lund University and to the Crafoord Foundation (20180643) for their financial support during my doctoral studies.

The pandemic introduced significant delays, particularly in data collection, as schools were understandably focused on their immediate priorities. This period of uncertainty required patience and adaptability, and the setbacks were at times frustrating. In hindsight, these challenges taught me invaluable lessons about perseverance, resilience, and problem-solving skills. With the unwavering support of my supervisors, Drs. Daiva Daukantaitė and Eva Hoff, we navigated the uncertainties together, adjusting plans and making the best of the circumstances. Talking to the other PhD students who faced similar challenges also helped ease my stress. I would also like to extend a special thanks to Dr. Matti Cervin, with whom I co-wrote my first article. His generous sharing of existing BRIEF data was immensely helpful, particularly as I faced delays in collecting my own data due to the pandemic.

I am also deeply thankful to Tiina Sarilidou, our contact person at Hogrefe Publishing, for the fruitful collaboration and for kindly providing free access to the BRIEF2. I also wish to extend my heartfelt thanks to my co-authors Dr. Pia Tallberg, Johan Klarin, and Annelie Hamilton. Your contributions were essential to the completion of this thesis.

Having such supportive and understanding supervisors has undoubtedly been one of the greatest privileges of this journey. I would like to thank Daiva and Eva for consistently reminding me that research is a team effort—one where we lift each other through the challenges, rather than face them alone. This has been especially

important, as my PhD journey coincided with significant personal challenges. After navigating the frustrations of delayed data collection and the sense that my project wasn't progressing as I had hoped, my husband and I also faced another struggle: having a second child. Dealing with fertility challenges was emotionally and physically exhausting, and at times, it deeply affected my capacity to work. Balancing research demands with the emotional weight of uncertainty was not easy, but I was fortunate to have exceptional support from those around me. I am again grateful for Daiva and Eva, whose understanding, patience, and encouragement helped me through some of the most difficult times during my PhD. I also want to express my sincere gratitude to Dr. Sofia Bunke, Deputy Head of the Department of Psychology, whose leadership and support made a profound difference to me during these times. I am also incredibly grateful to my colleagues in the PhD student group, with whom I have shared academic insights, struggles, and moments of laughter when things didn't go as planned. A special thanks to Laura Giese, for your help and encouragement in the final stages of my PhD.

Having a strong support system outside of academia has also been invaluable in navigating these past 5 years. While I deeply love my work and remain passionate about my research, I have also developed a deeper maturity and understanding of how crucial it is to have people who support and uplift you, both within and beyond the academic sphere. I therefore want to express my gratitude to everyone outside of academia whose perspectives have helped ground me and remind me that life extends beyond data collection, research articles and deadlines. My creative and spiritual pursuits have been a source of energy and balance, allowing me to recharge and engage with the world in a different way. I am grateful for the contacts and friends with whom I share these passions, as they have offered inspiration and perspective beyond the confines of research.

To my friends and family, in particular my brother Karl and my mother Margareta, I am endlessly thankful for the unwavering support, for holding space for me in times of doubt, and for reminding me why I embarked on this journey in the first place. A special thank you to my husband Sandro, whose endless encouragement and belief in me have been instrumental in pushing me forward, even when my motivation wavered. Also, a special thank you to my childhood friend Sophia, with whom I've shared my daily ups and downs along the way. Your support has been a major contributor to where I am today.

Finally, my deepest gratitude goes to my children, Orion, Eden, and my newborn baby Juno, who all fill my life with joy and who remind me of the beauty of life's simple pleasures and the importance of always maintaining work-life balance. And to Maxi, my ever-loyal border collie, who has accompanied me on endless kilometers of walks through the forests of Helsingborg, providing me with space to reflect, regain energy, and find renewed motivation.

Abstract

This thesis examines executive functioning (EF) among Swedish youth. EF is defined as a set of neurocognitive processes regulating cognitive, emotional, and behavioral activities essential for goal-directed behavior. I assessed EF using the self-, parent-, and teacher-report forms from the original and second editions of the *Behavior Rating Inventory of Executive Function* (BRIEF and BRIEF2). A primary aim of this thesis was to evaluate the psychometric properties of the Swedish BRIEF2 in a gender- and age-balanced community sample (Study I). In addition, I explored EF across clinical groups, including youth with neurodevelopmental disorders (NDDs) and psychiatric conditions such as obsessive-compulsive disorder (OCD), anxiety, and depression (Studies II and III). Finally, I investigated the associations between EF, mental health, and academic performance in an adolescent community sample (Study IV).

Study I supported the BRIEF2's original three-factor structure (Behavioral, Emotional, and Cognitive Regulation) across informants, with internal consistency ranging from moderate to excellent. The model fit was weaker for teacher ratings. Age and gender differences varied by informant: adolescents reported greater EF difficulties with age, while parents and teachers reported fewer. Girls self-reported greater EF difficulties than did boys, although parents and teachers generally reported the opposite, except in emotional control. All of these differences had small effect sizes.

Study II revealed that youth with OCD or anxiety disorders exhibited moderately elevated EF difficulties compared to community peers, but did not differ significantly from each other. EF was not associated with OCD symptom dimensions, severity, or treatment outcome.

In Study III, youth with NDDs showed substantial EF impairments across all domains, regardless of comorbidity, compared to both non-NDD (i.e., anxiety disorders) and control groups. The non-NDD and control groups also differed significantly on six of the nine EF domains, with moderate effect sizes. No significant differences were found between the NDD-only and NDD plus comorbidity groups, although youth with dual NDDs exhibited more EF difficulties than did those with a single NDD.

Study IV indicated that adolescents with self-reported NDDs reported significantly more EF difficulties, especially among younger students. Self-rated EF was strongly linked to internalizing symptoms, while teacher ratings showed weaker associations, suggesting that such difficulties may be less visible in classroom settings. Girls self-reported having more EF difficulties, whereas teachers rated more difficulties in boys. Teacher-rated EF was the strongest predictor of academic performance. Among girls, internalizing symptoms strengthened the link between EF and achievement, possibly reflecting compensatory strategies.

Together, these findings contribute to an understudied area of everyday EF in adolescents as assessed by multiple informants. The key takeaways include the importance of considering both informant and gender perspectives, as well as specific EF domains (e.g., shifting, emotional control, organization) for mental health and academic success. I discuss the methodological and conceptual challenges, encouraging future researchers to refine EF assessments and continue investigating EF, particularly among adolescent girls, to inform school-based interventions.

Populärvetenskaplig sammanfattning

Alla bär vi med oss minnen från skoltiden. Kanske har du någon gång suttit i ett klassrum, känt dig stressad över en uppgift och samtidigt försökt ignorera ljuden från klasskamraterna? Möjligen har du även, i samma stund, försökt komma ihåg vad läraren precis sade, samtidigt som du försöker planera hur du ska lösa uppgiften innan lektionen tar slut? Denna beskrivning är ett exempel på en situation då vi använder våra exekutiva funktioner. En annan situation är om vi behöver passa en tid. Vi behöver då utföra handlingar i olika steg för att uppnå ett visst resultat, till exempel hinna med bussen för att ta oss till ett möte. Vi behöver ställa klockan, vakna i tid, äta frukost, klä på oss och ta oss till mötet i tid för att uppnå vårt mål.

De exekutiva funktionerna kallas oftast för ”hjärnans kontrolltorn” eftersom de hjälper oss att styra våra tankar, känslor och beteenden i vardagen. De gör det möjligt för oss att hålla fokus, organisera våra handlingar samt reglera impulser och känslor. De är också avgörande för att vi ska kunna anpassa oss till förändringar. Alla dessa färdigheter är centrala i skolan, men också i arbetslivet och i vardagen i stort. Forskning visar att välfungerande exekutiva funktioner är en viktig faktor för skolframgång. Svårigheter med exekutiva funktioner kan försvåra planering, tidsuppfattning och minska vår stresstålighet, vilket i sin tur kan påverka skolprestationer negativt, samt öka risken för skolavhopp och psykisk ohälsa. Många barn och unga med neuropsykiatriska diagnoser som t. ex. ADHD och autism har svårigheter med exekutiva funktioner.

I dagsläget finns det en hel del forskning om exekutiva funktioner. Det saknas dock forskning om hur olika personer (ungdomarna själva, lärare och föräldrar) uppfattar ungdomarnas förmågor i vardagen. Ett mål med denna avhandling var därför att undersöka barn och ungas exekutiva funktioner med hjälp av självskattningar, föräldraskattningar och lärarskattningar, baserat på den svenska versionen av formuläret Behavior Rating Inventory of Executive Function 2 (BRIEF2), vilket består av många olika dimensioner av exekutiva funktioner.

Totalt omfattar avhandlingen fyra studier. Den första studien utvärderar skattningsskalan BRIEF2 utifrån tillförlitlighet och validitet. BRIEF2 har länge använts i Sverige utan att man utvärderat instrumentet. Resultaten visade att instrumentet är tillförlitligt för att mäta exekutiva funktioner hos svenska barn och ungdomar.

Studie två och tre undersöker exekutiva funktioner hos barn och ungdomar med psykiatriska diagnoser. Först undersöktes ungdomar med tvångssyndrom (OCD), vars exekutiva funktioner jämfördes med ungdomar med andra diagnoser såsom ångestsyndrom, autism och ADHD. Resultaten visade att ungdomar med OCD uppvisar liknande exekutiva svårigheter som ungdomar med ångest, men till skillnad från vad som tidigare setts hos vuxna patienter var svårigheterna inte tydligt kopplade till specifika symtom eller behandlingsutfall. Den tredje studien jämförde

ungdomar med ADHD, autism samt kombinerade diagnoser med en svensk kontrollgrupp utan psykiatriska diagnoser, med syfte att identifiera vilka faktorer som är mest förknippade med exekutiva svårigheter. Resultaten visade att ungdomar med neuropsykiatriska diagnoser (ADHD/autism) har avsevärt större svårigheter med exekutiva funktioner jämfört med jämnåriga utan diagnos. Särskilt omfattande svårigheter observerades hos ungdomar diagnosticerade med både ADHD och autism.

I den fjärde studien undersöktes ungdomars exekutiva funktioner i skolmiljö. Studien visade att ungdomar som själva uppger att de har en neuropsykiatrisk diagnos (ADHD/autism) också skattar mer exekutiva svårigheter. Dessa självskattade svårigheter var starkt kopplade till psykisk ohälsa, särskilt ångest och depression. Lärarnas skattningar visade ett svagare samband mellan exekutiva funktioner och psykisk ohälsa. Lärarnas skattningar av exekutiva funktioner vara den starkaste prediktorn för elevers skolframgång, vilket mättes via betyg i svenska, engelska och matematik. Intressant nog visade studien att när man också tittade på effekten av ångest och depression utöver exekutiva svårigheter, hade flickors ångest och depression en positiv koppling till skolframgång, vilket inte gällde för pojkar. Detta diskuterades i termer av att flickor med ångest- och depressionssymtom troligtvis använder sig av kompensatoriska strategier, vilka potentiellt maskerar exekutiva svårigheter. Detta förklarar möjligtvis varför svårigheter med exekutiva funktioner inte påverkar flickors skolprestation i samma utsträckning som pojkars.

Sammantaget visar resultaten i denna avhandling att själv-, föräldra- och lärarskattade exekutiva funktioner är starkt kopplade till både skolprestation, psykiatriska och neuropsykiatriska diagnoser, samt psykisk hälsa hos barn och ungdomar. Framtida forskning bör fortsätta undersöka hur olika perspektiv – från elever själva, föräldrar och lärare – samverkar i bedömningen av exekutiva funktioner, samt hur dessa perspektiv kan användas för att identifiera stödbehov hos barn och unga. I förlängningen vore det också värdefullt att utvärdera huruvida skolbaserade insatser (fokuserade på att stärka exekutiva funktioner) kan ha en positiv inverkan på elevers välmående, skolnärvaro och akademiska resultat. Slutligen är vidare forskning om flickors upplevelser av sina exekutiva funktioner, skolprestation och mentala hälsa även något som är viktigt att undersöka vidare.

List of Articles

Article I

Ilahi, F., Hoff, E., & Daukantaitė, D. (Under review). *The Swedish version of the BRIEF2: Psychometric properties and age- and gender-related differences in executive function across multiple informants.* Resubmitted and currently under review at *Child Neuropsychology*.

Article II

Rydqvist, F., (now Ilahi, F.), Hoff, E., Daukantaitė, D., & Cervin, M. (2023). Everyday executive functioning in pediatric obsessive-compulsive disorder: Diagnostic specificity, clinical correlations, and outcome. *BMC Psychiatry, 23*, 622. https://doi.org/10.1186/s12888-023-05111-1

Article III

Hamilton, A., Tallberg, P., Ilahi, F., Hoff, E., Ahmadi, B., & Daukantaitė, D. (2024). Behavioral manifestations of executive functioning in Swedish youth with ADHD, autism, and psychiatric comorbidity: a comparative analysis with community controls. *Child Neuropsychology*, 1–20. https://doi.org/10.1080/09297049.2024.2434736

Article IV

Daukantaitė, D., Klarin, J., Ilahi, F., Hoff, E., & Tallberg, P. (Under review). *The Overlooked Role of Internalizing Symptoms in Adolescent Executive Function: Insights from Self- and Teacher Ratings.* Resubmitted and currently under review at the *Journal of School Psychology.*

Author’s Contribution to The Articles

I hereby confirm that I have been actively involved in all aspects of this thesis and the empirical studies it comprises, from initial planning, study design, and ethical procedures to data collection, analysis, and final manuscript revisions. The only exception is Study II, where my contribution differed, as the ethical approval and data for this study had been obtained without my involvement. My contributions to the four studies are described below.

The overarching aim—to investigate EF through the behavioral lens of the Behavioral Rating Inventory of Executive Function, 2nd edition and explore its associations with mental health and academic achievement—originated from my own research interest and initiative. I played a key role in preparing the ethical application, ensuring that all procedures complied with relevant Swedish ethical guidelines and standards. Furthermore, I was responsible for the major components of data collection, including recruitment of schools, design and programming of digital surveys tailored to the target populations, as well as initiating and maintaining communication with participating schools to facilitate data acquisition. In addition, I was actively involved in selecting appropriate scientific journals for submission, based on each article's focus, audience, and methodological scope.

For Studies I and II, I contributed to the theoretical conceptualization, conducted portions of the data analyses, drafted the manuscripts, and took part in the review and editing process. In Study III, I developed the theoretical framework, wrote the original draft, and contributed to manuscript review and revision. For Study IV, I contributed to the theoretical conceptualization and participated in the manuscript review and editing.

Abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
ASD	Autism Spectrum Disorder
BRI	Behavioral Regulation Index
BRIEF	Behavior Rating Inventory of Executive Function
BRIEF2	Behavior Rating Inventory of Executive Function 2
CD	Conduct Disorder
CAP	Child and Adolescent Psychiatry
CRI	Cognitive Regulation Index
EF	Executive Functioning
ERI	Emotional Regulation Index
GEC	Global Executive Composite
IQ	Intelligence Quotient
NDD	Neurodevelopmental Disorder
OCD	Obsessive-Compulsive Disorder
ODD	Oppositional-Defiant Disorder
SR	Self-Regulation
SLD	Special Learning Disability
WM	Working memory
WMI	Working Memory Index

Introduction

Executive functioning (EF) is an umbrella term referring to various processes that aid goal-directed behavior and enable individuals to regulate their thoughts, emotions and actions, especially in situations that require focused attention, inhibition of automatic responses, or flexible adjustment to new demands (Diamond, 2013). There is broad agreement that EF involves key abilities needed for goal-directed behavior, including the integration of behavioral, emotional, and cognitive processes; however, the construct still lacks a unified definition, with many studies providing only implicit or inconsistent descriptions (Baggetta & Alexander, 2016). As a result, the field is fragmented, with ongoing debate over whether EF should be conceptualized as a unified construct or as a multidimensional constellation of distinct but interrelated processes. This lack of consensus has resulted in several methodological inconsistencies in how EF is measured.

This combination of theoretical complexity and real-world significance was what initially drew me into this field. As a clinician, I repeatedly observed how EF difficulties co-occurred with a range of challenges, including psychiatric diagnoses, mental health problems, and academic underperformance. These clinical experiences raised important questions for me about the developmental and functional significance of EF across the lifespan, sparking a deeper interest in understanding how these abilities influence broader psychosocial outcomes—particularly among young people in relation to their school performance and mental well-being.

Definition of Executive Functioning

In this thesis, I use the definition outlined in the Behavior Rating Inventory of Executive Function, Second Edition (BRIEF2; Gioia et al., 2015), where EF is operationalized in terms of everyday, observable manifestations of behavior across nine interrelated domains: impulse control (*Inhibit*), awareness of one's behavior (*Self-Monitor*), flexibility (*Shift*), emotion regulation (*Emotional Control*), task initiation (*Initiate*), information manipulation (*Working Memory*), strategic goal-setting (*Plan/Organize*), error detection (*Task-Monitor*), and ability to manage physical space and belongings (*Organization of Materials*).

Importantly, I use the term *executive functioning (EF)* to reflect a multidimensional and ecologically grounded understanding in line with the BRIEF2 framework. This choice emphasizes EF as a dynamic, contextually embedded process of "doing"—that is, how individuals enact self-regulatory abilities in everyday life—rather than as a static set of discrete capacities. This perspective aligns with the behavioral assessment approach used in this thesis, which focuses on assessment of real-world functioning across settings such as home and school.

To further distinguish this applied behavioral perspective from traditional cognitive or performance-based models of EF, I occasionally use the term *behavioral EF*. This distinction is intended to clarify the focus of the thesis on everyday functioning as measured by informant- and self-reports of daily behaviors, rather than on task-based or experimental measures of EF. Finally, I use *EF domains* to refer to distinct components that constitute the broader, multidimensional construct of EF.

The Conceptual Complexity of Executive Functioning

EF research is historically rooted in neuropsychological traditions and clinical observations of individuals with frontal lobe damage (Doebel, 2020); however, the theoretical landscape has evolved considerably since these early explorations. Some scholars have conceptualized EF as a central regulatory mechanism responsible for managing cognitive operations. For instance, Baddeley's model situates EF as the "central executive" within the broader working memory system (Baddeley, 2000; Baddeley & Hitch, 1974; Andersson, 2008). Similarly, Zelazo and colleagues (1997, 2003) differentiate between "hot" and "cool" EF domains—describing emotion-related and abstract-cognitive processes, respectively—but still conceptualize EF as an overarching regulatory system. Further empirical support for such unitary models comes from researchers such as Brydges et al. (2012) and Wiebe et al. (2011), who developed single-factor models of EF despite initially exploring multifactorial frameworks.

In contrast, other researchers have proposed multifactorial models of EF, often drawing on established models (Bagetta & Alexander, 2016). A widely cited example is the unity/diversity framework developed by Miyake et al. (2000), which identifies three core but separable EF components: inhibitory control, flexibility (shifting), and working memory. This model was refined later on (e.g. Miyake and Friedman, 2012) by introducing a common EF factor accounting for shared variance across EF tasks, alongside component-specific variance that reflects the unique processes tied to each domain.

A closely related model is that of Diamond (2006, 2013), who conceptualizes EF as a multidimensional construct consisting of three core domains: inhibitory control, working memory, and cognitive flexibility. Diamond proposes that these

components operate in coordination to support more complex, higher-order executive processes such as planning, reasoning, and problem-solving, thus departing from Miyake's premise of a single underlying executive mechanism.

Other researchers have proposed their own multidimensional models of EF, often building on elements from both Miyake and Diamond's frameworks. These models vary in their complexity, incorporating between two and six domains, as well as their assumptions about whether EF components operate independently or hierarchically (e.g. Chung & McBride-Chang, 2011; Garcia-Barrera, Kamphaus, & Bandalos, 2011; Gilhooly & Fioratou, 2009; Pnevmatikos & Trikkaliotis, 2013).

The lack of consensus raises questions about how EF is understood and operationalized in research, education, and clinical settings. While traditional models, such as Miyake et al.'s (2000), emphasize domain-general cognitive skills, other researchers challenge this reductionist view by highlighting the importance of context, values and culture. Doebel (2020) argues that EF should be seen as a goal-directed skillset shaped by sociocultural context and internalized values. According to this view, EF is not simply a set of cognitive processes, but a dynamic system activated in service of specific contextual goals. For example, children may inhibit impulses not solely due to cognitive control capacities, but because they perceive self-control (i.e. EF) as aligned with their group's norms. In one study, preschoolers delayed gratification longer and valued it more when they believed their in-group waited, highlighting the role of social identity and norms in shaping self-regulation (Doebel & Munakata, 2018). This approach highlights the role of context—such as values, identity, and beliefs—in shaping EF. It also critiques the limited predictive utility of traditional lab tasks, calling for more ecologically valid, context-sensitive approaches to both research and intervention.

Assessment of EF: Performance tasks vs. Rating scales

EF is commonly measured using performance-based tasks that capture specific cognitive abilities under highly controlled conditions. Rating scales —such as the BRIEF2—are used less frequently, particularly in non-clinical populations, despite their unique ability to capture how EF is expressed in everyday situations. Performance-based measures, such as the Stroop Task (which assesses inhibitory control) and Wisconsin Card Sorting Test (which measures cognitive flexibility and set-shifting), are valued for their objectivity and standardization; however, they may not effectively measure EF as it is applied in the real world. Indeed, Shallice and Burgess (1991) found that patients with frontal lobe damage performed well on lab tasks despite showing significant impairments in everyday life. Alderman et al. (2003) similarly noted that such tasks often fail to predict functional outcomes. Consistent with this, numerous studies report weak correlations between

performance-based and rating-based EF measures, with effect sizes frequently around $r = .10$ (Duckworth & Kern, 2011; Cyders & Coskunpinar, 2011).

In clinical contexts, EF is frequently assessed using both types of measures. Meta-analyses have confirmed that children with attention-deficit/hyperactivity disorder (ADHD) show significant deficits on lab-conducted EF tasks, particularly in reaction time variability, a marker linked to attentional lapses and task-negative brain network activity (Frazier et al., 2004; Kofler et al., 2013; Levy et al., 2018). However, lab-based EF tasks often lack diagnostic specificity, as EF impairments are observed in people with other psychiatric conditions aswell (Bloemen et al., 2018; Chang et al., 2020; Martel et al., 2017; Rock et al., 2014), and frequently fail to reliably distinguish ADHD from other developmental disorders (Kofler et al., 2013; Lipszyc & Schachar, 2010; Munkvold et al., 2014; Nichols & Waschbusch, 2004; Preston et al., 2005; Schatz et al., 2001).

These findings suggest that performance-based tasks and rating scales capture different aspects of EF (Toplak et al., 2013). While laboratory tasks assess EF under structured and decontextualized conditions, rating scales better reflect how EF difficulties manifest in everyday behavior. As noted by Toplak et al. (2009) and Soto et al. (2020), these approaches should be viewed as complementary, as they appear to measure distinct underlying constructs. Nevertheless, the field has historically prioritized performance-based assessments. For example, Baggetta and Alexander (2016) identified performance tasks as the dominant way EF has been operationalized. This pattern is further supported by a recent bibliometric review showing that 77% of highly cited EF studies—excluding reviews and meta-analyses—relied on performance-based instruments (Heidary et al., 2024).

EF Rating Scales: Ecological Validity and Context-Specific Assessment

EF rating scales are increasingly recognized for their ecological validity and clinical relevance. Most EF rating instruments were developed for clinical use, and they vary in both their scope and their psychometric structure (Malloy & Grace, 2005; Roth et al., 2005). Typically completed by multiple informants, including parents, teachers, and adolescents themselves, these tools provide a behaviorally grounded perspective, capturing aspects of EF that differ from those assessed through task-based methods (Toplak et al., 2013). Although not diagnostic instruments in themselves, rating scales are widely used in clinical settings, especially in the assessment of neurodevelopmental disorders (NDDs). In line with this, current guidelines in Sweden emphasize that neuropsychiatric evaluations should describe real-world functioning and not be limited to diagnostic categorization (Socialstyrelsen, 2024).

Well-known rating scales such as the BRIEF (Gioia et al., 2000) and its updated version, the BRIEF2 (Gioia et al., 2015), were designed to assess EF in naturalistic settings. Other instruments, such as the *Childhood Executive Functioning Inventory* (CHEXI; Thorell & Nyberg, 2008; Thorell et al., 2010) or the *Executive Functioning Questionnaire* (EFQ; Spinella, 2005), were developed to assess specific EF domains (particularly inhibition, working memory, and planning) that are conceptually closer to those measured by performance-based tasks. Tools like the BRIEF2 capture not only cognitive control but also behavioral and emotional regulation (Gioia et al., 2015), representing a shift away from viewing EF as a purely cognitive or unitary construct, in line with ideas proposed by Doebel (2020). There is evidence that rating scales such as the BRIEF2 provide an ecologically valid means of assessing EF in real-world settings and are effective in distinguishing youth with ADHD from their typically developing peers (Biederman et al., 2008; Dehili et al., 2013; Tan et al., 2018; Toplak et al., 2009). However, ratings are inherently context-dependent, and their interpretation should consider the environmental and interpersonal circumstances in which behaviors are observed. Meta-analyses often exclude studies that rely on rating-based measures of EF, possibly due to the typically low correlations observed between rating scales and performance-based tasks (McAuley et al., 2010), or because of concerns about subjectivity, informant bias, and shared method variance. There are also comparatively fewer rating-based studies, particularly in non-clinical populations. Nevertheless, these measures provide unique and ecologically valid insights into how EF can manifest in everyday life—perspectives not captured by performance-based tasks, which are often conducted in highly controlled settings. Excluding rating-based studies therefore risks overlooking critical aspects of real-world executive functioning and may limit the ecological validity and generalizability of meta-analytic conclusions.

What Are We Really Measuring? Distinctions and Overlaps with Related Constructs

Because of the lack of consensus on the definition and conceptualization of EF, terminology in the field remains similarly inconsistent with many overlapping definitions (Stuss & Alexander, 2000). Baggetta and Alexander (2016) emphasize the need for clearer theoretical frameworks and greater precision in how EF is defined and operationalized across different studies. EF, when assessed through rating-based measures like the BRIEF2, tends to show clear associations with similar constructs. While conceptually distinct, these constructs all contribute to understanding how individuals manage behavior, pursue goals, and adapt to complex environments, highlighting a contextual approach, while also raising questions about what behavioral, multi-informant ratings like the BRIEF2 actually measure.

EF and Self-Regulation

One of the most closely aligned constructs to EF is self-regulation (SR). SR can be defined as the flexible monitoring, inhibition, adaptation, and sustainment of behavior, attention, emotions, and cognitive strategies in response to internal goals and external demands (Moilanen, 2007). According to Nigg (2017), EF refers to a set of cognitive capacities—such as working memory, response inhibition, and cognitive flexibility—that support goal-directed behavior, whereas SR is a broader adaptive process that involves modification of internal states, emotions, and behavior. EF may thus be understood as a mechanism that facilitates SR, but the constructs are not synonymous (Nigg, 2017; Friedman & Miyake, 2016; Miyake et al., 2000). Heidary et al. (2024) remark that SR is often used interchangeably with EF, contributing to definitional confusion. Although the constructs overlap substantially—particularly regarding inhibitory control—they do show several differences. For example, EF research has focused largely on cognitive and intentional control (e.g., emotion suppression), whereas SR research emphasizes both the regulation of disruptive emotion and the cultivation of positive emotion (Blair & Diamond, 2008).

In this thesis, I argue that my emphasis on behavioral EF, as measured through the BRIEF and BRIEF2, aligns more closely with SR than with purely cognitive EF models. This perspective has implications for how EF is interpreted in relation to adaptive functioning, developmental progression, and intervention strategies. Given this alignment, it may be conceptually coherent to view behavioral EF more as an applied expression of SR, as both constructs (if operationalizing EF from a rating-based, behavioral perspective) involve managing impulses, sustaining attention, and pursuing goals in a given context. Furthermore, both constructs share a

developmental trajectory—shifting from externally guided responses to increasingly autonomous control (Zelazo, 2015; Nigg, 2017).

EF and IQ

Similarly, EF and the Intelligence Quotient (IQ) are sometimes conflated, with research increasingly supporting that, while related, they are distinct constructs (Friedman et al., 2006; Friedman & Miyake, 2017). For instance, working memory (WM), which is often considered a core component of EF (Miyake et al., 2000), is also included in the Wechsler Intelligence Scales for Children (WISC-V; 2014), through the Working Memory Index (WMI).

However, while WM is a component of several indices, research shows that performance on other indices in the WISC (e.g., Verbal Comprehension, Visual Spatial Ability) may not fully reflect an individual's EF in everyday life. This further aligns with my own clinical experience, where I have observed how individuals can have normative or even high IQ scores, even as they struggle with EF-related challenges in daily life. For this reason, differentiation is crucial, particularly in diagnostic settings, where both constructs must be considered independently (Tassé et al., 2016). Supporting this distinction, recent Nordic research (e.g., Gravråkmo et al., 2023) has shown that behavioral EF, as assessed by rating scales, predicts adaptive functioning in children with mild intellectual disability, whereas IQ does not.

EF, Grit & Agency

EF also shares conceptual space with constructs such as grit and agency. Grit is defined as passion and perseverance for long-term goals (Duckworth, 2016), while agency encompasses the ability to assess, influence, and adapt to one's environment (Bandura, 1997; Kundu, 2017); both emphasize goal-directed behavior and self-regulation. While EF has traditionally been studied using cognitive tasks (e.g., Stroop tests), grit and agency are typically assessed using self-reports or real-life observation. Compared to the more narrowly defined, task-based EF assessed in lab settings, the rating-based, behavioral conceptualization of EF that I employ in this thesis aligns more closely with these constructs. Indeed, agency also considers the role of environmental supports and societal structures (Kundu, 2017), a point that resonates with recent calls to reconceptualize EF within broader sociocultural frameworks (Doebel, 2020; Gaskins & Alcala, 2023; Haslam et al., 2019; Jukes et al., 2021; Miller-Cotto et al., 2021).

EF and Motivation

Motivation is yet another construct closely tied to EF, particularly in the context of SR. Self-determination theory (Deci & Ryan, 1985; Ryan & Deci, 2000, 2017) posits a continuum from intrinsic to controlled motivation, in which satisfaction of basic psychological needs such as autonomy, competence, and relatedness plays a role. Integrated and identified motivation—where individuals internalize and accept the value of their actions—are especially relevant to EF, as both involve sustained, goal-directed behavior. In contrast, introjected motivation, which is driven by internal pressure, and amotivation, characterized by disengagement, may relate to EF difficulties. For example, students with learning disabilities often report lower EF as well as less adaptive motivational profiles (Alesi et al., 2024). Classic EF tasks like the marshmallow test (Mischel, Shoda, & Rodriguez, 1989) illustrate this interplay, as they require both cognitive control and motivational regulation.

Development of Executive Functioning during Adolescence

Generally, EF development has been described in two ways: as a set of domain-general processes that emerge over time and operate largely independently of context (e.g., Carlson & Moses, 2001; Miyake & Friedman, 2012), and as goal-specific skills shaped by individual experiences, beliefs, values, and sociocultural influences (e.g., Doebel, 2020).

Rather than viewing these perspectives as mutually exclusive, Ibbotson (2023) proposes an integrative approach, wherein EF development involves both general cognitive mechanisms and context-sensitive skills learning. This theoretical complexity is further compounded by the variety of operationalizations and approaches used to measure EF. As Welsh (2002) notes, developmental differences observed across studies may reflect distinct facets of specific EF domains, depending on the nature of the tasks or instruments used. Taken together, these conceptual and methodological differences make it difficult to adopt a unified model of EF development. Therefore, in the current thesis, I begin with a broad overview of EF development before narrowing the focus to how EF develops as observed through behavioral rating scales—specifically the BRIEF2—across informants and developmental stages.

In general, researchers agree that EF development is a protracted process, with early onset in childhood and extending into early adulthood (e.g., Diamond, 2013; Ferguson et al., 2021). Much of the research on the development of EF relates to components initially conceptualized by Miyake and colleagues (2000), (i.e., inhibition, working memory, and cognitive flexibility), and shows that EF matures

throughout adolescence. For example, inhibitory control, which involves resisting distractions or suppressing impulsive responses, improves significantly during this period, enabling adolescents to better regulate behavior, emotions, and attention (Crone et al., 2006; Diamond, 2013). Working memory—the ability to hold and manipulate information over short periods—also strengthens throughout adolescence, contributing to improved learning, reasoning, and self-monitoring (Ahmed et al., 2022). Cognitive flexibility, which is the ability to shift perspectives or adapt to changing demands, is known to develop more slowly and remains under refinement well into adolescence and even early adulthood (Garon et al., 2008; Gupta et al., 2009). Some studies have shown that during adolescence, EF becomes increasingly sophisticated, integrating lower-level skills such as attention and response inhibition with more advanced abilities like cognitive flexibility, planning, and problem-solving (Vink et al., 2020).

In clinical populations, EF development in children with NDDs is known to deviate from normative trajectories. Several theoretical models propose that EF develops gradually and hierarchically, with complex skills building on foundational abilities (e.g., Barkley, 1997). According to Barkley's influential framework, inhibition develops early on, setting the stage for more advanced functions such as working memory and cognitive flexibility. In typically developing children, this sequence unfolds progressively, while in children with ADHD, the trajectory is delayed. Early deficits (e.g., in inhibition) are more evident in childhood, whereas difficulties in later-maturing functions (e.g., working memory and set-shifting) might persist into adolescence. Barkley (1997) also noted that some EF delays only become apparent once those functions have matured in typically developing peers.

Recent meta-analytic evidence indicates that delayed EF development is a transdiagnostic hallmark of many pediatric NDDs (Sadozai et al., 2024). Moderate EF impairments have been observed in children with ADHD, autism spectrum disorder (ASD), and special learning disability (SLD), while children with tic disorders (TD) showed smaller deficits. Children with ADHD tended to have marked difficulties in attention, working memory, inhibition, and planning, whereas children with ASD exhibited greater set-shifting impairments. Comorbid NDDs have also been linked to more severe EF difficulties compared to singular diagnoses (Sadozai et al., 2024).

Similar EF developmental delays were observed in Swedish longitudinal investigations (e.g. Tillman et al., 2015), which followed children with externalizing behavior problems—including ADHD, oppositional-defiant disorder (ODD), and conduct disorder (CD)—over four years. Inhibition and sustained attention were assessed in middle childhood (ages 8–12), and working memory and set-shifting in early adolescence (ages 12–15). Early inhibition—but not sustained attention—predicted later working memory, supporting the hierarchical structure of EF. Children with ADHD showed pronounced inhibition and attention deficits in childhood, with additional working memory impairments persisting into

adolescence. Set-shifting difficulties emerged only in adolescence, suggesting a later developmental trajectory compared to typically developing peers. Notably, early inhibition deficits accounted for later working memory difficulties, reinforcing the idea that foundational EF disruptions may contribute to more complex impairments later on.

EF Development and Gender Differences Through the Lens of the BRIEF2

As previously stated, Welsh (2002) describes how developmental differences observed across studies may reflect distinct facets of specific EF domains, depending on the nature of the tasks or instruments used. Viewed in terms of the BRIEF2, EF development can be explored from a more contextual, behavioral perspective (Gioia et al., 2015). However, there are relatively few studies that take this approach.

Drawing on a large Dutch sample of children and adolescents aged 5 to 18, Huizinga et al. (2023) analyzed parent-, teacher-, and self-reports on the BRIEF2 and found significant age-related improvements across most EF domains. EF difficulties were generally more pronounced in younger children and decreased with age, particularly in inhibition, flexibility, and emotional control. However, certain domains, such as self-monitoring, sometimes showed an increase in difficulties during late adolescence, likely reflecting the growing demands for autonomous regulation during this period.

In terms of gender, the same Dutch study revealed small but statistically significant differences across informants. According to teacher and parent ratings, boys were consistently rated as having greater EF difficulties than were girls, particularly in domains related to behavioral regulation. Self-reports revealed the opposite pattern: girls reported greater EF difficulties than did boys, although these differences were small. Similar gender-related trends were reported in other populations. For instance, Moura et al. (2023), using the Portuguese BRIEF2 parent-report version, found that boys exhibited greater difficulties than did girls across five scales: Inhibit, Self-Monitor, Initiate, Plan/Organize, and Task-Monitor. These differences were also reflected in higher scores on the Behavioral Regulation Index (BRI), Cognitive Regulation Index (CRI), and Global Executive Composite (GEC), leading the authors to advocate for gender-specific norms in some contexts.

Supporting these findings, Jiménez and Lucas-Molina (2019) found comparable gender differences in a socially vulnerable Dominican sample, where boys were rated by parents and caregivers as having greater difficulties for the Shift, Initiate, Task-Monitor, and Organization of Materials scales. These findings are consistent with earlier BRIEF and BRIEF2 standardization samples (Gioia et al., 2000, 2015), as well as clinical studies (e.g., Cumming et al., 2021), all pointing to a tendency

for boys to display greater difficulties in behavioral and organizational aspects of EF when rated by parents, caretakers, and teachers.

Taken together, these studies underscore that while EF generally strengthens with age throughout adolescence, individual trajectories may vary by domain, informant, and context. Gender differences have also been observed, particularly in initiation, planning, and behavioral regulation. These findings highlight the need for further investigation and potential use of age- and gender-sensitive interpretations of BRIEF2 ratings.

EF and Mental Health: A Risk and Resilience Perspective

Definition of Mental Health

Much like EF, the definition of mental health is often inconsistent across studies, and remains somewhat conceptually diffuse. In this thesis, I adopt the definition proposed by Swedish authorities, particularly the Swedish National Board of Health and Welfare (Socialstyrelsen, 2024). According to this definition, mental health comprises both well-being and mental ill-being. Well-being is the positive dimension of mental health and is not defined by the absence of illness or challenges. Rather, it involves the capacity to balance positive and negative emotional experiences, be satisfied with one's life and have a sense of purpose, and cultivate meaningful social relationships that support personal development. In contrast, mental ill-being is a broad concept that includes psychological difficulties of varying intensity and duration, which may cause distress for the individual or their surroundings. This encompasses both subclinical mental health problems—such as low mood, symptoms of distress and anxiety, and sleep disturbances—and clinical conditions like depression and anxiety disorders and NDDs, which are particularly relevant for EF (Socialstyrelsen, 2024).

NDDs: National Prevalence and Gender Differences in ADHD and ASD

Among the most common NDDs are attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD). ADHD is characterized by difficulties with attention regulation, impulse control, and hyperactivity that are inappropriate for the individual's developmental level (American Psychiatric Association, 2013). Symptoms typically emerge in childhood and may persist into adulthood, impacting academic performance, work productivity, and social

relationships. ADHD is commonly categorized into three presentations: predominantly inattentive, predominantly hyperactive-impulsive, and combined. ASD is defined by persistent deficits in social communication and interaction, alongside restricted and repetitive behaviors, interests, or activities (American Psychiatric Association, 2013). The severity of ASD symptoms varies widely, from requiring substantial support to presenting with relatively mild functional impairments.

According to recent Swedish estimates, the prevalence of ADHD and ASD among children and adolescents in Stockholm County has steadily increased. As of 2023, 6.1% had received an ADHD diagnosis and 3.1% an ASD diagnosis (Jablonska et al., 2024). Notably, the increase has been more substantial in girls: since 2011, ADHD diagnoses have increased sixfold and ASD diagnoses fivefold among girls, compared to threefold increases for boys. Adolescents aged 13–17 have the highest diagnostic rates, with 15.1% of boys and 11.4% of girls having an ADHD diagnosis. Gender disparities in referral patterns have also been observed: boys aged 0–12 were twice as likely as girls to undergo neuropsychiatric assessment, whereas girls were more frequently assessed in adolescence. These trends may reflect gender differences in symptom presentation or diagnostic bias. Comorbidity is common, with over 50% of psychiatric service users aged 0–17 also having a diagnosis of ADHD or ASD.

National guidelines from Sweden's National Board of Health and Welfare (2024) emphasize the importance of early, individualized assessment and intervention for ADHD and ASD. Evaluations should be conducted by multidisciplinary teams using evidence-based tools, including structured interviews, observations, and behavior rating inventories. A focus on EF is recommended to help identify support needs and guide interventions, particularly in educational settings. These guidelines also advocate for cross-sectoral collaboration among healthcare providers, schools, and social services to ensure coordinated care and improved outcomes.

Despite the existence of these guidelines, Swedish data confirms gender differences in symptom presentation and referral, with girls generally being more likely to be referred to specialist services for emotional concerns such as anxiety or depression, and boys presumably not for emotional concerns, but EF difficulties through referral for suspected NDDs like ADHD (Klefsjö et al., 2021). This gender disparity may contribute to delayed or missed identification of EF deficits in girls, particularly when these deficits are masked by compensatory strategies, highlighting a need for more research and appropriate intervention (Klefsjö et al., 2021).

Anxiety and Depression: National Prevalence and Gender Differences

Anxiety is a psychological state characterized by excessive worry, tension, and physiological arousal—such as restlessness or an elevated heart rate—often accompanied by a persistent expectation of potential threat, even in the absence of immediate danger (American Psychological Association, 2025a). Depression, on the other hand, is marked by prolonged periods of sadness, reduced interest in previously enjoyed activities, and disruptions in cognitive and emotional functioning. Individuals with depression often report hopelessness, fatigue, and difficulties with concentration, which can significantly impair daily life functioning (American Psychological Association, 2025b). Both anxiety and depression exist on a continuum, ranging from subclinical symptoms to severe, diagnosable disorders requiring clinical attention. In this thesis, I refer to both internalizing symptoms (i.e., self-reported symptoms of anxiety and depression as assessed through rating scales) and clinical conditions (i.e., anxiety and depressive disorders diagnosed by clinicians using standardized diagnostic instruments, as described later).

Both anxiety and depression are reported to have increased among children and adolescents in recent years, both in Sweden (e.g. Blomqvist et al., 2019; Socialstyrelsen, 2020) and internationally (e.g. Armitage et al., 2025; WHO, 2021). National data from Sweden show that depressive conditions among children and adolescents aged 10–18 are often moderate but recurrent. Anxiety-related diagnoses frequently present as mixed anxiety-depressive states or acute stress reactions. Swedish clinicians commonly assign unspecified diagnoses, particularly for depression, often with co-occurring anxiety; this suggests a certain diagnostic ambiguity regarding symptom origins, comorbidities, and severity levels. Such early-onset internalizing conditions are associated with a heightened risk of chronic impairment, sustained use of psychiatric services, and long-term pharmacological treatment (Socialstyrelsen, 2020).

Notably, there is an overrepresentation of Swedish girls aged 10–17 seeking psychiatric help for anxiety and depressive symptoms. While the causes of this trend remain unclear, one plausible explanation is that the increased public awareness of and reduced stigma for these conditions have led to greater help-seeking and diagnostic detection. However, even if the increase does reflect improved reporting rather than true prevalence shifts, the observed growth in psychiatric medication prescriptions—particularly among adolescent girls—suggests a pressing need for more targeted research and early intervention (Socialstyrelsen, 2020). Similarly, another more recent national report highlights that gender differences in well-being persist among Swedish youth, with girls consistently reporting lower life satisfaction and mental well-being compared to boys across all age groups. In particular, 13- and 15-year-old girls rate themselves as lower in self-efficacy and self-esteem relative to their male peers (Folkhälsomyndigheten, 2023).

EF and Mental Health

Although EF has been most extensively studied within the context of NDDs, emerging research highlights its relevance for internalizing problems such as anxiety, depression, and emotional distress (e.g., Shi et al., 2019). Understanding EF in the broader context of mental health is crucial, as individual differences in EF have been linked to diverse developmental outcomes, including academic achievement (Best et al., 2009; Miller et al., 2012; Valiente et al., 2013), social competence (Sprague et al., 2011; De Panfilis et al., 2013), physical health (Hall et al., 2006; Falkowski et al., 2014), and susceptibility to problematic substance use (Nigg et al., 2006; Ersche et al., 2012).

More specifically, Zelazo (2020) highlights the critical role of EF in psychopathology from a neurodevelopmental perspective. EF difficulties are considered a transdiagnostic marker, meaning impairments in EF are observed across a range of mental health conditions, including ADHD, ASD, CD, depression, and anxiety. These difficulties are linked to both internalizing and externalizing problems, and disruptions to EF development may be triggered by environmental stressors such as adverse childhood experiences. These disruptions can undermine the neural systems supporting EF, increasing the risk of broader psychopathological outcomes. Furthermore, Zelazo (2020) discusses the potential of EF training as a transdiagnostic intervention. By promoting EF skills through scaffolded practice and autonomy-supportive environments, it may be possible to mitigate the onset of psychopathology during developmental windows such as early childhood, adolescence, and late adolescence.

Similarly, in a large cross-sectional study with 2,395 children aged 6–12 years, Martel et al. (2017) found a connection between EF and the general psychopathology factor (p factor)—a construct broadly reflecting different aspects of mental health. Performance on a battery of EF tasks was associated with the risk of a latent p factor but not specific factors. This relationship emphasizes that EF deficits are not only a feature of specific disorders but also of mental ill health in general, underscoring the importance of EF for understanding child mental health as a whole.

In addition to the deficit-based perspective, a growing body of research highlights EF as a protective factor supporting mental well-being. Strong EF may promote resilience through effective problem-solving, adaptive coping strategies, and enhanced social functioning (Best & Miller, 2010; Compas et al., 2017). A recent meta-analysis by Yang et al. (2022), synthesizing data from 167 longitudinal studies with over 66,000 participants, confirmed that stronger EF predicted lower levels of a wide range of psychopathologies, including ADHD, conduct problems, substance use, and internalizing symptoms. Youth with stronger EF were more likely to demonstrate emotional regulation and resilience in stressful contexts.

Taken together, these findings highlight how EF plays an important role in the development and manifestation of psychopathology. EF impairments do not appear to be limited to individual disorders but are integral to understanding the complexity of mental health across different populations. They also point to the potential of interventions that specifically target EF for preventing or alleviating the impact of psychopathology across the lifespan.

EF in ADHD and ASD

NDDs such as ADHD and ASD are closely linked to EF difficulties, with research indicating a bidirectional relationship between EF impairments and these conditions, influenced by both genetic and symptomatic factors (e.g., Chang et al., 2020; Biederman et al., 2004; Corbett et al., 2009; Shanmugan et al., 2016). Despite much heterogeneity among young people with ADHD, many show greater EF impairments than do typically developing peers (Frazier et al., 2004; Pievsky & McGrath, 2018; Willcutt et al., 2005). Meta-analytic findings indicate deficits across multiple EF domains, including working memory, attention, inhibition, and planning (Frazier et al., 2004; Ramos et al., 2020; Schachar, 2023). Similarly, youth with ASD frequently demonstrate EF difficulties—especially in cognitive flexibility, self-monitoring, emotional regulation, and behavioral control—with some evidence suggesting more pronounced difficulties among girls (Gentil-Gutiérrez et al., 2022; Demetriou et al., 2018; Lai et al., 2019).

EF & Internalizing Symptoms: Anxiety and Depression

There is a growing body of research indicating that EF impairments are present in various child and adolescent psychiatric disorders and are linked to both the emergence and maintenance of internalizing symptoms such as anxiety and depression (Willcutt et al., 2005; Bora et al., 2009; Snyder, 2015). Importantly, EF may function both as a risk factor for and a consequence of psychopathology: cross-sectional studies show associations between poor EF and increased psychiatric symptoms (Kavanaugh et al., 2019; Mullin et al., 2020), while longitudinal studies suggest bidirectional influences between EF and mental health over time (Brieant et al., 2022; Romer & Pizzagalli, 2021). Mullin et al (2020) investigated the relationship between behavioral EF impairments (as measured by the BRIEF) and internalizing symptoms in adolescents. They found that adolescents who self-reported EF difficulties exhibited significantly higher levels of internalizing symptoms, such as anxiety and depression, which supporting their hypothesis that subjective perceptions of EF deficits are linked to mental health challenges.

Some research points to how certain EF domains, such as working memory and cognitive flexibility (which arguably mirror the Shift scale of the BRIEF2), appear particularly important for internalizing symptom development. Youth with poor

cognitive flexibility may struggle more with ruminative thinking, increasing their vulnerability to anxiety and depression (Snyder et al., 2015). Emotional regulation, often considered an EF-related process, also plays a central role in managing emotional distress and adapting to stressors (Zelazo & Carlson, 2012).

Interestingly, some studies have indicated that EF is more strongly associated with depression than with anxiety in the general population (e.g. Yang et al., 2022). Specifically, poorer EF is linked to increased depressive symptoms over time (albeit with a small effect size) but there is no significant association between early EF and later anxiety symptoms. Additionally, only "cool" EF tasks (those involving emotionally neutral processes like inhibition and working memory) predicted internalizing outcomes; "hot" EF tasks, involving emotion and reward, were not significantly related. These findings suggest that while EF contributes to mental health trajectories, its predictive strength may vary with the symptom domain and assessment method (Yang et al., 2022).

In a Nordic context, longitudinal studies have contributed valuable insights into the links between rating-based behavioral EF and psychopathology. A recent Norwegian study found that impaired behavioral EF (as rated by the BRIEF2) predicted greater symptoms of depression, anxiety, ADHD, and ODD/CD, suggesting reciprocal relationships between EF impairments and psychiatric symptoms (Halse et al., 2022). Another Norwegian study revealed that behavioral EF (as measured by the BRIEF) was significantly associated with internalizing symptoms, but not intelligence, among youth with intellectual disabilities (Gravråkmo et al., 2025).

EF in Youth with Comorbidity and Complex Clinical Profiles

Children and adolescents with comorbid ADHD and ASD often exhibit more severe EF difficulties and are at elevated risk for internalizing disorders (e.g. Sadozai et al., 2024; Hamilton et al., 2024). Anxiety and depression also frequently co-occur with these conditions. Anxiety is present in 11–84% of youth with ASD (White et al., 2009) and 25–42% of those with ADHD (Mayes et al., 2009; Mitchison & Njardvik, 2019); depression is also common, affecting 10–14% of youth with ASD (Simonoff et al., 2008; Leyfer et al., 2006) and 4–20% of those with ADHD (Mitchison & Njardvik, 2019; Meinzer et al., 2014). In Sweden, 30% of children with ASD and 40% with both ADHD and ASD remained in psychiatric care one year after diagnosis (Jablonska et al., 2024). Youth with these conditions often struggle with persistent challenges in school attendance, peer relationships, and daily functioning. Early identification and intervention—including psychoeducation, behavioral therapies, cognitive supports, and medication—are emphasized in national guidelines to prevent long-term adverse outcomes such as school dropout, depression, and substance misuse.

Studies also suggest that strong EF abilities in youth with NDDs, particularly ASD, are associated with increased resilience and lower rates of internalizing symptoms (Dajani et al., 2016; Genet & Siemer, 2011; Iacoviello & Charney, 2014). Conversely, difficulties with EF—particularly in flexibility and inhibition—are associated with greater psychosocial challenges, including anxiety and depression (Baribeau et al., 2020; Hollocks et al., 2014; Jarrett & Ollendick, 2008; Lawson et al., 2015; Snyder et al., 2015). Swedish studies further show that internalizing symptoms are underrecognized in youth with ADHD and ASD, particularly by parents (Davidsson et al., 2017), which indicates the need for multi-informant assessments and context-sensitive tools to ensure accurate diagnosis and effective intervention.

EF and Academic Achievement

In addition to its relevance for mental health, EF plays a critical role in academic development and school performance—another focus of this thesis. Studies have consistently linked EF to academic performance (e.g. Gathercole & Pickering, 2000; Swanson & Beebe-Frankenberger, 2004), with EF abilities in early childhood predicting later academic performance, including literacy and mathematics outcomes (Bull et al., 1999; Bull & Scerif, 2001; Dekker et al., 2017; Mulder et al., 2017; Ribner et al., 2017). More specifically, deficits in working memory, inhibitory control, and cognitive flexibility are associated with struggles in mathematics and reading (Blair & Raver, 2015). However, there are few meta-analytic reviews of the link between EF and learning, and more longitudinal research is needed (Spiegel et al., 2021).

As for rating-based EF and academic outcomes, research using the BRIEF/BRIEF2 has expanded our understanding of the predictive value of EF for academic outcomes. In a longitudinal study by Samuels et al. (2016) with middle school students, teacher-rated BRIEF scores significantly predicted grade point average (GPA) in English, math, science, social studies, and Spanish from grades 6 to 9. The predictive value of EF remained significant even when controlling for gender, socioeconomic status, and the presence of individualized education plans.

Samuels et al. (2019) and Samuels et al. (2023) also examined teacher- and student-rated EF using the BRIEF. Across grades 6 to 12, both self- and teacher-rated EF predicted GPA, with teacher ratings being the stronger predictors. In a sample of 688 students—34% of whom had a diagnosed disability (e.g., learning disabilities, ADHD, or another neurodevelopmental condition)—teacher-rated EF scores were associated with performance across different subjects, particularly language-based ones. The behavioral regulation and metacognitive subscales of the BRIEF were

especially predictive. These findings emphasize that teachers' evaluations of EF may capture school-relevant behaviors more effectively than do self-reports.

Few studies have simultaneously used performance-based EF tests and BRIEF/BRIEF2 ratings. An exception is that by Dekker et al. (2017), who found that cognitive EF measures were more predictive of math performance, while both cognitive and rating-based EF assessments predicted spelling performance in Dutch students aged 6–8. Notably, teacher ratings had unique predictive value beyond that of performance-based EF measures; however, parent ratings did not add significant explanatory power.

A similar pattern was observed in a more recent Chilean study by Pino Muñoz and Arán Filippetti (2021), which used BRIEF2 parent- and teacher ratings alongside cognitive EF tests. BRIEF2 teacher ratings were strongly associated with academic outcomes in language, mathematics, and natural sciences. Among the three regulatory indices (BRI, ERI and CRI), the CRI—which reflects working memory, planning, organization, and task monitoring—had the strongest and most consistent associations with academic performance. Teacher ratings were again more predictive than were parent ratings, suggesting that informant context plays a significant role in identifying EF-related difficulties that impact school functioning.

EF, Academic Challenges, and the Swedish Context

While I do not intend to evaluate Swedish educational performance directly, this national data does provide important context for understanding the rationale behind linking EF, mental health, and academic outcomes, while analyzing potential gender differences.

According to the PISA 2022 results, Swedish 15-year-olds are showing declining performance in mathematics and reading comprehension, returning to levels observed a decade ago—paralleling international trends (OECD, 2023). While data on school attendance in Sweden is limited, absenteeism is also growing concern. While a comparative PISA-based study examining self-reported absenteeism in Sweden, Germany, Japan, and the UK found that Swedish students reported lower rates of full-day absences than did UK students (Swedish Research Council, 2023), national organizations such as the Parents' Network for the Right to Education have observed a sharp rise in problematic school absenteeism. The number of homebound students due to school refusal has doubled in just four years, increasing from approximately 8,500 to 17,000. Additionally, an estimated 140,000 students—many diagnosed with ADHD and/or ASD—are now considered at risk for problematic absenteeism, defined as missing over 20% of school days. Despite these alarming trends, Sweden currently lacks a systematic, nationwide approach to collecting attendance data, and budget constraints in some municipalities have further reduced

support services for students with special educational needs (Föräldranätverket Rätten till Utbildning, 2023).

Recent national findings from 2021/2022 have shown a continued decline in school satisfaction among Swedish adolescents, with fewer 13- and 15-year-old students reporting that they enjoy school than in previous years. Simultaneously, perceived academic pressure has steadily increased among both girls and boys across all age groups since 2009/10, while indicators of the social climate in school have worsened, including decreasing levels of perceived peer support and a growing number of students reporting experiences of bullying (Folkhälsomyndigheten, 2023). An increasing number of Swedish school children also experience stress related to schoolwork and report multiple psychosomatic health complaints. School-related stress is strongly linked to more frequent health complaints and lower life satisfaction, with evidence suggesting a bidirectional relationship between stress and well-being (Folkhälsomyndigheten, 2024).

These trends have become more pronounced following the 2011 school reform, which introduced earlier grading, more national tests, and stricter academic requirements. The resulting increase in academic pressure has been associated with reduced academic confidence and more health complaints, particularly among girls. Sweden's Public Health Agency have emphasized the importance of supportive school environments and sufficient resources for teachers to help students manage academic demands—benefiting both learning and mental health (Folkhälsomyndigheten, 2024).

The most recent national data also indicate a narrowing of gender differences in Swedish students' school performance, but this trend is primarily explained by declining results among girls rather than improvements among boys. The downturn is particularly evident in mathematics, where boys now outperform girls for the first time, and is most pronounced among girls with a Swedish background, regardless of socioeconomic context. Contributing factors include lower school satisfaction, increased stress, reduced confidence in mathematics, less perceived teacher support, and heavier use of social media, alongside broader declines in girls' well-being. While boys—especially with an immigrant background—have shown improved outcomes, the negative development among girls signals the need for systematic monitoring and targeted interventions (Skolverket, 2025).

Knowledge Gaps, Rationale, Aims

EF is widely recognized as a central construct in developmental psychology and clinical neuroscience, with important implications for understanding both typical and atypical patterns of cognitive, emotional, and behavioral regulation in youth. Although much of the existing literature has focused on EF in clinical populations—particularly those with NDDs—several important knowledge gaps remain. Below, I outline the primary gaps that this thesis aims to address.

A major gap is in the validation and limited use of behavior-based assessments of EF, especially outside of clinical contexts. Much of the EF literature has relied on performance-based measures, such as neuropsychological tests administered under controlled conditions in labs. These methods, while standardized and objective, often do not capture how EF difficulties are expressed in real-life settings, unlike behavior rating scales such as the BRIEF2 (Gioia et al., 2015). However, despite the BRIEF2's widespread clinical use, the Swedish version has lacked psychometric validation, which undermines its utility in both research and practice.

This doctoral thesis addresses these gaps by using behavioral expressions of EF as measured by the Swedish adaptation of the BRIEF2, drawing on multi-informant data (self-, parent-, and teacher-reports), with the objective of validating the instrument psychometrically in a Swedish context. This can enhance its value in both Swedish clinical and educational settings.

Another critical gap concerns the underrepresentation of community samples in EF research. While EF difficulties are well-documented in children and adolescents with NDDs, less is known about how such difficulties manifest in youth experiencing internalizing problems, such as anxiety, depression, and emotional distress, whether formally diagnosed (with or without comorbid NDDs) or at subclinical levels. Despite growing evidence that EF impairments contribute to the development or maintenance of internalizing symptoms, there are still few studies in this area overall. This thesis aims to expand understanding by examining behavioral EF in relation to a broad spectrum of mental health indicators, including both clinical diagnoses and subclinical psychological symptoms.

Besides mental health, academic achievement is a key area of functional impact for youth with EF difficulties. Numerous studies have linked core EF domains—such as working memory, cognitive flexibility, and inhibition—to success in academic settings (e.g., Gathercole & Pickering, 2000; Best et al., 2011). Moreover, EF is known to continue maturing throughout adolescence, with refinements in higher-order regulation and planning supporting increasingly complex academic demands. However, few studies have examined how behavioral EF, particularly as rated by multiple informants, relates to academic outcomes in diverse school subjects or across educational stages. This thesis addresses that gap by focusing specifically on

self- and teacher-rated EF in relation to academic achievement, while controlling for self-reported internalizing problems and NDDs.

Additional underexplored areas include gender and age differences in EF development and the degree of agreement between informants for behavioral EF measures such as the BRIEF2, which have important implications for the accuracy of EF assessments and intervention planning. Multi-informant discrepancies are common in EF research and may reflect contextual variations in how behaviors are perceived across home, school, and individual perspectives.

Aims and Research Objectives

Building on the above identified gaps in the literature and the need for more ecologically valid, multi-informant assessments of EF, this thesis was designed with the following overarching aim and research objectives.

The overarching aim is to advance current understanding of behavioral EF in youth, as assessed by the Swedish version of the BRIEF2, through examination of its psychometric properties, clinical relevance, and associations with mental health and academic achievement. I approach EF from an ecological perspective—how it manifests in everyday life—using multi-informant data (self-, parent-, and teacher ratings) collected across both clinical and community samples.

The thesis has four core objectives addressed across the four articles included:

(1) To evaluate the psychometric properties of the Swedish version of the BRIEF2, including its factor structure, internal consistency, inter-rater reliability, and measurement invariance, in a gender- and age-balanced community sample across self-, parent-, and teacher-report forms.

(2) To explore age- and gender-related differences in behavioral EF within the community sample as assessed through multiple informants.

(3) To identify behavioral EF profiles across diverse clinical groups, including both youth with NDDs and those with other psychiatric conditions (non-NDDs), in comparison with each other and community controls.

(4) To identify associations of behavioral EF, in terms of student and teacher ratings on the BRIEF2, with mental health and academic achievement in a community sample of adolescents.

Methods

Participants

The studies included both community and clinical samples. Studies I and IV were based on a community sample of adolescents recruited from schools in southern Sweden. In contrast, Studies II and III focused on clinical samples of adolescents who had been referred to child and adolescent psychiatric services for various psychological concerns. In Study III, community controls were selected from the sample used in Studies I and IV and matched on gender and age.

Community Sample

Study I involved a broad normative sample of Swedish children and adolescents. The self-report form of the BRIEF2 was completed by 1,257 students aged 11–18 years (51.8% girls), of whom 19.1% had a foreign background[1]. The parent-report form was completed by 1,340 parents of children aged 5–18 years (46.7% girls); 11.1% had a foreign background. Respondents included 54.7% mothers and 42.8% fathers, and their educational backgrounds were diverse. The teacher-report form was completed by 38 teachers, who assessed a total of 510 adolescents aged 13–18 years (58.4% girls), with each rating an average of 15 students. Teachers were selected based on their roles as class mentors and their familiarity with the students. Data for inter-informant comparisons were available for a subset of participants. A total of 226 individuals (102 girls and 124 boys) had both self- and parent-report data, while 508 individuals (297 girls and 211 boys) had both self- and teacher-report data. Participants with self- or parent-reported NDD (10.8%) were excluded from the analyses for this study.

Study IV included a subsample of youth from Study I, specifically those for whom teacher ratings of EF were also available. This subsample consisted of 393

[1] A child is considered to have a foreign background if they were born abroad with at least one foreign-born parent, or born in Sweden with both parents born abroad, according to Statistics Sweden.

adolescents in grades 7–9 (180 girls, 210 boys, 3 identifying as other; M = 14.0 years, SD = 0.87), of whom 25.4% reported a foreign background. In total, 38 teachers participated, each rating between 2 and 38 students (average = 15). Teachers were selected based on their knowledge of the students. All students completed the BRIEF2 Self-Report Form, while their teachers completed the BRIEF2 Teacher Form.

Clinical Samples

The clinical samples in this thesis were drawn from two separate studies conducted at specialized child and adolescent psychiatric outpatient clinics in southern Sweden.

Study II included 163 children and adolescents (M_{age} = 13.6, SD = 2.7; 67% female) part of a larger project investigating the emotional and cognitive processes of pediatric OCD. Of the sample, 96 were diagnosed with OCD as their primary disorder and 67 were diagnosed with other anxiety disorders, including generalized anxiety disorder (38%), social anxiety disorder (28%), specific phobia (12%), separation anxiety disorder (11%), and panic disorder (11%). Importantly, none of the participants in the other anxiety disorder group met the diagnostic criteria for OCD. Additionally, 21% of the full sample had co-occurring NDDs, including ASD (6%) and ADHD (18%).

Study III included 79 clinically referred children and adolescents aged 7–17 years (M_{age} = 12.1, SD = 3.0; 50.6% girls) who underwent a comprehensive psychiatric assessment at an outpatient child and adolescent psychiatry (CAP) clinic in southern Sweden. The clinical group was compared with 151 matched controls (M_{age} = 12.4, SD = 2.8; 51.7% girls) drawn from the community sample from Study I. Diagnoses were based on structured evaluations, including developmental history, standardized rating scales, and the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID), in line with DSM-5 criteria (American Psychiatric Association, 2013). The sample was transdiagnostic and included youth with a range of conditions such as ADHD, ASD, OCD, anxiety disorders, depression, stress- and trauma-related disorders, ODD, and CD. Youth with intellectual disability were excluded. For analysis, participants were grouped into (1) Only NDD group (n = 20, 25.3%), (2) NDD and non-NDD comorbid psychiatric group (n = 32, 40.5%), (3) Only non-NDD comorbid psychiatric group (n = 27, 34.2%).

Procedure

The four studies in this thesis employed a combination of clinical and school-based procedures, with ethical approvals obtained from the Swedish Ethical Review Authority (Study I: 2021-01666; Study II: 2015/663; Study III: 2020–05885, 2021–01666; Study IV 2021-01666, 2023-01013-02). Informed consent was collected from all participants, and in accordance with Swedish law, additional parental consent was obtained for children and adolescents under the age of 15. Participants were informed about the voluntary nature of the research and their right to withdraw at any time without penalty or impact on their treatment (this applies to Studies II and III, which involved clinical samples).

Studies I and IV involved school-aged children and adolescents recruited from regular schools in southern Sweden and through an external data collection service. The BRIEF2 was completed digitally, by parents at home and by students and teachers at school. Demographic data were collected from all respondents. Teachers selected to complete the BRIEF2 ratings were class mentors who were familiar with the students. They received clear instructions and were compensated 50 SEK for each completed rating.

Study II was conducted at a specialized outpatient clinic for pediatric OCD. Diagnostic status was assessed at intake using the MINI-KID. Participants with OCD also completed the CY-BOCS at both intake and follow-up, with an average follow-up interval of 13.3 months. Treatment data were collected: all OCD participants were offered exposure-based cognitive behavioral therapy (CBT), of whom 78% participated and 31% received combined CBT and selective serotonin reuptake inhibitor (SSRI) treatment. The average number of CBT sessions was 9.3.

Study III recruited youth referred for comprehensive psychiatric evaluations at CAP clinics. All participants underwent diagnostic interviews using the MINI-KID, supplemented by developmental history and standardized rating scales. BRIEF2 parent-report forms were administered following clinical intake. Children with intellectual disability were excluded. At the time of participation, children and adolescents were either awaiting a full diagnostic work-up or were receiving treatment (e.g., CBT or pharmacological interventions). For the typically developing control group, matched adolescents were selected from the community sample used in Study I.

Materials

Each measure used in the studies comprising this thesis was selected based on its relevance for assessing EF, clinical diagnoses, mental health, well-being, and academic outcomes in children and adolescents included across the four studies.

Assessment of EF: BRIEF and BRIEF2

The BRIEF, developed by Gioia et al. (2000), is one of the most widely used rating scales for assessing everyday EF in children and adolescents aged 5–18 years. It was originally designed for completion by parents and teachers, but a self-report version for adolescents was introduced later (Guy et al., 2004). The original BRIEF included 86 items across eight subscales—Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. These were grouped into two higher-order indices: the Behavioral Regulation Index (BRI) and the Metacognition Index (MI). Subsequent analysis of the Parent Form (Gioia et al., 2002) led to a revised nine-scale configuration, with the Monitor scale being divided into Self-Monitor and Task Monitor. It also introduced a three-factor model including the BRI, MI, and a new Emotion Regulation Index (ERI).

In 2015, the instrument was revised and published as the BRIEF2 (Gioia et al., 2015). The updated version reduced the item count to 63, retained the nine-scale structure, and reorganized the indices into the BRI, ERI, and Cognitive Regulation Index (CRI) (formerly MI). Confirmatory factor analyses for both normative and clinical samples supported this three-factor structure. The BRIEF2 also introduced three validity scales—Inconsistency, Negativity, and Infrequency—to evaluate response quality. The Inconsistency scale flags contradictory responses across paired items; scores ≤ 4 are considered acceptable. The Negativity scale identifies overly negative response patterns, with scores ≤ 2 falling within the acceptable range. Finally, the Infrequency scale detects atypical item endorsements rarely seen even in clinical populations; scores above 0 on this scale are uncommon. Collectively, these validity indicators enhance the interpretability and reliability of BRIEF2 ratings (Gioia et al., 2015).

The Swedish version of the BRIEF2 was initially published as separate translations based on informant: the BRIEF (parent and teacher forms) and BRIEF-SR (self-report form). These three forms were later integrated into the unified BRIEF2. The original American version of the BRIEF2 included several item-level and structural revisions compared to earlier versions. Rather than relying on the earlier Swedish translations and translating only the new items, a full retranslation of all BRIEF2 items was undertaken. The translation process was carried out by the Swedish branch of the Hogrefe Publishing Group, which owns the distribution rights for the

BRIEF2 in Sweden. According to the head of test development at Hogrefe Sweden, this process involved several steps: first, all items were translated by a professional translation agency specializing in psychometric instruments. The translated items were then reviewed independently by a psychologist with expertise in EF and by psychologists on Hogrefe's development team. The reviewers' comments were compiled and discussed in a joint session to finalize the item formulations, considering their meaning, construct relevance, intended use, and alignment with their respective scales. Finally, the items were proofread by an external language expert to ensure clarity, linguistic quality, and ease of understanding.

Until now, the BRIEF2 has been administered in Sweden using the original American manual and normative data, based on ratings collected in 2013–2014 from a total of 3,603 respondents (1,400 parents, 1,400 teachers, and 803 children and adolescents), alongside a Swedish administration manual (quick guide) and Swedish-language forms.

The three versions of the BRIEF2

The BRIEF2 Self-Report Form

The self-report form is designed for respondents aged 11–18 years. It comprises 55 items divided into seven clinical scales: Inhibit, Self-monitor, Shift, Emotional Control, Task-Completion, Working Memory, and Plan/Organize. These scales contribute to three higher-order indices: the Behavioral Regulation Index (BRI; comprising Inhibit and Self-Monitor), the Emotional Regulation Index (ERI; comprising Shift and Emotional Control), and the Cognitive Regulation Index (CRI; comprising Task-Completion, Working Memory, and Plan/Organize). Together, these indices are used to calculate a Global Executive Composite Index (GEC), which serves as a comprehensive indicator of an individual's EF (Gioia et al., 2015).

The BRIEF2 Parent-Report Form

The parent-report form is designed to gather supplementary information about the EF of children and adolescents aged 5 to 18. It encompasses 63 items categorized into nine clinical scales. Seven of these scales mirror those in the self-report form: Inhibit, Self-Monitor, Shift, Emotional Control, Initiate[2], Working Memory, and Plan/Organize. Additionally, the parent-report version features two extra scales: Task-Monitor and Organization of Materials. These nine scales contribute to three overall indices: the BRI (comprising Inhibit and Self-Monitor), the ERI (comprising

[2] *Note.* Initiate in the parent- and teacher-report forms, Task Completion in the self-report form

Shift and Emotional Control), and the CRI (Initiate, Working Memory, Plan/Organize, Task-Monitor and Organization of Materials); from these, an overall GEC is calculated (Gioia et al., 2015).

The BRIEF2 Teacher-Report Form

The teacher-report form is employed to gather information regarding the EF of children and adolescents aged 5–18. It consists of 63 items divided into nine clinical scales identical to those found in the parent-report form. Like the parent-report form, these nine scales contribute to the computation of three higher-order indices, which are in turn used to calculate a GEC (Gioia et al., 2015).

BRIEF2 Scales and Scoring

Each item in the BRIEF2 is rated on a 3-point Likert scale reflecting the frequency with which the behavior occurs (1 = never, 2 = sometimes, 3 = often). Higher scores indicate more difficulties and thus greater executive dysfunction. The BRIEF2 yields a total score known as the GEC, as well as three broad indices— BRI, ERI, and CRI—which are further divided into nine clinical scales:

The total raw score is transformed into T-scores based on age- and gender-specific normative data. T-scores ≥ 65 are considered clinically elevated and may indicate significant EF difficulties. Scores between 60 and 64 are interpreted as being in the potentially problematic range, while scores below 60 are typically considered within normal limits (Gioia et al., 2015).

The BRIEF2 Clinical Scales and Examples of Items

Inhibit (included in all three versions)

The Inhibit scale assesses an individual's ability to control impulses and stop inappropriate behavior at the right moment. This skill is crucial for self-regulation and social interaction, as difficulties in inhibition may lead to impulsivity, difficulty following rules, and interrupting others. Adolescents who struggle with inhibition often require structured environments to minimize impulsive actions and improve their self-control. This scale consists of eight items, such as:

"Is fidgety"/ "Är rastlös"

Self-Monitor (included in all three versions)

The Self-Monitor scale evaluates how well an individual recognizes and understands their behavior and how it affects others. It specifically measures self-awareness in social situations, which is essential for adjusting behavior to match social expectations. Adolescents with difficulties in self-monitoring may struggle to recognize social cues, leading to challenges in peer relationships and group settings. The Self-Monitor scale includes five items, such as:

"Is unaware of how his/her behavior affects or bothers others"

"Är omedveten om hur hans/hennes beteende påverkar eller stör andra"

Shift (included in all three versions)

The Shift scale measures flexibility, or the ability to adapt to changing situations, switch between tasks, and adjust to new information. This skill is particularly relevant for problem-solving and in academic settings where individuals must transition between subjects or concepts. Adolescents who have difficulty shifting may become stuck in a single way of thinking, resist changes in routine, or struggle with unexpected transitions. This scale consists of eight items, such as:

"Resists or has trouble accepting a different way to solve a problem with schoolwork, friends, tasks, etc."

"Motsätter sig, eller har svårt att acceptera ett annat sätt att lösa ett problem med t.ex. skolarbetet, kompisar, uppgifter"

Emotional Control (included in all three versions)

The Emotional Control scale assesses an individual's capacity to regulate their emotional responses to everyday events. Emotional regulation is essential for maintaining social stability, managing frustration, and effectively handling stress. Difficulties with emotional control may manifest as intense emotional reactions, mood swings, or excessive frustration in response to minor challenges. Emotional Control comprises six items, such as:

"Has explosive, angry outbursts"

"Får häftiga vredesutbrott"

Initiate/ Task Completion[3] *(included in all three versions)*

The Initiate/ Task Completion scale evaluates how well an individual begins tasks independently, generates ideas or solutions, and finishes assignments. Adolescents with poor task initiation may appear unmotivated or dependent on external prompts to start assignments or chores. This difficulty is often mistaken for laziness when it actually reflects an EF challenge in overcoming task inertia. The scale includes seven items, such as:

"Is not a self-starter"

"Har svårt att komma igång med saker på egen hand"

Working Memory (included in all three versions)

The Working Memory scale measures an individual's ability to hold and manipulate information in their mind to complete a task. Working memory is critical for following instructions, problem-solving, and multistep activities. Deficits in this area can result in forgetfulness, losing track of information, or struggling with complex academic tasks. The Working Memory scale consists of eight items, such as:

" When given three things to do, remembers only the first or last"
"Minns bara det första eller sista om han/hon ges tre saker att göra"

[3] *Note.* Initiate in the parent- and teacher-report forms, Task Completion in the self-report form

Plan/Organize (included in all three versions)

The Plan/Organize scale assesses an individual's ability to set goals, develop step-by-step strategies, and organize information effectively. Adolescents with poor planning skills may struggle with long-term assignments, underestimate the time required for tasks, and fail to break projects into manageable steps. Organizational difficulties can also impact memory and information retrieval, making learning more challenging. This scale comprises ten items, such as:

"Does not plan ahead for school assignments"

"Planerar inte skolarbete i förväg"

Task-Monitor (only included in teacher and parent versions)

The Task-Monitor scale evaluates how well an individual reviews their work and checks for errors. Effective task monitoring ensures accuracy and quality control in assignments and problem-solving. Adolescents with difficulties in this area might often make careless mistakes, rush through tasks, or fail to review their work before submission. The Task-Monitor scale includes six items, with some examples extracted from the parent form below:

"Work is sloppy"

"Gör uppgifter slarvigt"

Organization of Materials (only included in teacher and parent versions)

The Organization of Materials scale measures how well an individual organizes their belongings, school materials, and workspaces. Poor organization can result in lost homework, messy desks, and difficulty in finding the necessary supplies, which might hinder academic performance and time management. This scale includes five items, such as:

"Cannot find things in room or school desk"

"Kan inte hitta saker i ett rum eller i skolbänken"

BRIEF2 Validity Scales

Inconsistency

The Inconsistency scale indicates the extent that a respondent answered similar items inconsistently in comparison to responses from normative clinical samples. A high score on this scale indicates that the respondent has answered similar items in a contradictory manner. For instance, a high Inconsistency score might result from answering “Never” to the item “Small events trigger big reactions” but “Often” to “Becomes upset too easily.” The Inconsistency scale does not produce T scores; instead, it sums the absolute differences between eight paired items to create a total difference score. This score is compared to percentile ranks derived from clinical samples to classify the respondent as Acceptable, Questionable, or Inconsistent. An Inconsistency score of ≤4 falls within the Acceptable range, suggesting that the respondent's answers were relatively consistent. (Gioia et al., 2015)

Negativity

The Negativity scale assesses the extent to which the respondent answers certain BRIEF2 items negatively in comparison to clinical samples. This scale identifies unusually negative responses, with higher raw scores indicating a more substantial degree of negativity. In clinical samples, fewer than 3% of respondents scored six or higher on this scale. Similar to the Inconsistency scale, T scores are not calculated for the Negativity scale. A Negativity score of 2 falls within the acceptable range, suggesting that the respondent’s perspective is not excessively negative and that the BRIEF2 protocol is likely valid. (Gioia et al., 2015)

Infrequency

The Infrequency scale evaluates how unusually the respondent endorses certain items, focusing on three items most respondents typically answer in a specific way. Selecting “Sometimes” or “Often” for any of these items is rare, even among individuals with severe impairments. An example of an item belonging to the Infrequency scale is whether the respondent “forgets his or her name.” The items included in the Infrequency scale are listed in the summary table. Higher raw scores indicate a greater level of infrequency, with fewer than 1% of respondents in the standardization sample scoring 1 or higher. Like the Inconsistency and Negativity scales, T scores are not provided for the Infrequency scale. A score of 0 on this scale is considered acceptable, indicating a low likelihood of atypical response patterns (Gioia et al., 2015).

Clinical Assessment and Diagnostic Measures

Clinical Assessments of NDDs: ADHD and ASD

In the clinical sample, ADHD and ASD diagnoses were made by licensed clinical psychologists and child psychiatrists based on a comprehensive, multi-informant assessment process. The diagnostic evaluations incorporated multiple components, such as clinical interviews with the child or adolescent; behavioral rating scales completed by parents, teachers, and the patient when applicable; standardized psychological testing of cognitive abilities and EF; and, where relevant, autism-specific assessments such as the Autism Diagnostic Interview–Revised (ADI-R) and the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2). In determining diagnostic status, clinicians considered the presence and persistence of symptoms, their manifestation across different settings, and the degree of functional impairment. Final diagnostic decisions were based on criteria of the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5) (American Psychiatric Association [APA], 2013), as evaluated through the MINI-KID interview in combination with broader neuropsychological and psychiatric assessment.

Psychiatric Diagnostic Interview Manual: MINI-KID

In Studies II and III, the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID) was employed to help establish psychiatric diagnoses. The MINI-KID is a clinician-administered diagnostic interview for assessing psychiatric conditions in children and adolescents aged 6–17 years, based on the DSM-5 criteria (American Psychiatric Association [APA], 2013). It is a widely used and validated instrument, offering high reliability and diagnostic accuracy across a range of clinical presentations (Sheehan et al., 2010).

Self-reported NDDs

In Studies I and IV, the occurrence of self-reported NDDs was assessed using a single-item question: *"Have you undergone an evaluation and received a confirmed neuropsychiatric diagnosis (e.g., autism, ADHD, ADD)?"* Response options included: "Yes," "No," "No, but we are waiting for an evaluation," and "No, but we have a suspicion." Participants who responded "Yes" were prompted to specify which diagnoses they had received. Some students reported having received multiple NDD diagnoses, such as combinations of ASD and ADHD or ASD and ADD.

Clinical Assessment of OCD Severity and General Functioning

Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS)

The CY-BOCS assesses OCD severity in youth (Scahill et al., 1997) evaluating obsessions and compulsions separately across five dimensions—time occupied, distress, functional interference, resistance, and perceived control—using 5-point Likert-scale items (ranging from 0 to 4), resulting in a total score ranging from 0 to 40. Higher scores indicate more severe OCD symptoms. A score of 14 or above reflects clinically significant OCD, scores above 21 suggest moderate severity, and scores between 30 and 40 indicate severe OCD (Cervin et al., 2022). In Study II, trained clinicians administered the CY-BOCS at both intake and follow-up for participants diagnosed with OCD. All interviews were conducted in the presence of the child or adolescent, and in most cases, one or both parents also participated.

Dimensional Yale-Brown Obsessive Compulsive Scale (DY-BOCS)

The DY-BOCS is a semi-structured, clinician-administered interview designed to assess the severity of obsessive-compulsive symptoms across distinct symptom dimensions (Rosario-Campos et al., 2006). In Study II, severity ratings were obtained for three core OCD dimensions: disturbing thoughts/checking, symmetry/ordering, and contamination/cleaning. Each dimension is scored using three items (rated 0–5) that evaluate time spent, interference, and distress associated with symptoms, yielding a dimensional severity score ranging from 0 to 15. Higher scores reflect greater symptom severity within the given domain. Besides symptom severity, the interview captures the age of OCD symptom onset. The DY-BOCS has shown good validity and clinical utility in Swedish samples of youth with OCD (Cervin et al., 2019).

Children's Global Assessment Scale (CGAS)

As part of the clinical interview in Study II, children and adolescents' overall psychosocial functioning was rated using the Children's Global Assessment Scale (CGAS; Shaffer et al., 1983). The CGAS is a clinician-administered tool that provides a single score ranging from 1 to 100 that reflects a global level of impairment, integrating psychological, social, and academic functioning, without being tied to specific symptom domains. The scale has demonstrated acceptable reliability and validity in clinical populations (Green et al., 1994). Study II used the Swedish translation of the CGAS, which has shown good inter-rater reliability in naturalistic clinical settings (Lundh et al., 2010).

Measures of Mental Health

Anxiety and Depression: Revised Children's Anxiety and Depression Scale (RCADS-25)

Internalizing symptoms were assessed using the Swedish translation of the Revised Children's Anxiety and Depression Scale – short version (RCADS-25), a self-report questionnaire developed to screen for symptoms of anxiety and depression in youth (Ebesutani et al., 2012). The 25-item short form includes items drawn from the original 47-item RCADS and produces separate scores for anxiety and depression, as well as a Total Internalizing score. Respondents rate how often each symptom applies to them using a 4-point Likert scale (0 = *never* to 3 = *always*).

In Study IV, overall internalizing symptoms, as well as anxiety and depression symptoms in the follow-up analyses, were transformed into T-scores using normative data from Carlander et al. (2024), who validated the RCADS-25 in a Swedish national sample. T-score severity levels were defined as follows: scores of 0–64 indicated low severity of internalizing symptoms, 65–69 indicated medium severity (subclinical level), and 70 or above indicated high severity, meeting the clinical threshold.

Academic Achievement

In Study IV, academic achievement was assessed using official school grades in Swedish, Mathematics, and English for the current academic year, obtained directly from participants' schools. In the Swedish educational system, grades range from F (fail) to A (highest grade). Grades in each subject were transformed into a standardized 0–5 scale for the analysis, with higher scores reflecting better academic performance. Intercorrelations between subjects were strong and significant ($p < .001$): Swedish and Math ($r = .70$), Math and English ($r = .63$), and Swedish and English ($r = .67$). These correlations, together with a high internal consistency (Cronbach's $\alpha = .85$), indicated that the three subjects could be considered indicators of a single underlying academic construct. Consequently, the standardized scores were averaged to create a composite index of academic achievement.

Data Analysis

The four studies included in this thesis employed a range of statistical analyses tailored to their respective research questions, samples, and data structures.

In Study I, confirmatory factor analyses were used to examine the factor structure of the BRIEF2 across the self-, parent-, and teacher-report forms. Models were evaluated using maximum likelihood estimation in Mplus (Version 8). Model fit was assessed using the root mean square error of approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI), with cut-off criteria based on those provided by Hooper et al. (2007) and Hu and Bentler (1999). Measurement invariance across age and gender was assessed using changes in the CFI and RMSEA, applying thresholds recommended by Chen (2007) and Sass (2011) and considering the limitations of chi-square difference tests in large samples (Putnick & Bornstein, 2016). Internal consistency was evaluated using Cronbach's alpha (α), with reference values from DeVellis (2017), and item-total correlations were considered satisfactory if ≥.30 (Nunnally & Bernstein, 1994). Age and gender differences in EF ratings were explored using multivariate analyses of variance (MANOVA) for self-ratings and linear mixed models (LMM) for teacher-ratings. Assumptions for MANOVA regarding equal variances and normality were tested using Box's M and Levene's F tests. Given the sensitivity of these tests in large samples, robustness was evaluated based on standard deviation ratios (Hahs-Vaughn, 2016; Howell, 2009). Post hoc comparisons were conducted using the Games–Howell procedure, and effect sizes were interpreted using partial η^2 thresholds for small (.01), medium (.06), and large effects (≥.14). For teacher-rated EF, an LMM approach was applied to account for the nesting of students within teachers. The analyses examined the effects of age group (13–15 vs. 16–18 years) and gender (girl/boy) on BRIEF2 domains and composites, with clustering by teacher controlled through the inclusion of teacher as a random effect. Assumptions were evaluated prior to analysis. Residuals were inspected to verify linearity, normality, and homoscedasticity, with no substantial deviations observed. Independence of observations between clusters (teachers) was assumed, and within-cluster dependency was addressed in the LMM specification.

Study II employed one-sample t-tests to determine whether children and adolescents with OCD or anxiety disorders differed from normative samples on BRIEF T-scores (mean = 50, SD = 10). Analyses were conducted with and without participants with co-occurring NDDs to assess the potential influence of NDDs. Linear regression analyses were used to compare EF domains between diagnostic groups while adjusting for age, gender, and NDD status. Additional regression models examined the relationship between EF (raw scores) and OCD symptom dimensions as measured using the DY-BOCS, with age and gender included as covariates. Associations between EF and clinical features such as OCD severity, age of onset, and symptom duration were examined using Pearson correlations. Multiple

regression analysis was used to predict post-treatment outcomes, with CY-BOCS scores at follow-up as the dependent variable and intake scores, EF, age, gender, and NDD status as predictors. A more stringent alpha level of $p < .01$ was applied to account for multiple comparisons.

In Study III, one-way analyses of variance (ANOVAs) with planned contrasts and post hoc tests were used to compare EF profiles between clinical subgroups and community controls. Before the analysis, assumptions of normality and homogeneity of variance were tested. Skewness values within ±2 were deemed acceptable (Gravetter & Wallnau, 2014), while Levene's F tests confirmed homogeneity for all scales except for Inhibition. In that case, group standard deviations were checked to ensure that none were four times the size of the smallest, as recommended by Howell (2009). Effect sizes were reported using partial η^2 for ANOVAs and Cohen's d for post hoc comparisons, with interpretations following conventional thresholds: small (.01/.20), medium (.06/.50), and large (≥.14/.80). Bonferroni corrections were applied when no specific hypotheses were stated, setting a corrected significance level of $p < .004$.

Study IV used two-way ANOVAs to evaluate differences in self-rated EF among younger (mean age = 14) and older (mean age = 17) adolescents. Analyses examined (1) self-reported NDD status (yes/no) and gender (girl/boy), and (2) internalizing symptom level (low, subclinical, clinical) and gender. Assumptions of normality and equal variances were satisfied. Because each teacher rated an average of 15 students, teacher-rated EF was analyzed using linear mixed models (LMMs) to account for nesting within teachers. Separate models tested (1) NDD status and gender, and (2) internalizing symptom level and gender, with teacher included as a random effect. Assumptions were evaluated, and residuals showed no substantial deviations. To enhance the specificity of the non-NDD group in the first analysis, adolescents with subclinical or clinical levels of internalizing symptoms were excluded to minimize confounding effects. Similarly, adolescents with NDD were excluded from analyses examining the relationship between internalizing problems and EF to further reduce confounding.Pearson correlations were used to examine associations between academic outcomes, EF, internalizing symptoms, and NDD status. Hierarchical multiple regression models were used to identify predictors of academic performance while controlling for NDD status and internalizing problems. The assumptions of normality, linearity, multicollinearity, and homoscedasticity were tested and upheld.

Summary of studies

Study I

Ilahi, F., Hoff, E., & Daukantaitė, D. (2025). *The Swedish version of the BRIEF2: Psychometric properties and age- and gender-related differences in executive function across multiple informants.* Currently under review at *Child Neuropsychology*.

This study evaluated the psychometric properties (factor structure, internal consistency, inter-rater reliability, and measurement invariance) of the Swedish version of the Behavior Rating Inventory of Executive Function–Second Edition (BRIEF2), a widely used instrument for assessing EF in with self-, parent-, and teacher-report forms. Despite its broad international use, the BRIEF2 had not been comprehensively validated in Sweden prior to this study. In addition to assessing the psychometric properties of the BRIEF2, the study also examined age- and gender-related differences in EF ratings across different informants.

The sample consisted of 1,257 adolescents (ages 12 to 18) who completed the self-report form, 1,340 parents who rated their children or adolescents (ages 5–18) using the parent-report form, and 38 teachers who provided ratings for 510 students (ages 13–18) using the teacher-report form. For the present analyses, participants with self- or parent-reported NDD (10.8%) were excluded.

The results indicated that the three-factor structure comprising behavioral, emotional, and cognitive regulation demonstrated acceptable to excellent model fit for the self- and parent-report forms, and a weaker but adequate fit for the teacher-report form. Internal consistency was high across all forms, although item redundancy was observed in the teacher-report form.

Inter-rater reliability was moderate between self- and parent-reports and lower between self- and teacher-reports. Gender-related patterns differed by informant: boys' self-reports were more consistent with those of their parents, while girls' self-reports aligned more closely with those of teachers. Self-reports indicated increasing EF difficulties with age, whereas parent and teacher reports indicated fewer difficulties among older adolescents.

Overall, the findings indicate that the Swedish BRIEF2 has solid psychometric properties across multiple informants. The observed variations in age and gender

patterns across informants underscore the need for context-sensitive interpretation when evaluating executive functioning in youth.

Study II

Rydqvist, F. (now Ilahi, F.), Hoff, E., Daukantaitė, D., & Cervin, M. (2023). Everyday executive functioning in pediatric obsessive-compulsive disorder: Diagnostic specificity, clinical correlations, and outcome. *BMC Psychiatry, 23*(1), 622. 2 https://doi.org/10.1186/s12888-023-05111-1

This study compared EF difficulties in youth diagnosed with obsessive-compulsive disorder (OCD) and those with anxiety disorders, and investigated whether EF was associated with specific OCD symptom dimensions or treatment outcomes. The clinical sample consisted of 163 Swedish youth (mean age ≈ 13.6 years) from an outpatient clinic, of which 96 had OCD and 67 had an anxiety disorder.

EF was assessed using the parent-report form of the BRIEF. Scores were compared to normative data and between the two clinical groups. Both the OCD and anxiety groups exhibited moderate EF difficulties relative to normative expectations, particularly on the Shift, Emotional Control, and Initiate subscales. However, no significant differences in EF scores were found between the OCD and anxiety groups, suggesting that EF challenges are not unique to OCD.

Moreover, EF scores were not significantly associated with specific OCD symptom dimensions (e.g., checking, contamination, symmetry) and they did not predict treatment outcomes as measured by post-treatment CY-BOCS scores. The presence of co-occurring NDDs did not account for the observed EF difficulties.

The findings indicate that while EF difficulties are present in youth with both OCD and anxiety disorders, they do not appear to be specific to OCD or predictive of clinical outcomes. The strengths of the study include the use of a well-characterized clinical sample and the novel application of a rating-based EF assessment in a Swedish context. The limitations include the use of U.S.-based normative data, a reliance on parent reports, and the variability in treatment and follow-up due to the naturalistic design. Overall, the study underscores the need for further research into the clinical relevance and utility of rating-based EF measures in pediatric OCD.

Study III

Hamilton, A., Tallberg, P., Ilahi, F., Hoff, E., Ahmadi, B., & Daukantaitė, D. (2024). Behavioral manifestations of executive functioning in Swedish youth with ADHD, autism, and psychiatric comorbidity: a comparative analysis with community controls. *Child Neuropsychology*, 1–20. https://doi.org/10.1080/09297049.2024.2434736

This study investigated parent-reported EF profiles in youth with NDDs (ADHD and/or ASD), both with and without psychiatric comorbidities, in comparison to youth with non-NDD psychiatric conditions and a matched community control group. The key aims of this study were to explore differences in EF deficits depending on whether youth had no diagnosis, only NDDs, NDDs with psychiatric comorbidity, or other non-NDD disorders, as well as whether they had single versus dual NDD diagnoses.

The clinical sample comprised 79 medication-free children and adolescents aged 7–17 years, recruited from child and adolescent psychiatric clinics, and 151 age- and gender-matched community controls. Diagnoses were made using the MINI-Kid structured interview and clinical assessment. EF was assessed using the parent-report form of the Swedish BRIEF2.

The results indicated that all clinical groups showed significant EF deficits compared to community controls, with the most substantial impairments observed on the Shift and Emotional Control scales and on the Emotion Regulation Index. Youth with NDDs—particularly those with both ADHD and ASD—exhibited the most severe EF deficits. Youth with psychiatric conditions but no NDDs showed milder difficulties, primarily in emotional regulation and task initiation.

Further comparisons between youth with single versus dual NDD diagnoses revealed that those with both ADHD and ASD experienced more pronounced EF deficits, particularly in cognitive flexibility. However, the presence of additional psychiatric comorbidities did not significantly affect EF profiles within the NDD group.

These findings underscore the strong association between NDDs and EF deficits and demonstrate that the BRIEF2 can effectively differentiate between diagnostic groups in terms of real-world functioning. The strengths of the study include the use of a well-characterized, medication-free clinical sample and a rigorously matched community control group. The limitations include the small subgroup sizes and a reliance on parent reports. Overall, the results highlight the clinical utility of the Swedish BRIEF2 and support its application in understanding EF deficits among school-aged youth with complex diagnostic presentations.

Study IV

Daukantaitė, D., Klarin, J., Ilahi, F., Hoff, E., & Tallberg, P. (Under review). *The overlooked role of internalizing symptoms in adolescent executive function: Insights from self- and teacher ratings.* Currently under review at the *Journal of School Psychology.*

The study examined the associations between EF, self-reported NDDs (e.g., ADHD, autism), internalizing symptoms (e.g., anxiety, depression), academic achievement, and gender in Swedish adolescents using a multi-informant approach. EF was measured with the BRIEF2, which was completed by both students and teachers in two cohorts: younger adolescents (mean age = 14) and older adolescents (mean age = 17).

Adolescents with self-reported NDDs exhibited significantly greater EF difficulties across all domains, particularly in the younger cohort, according to both the self- and teacher reports. Notably, internalizing symptoms were strongly associated with self-reported EF problems but showed minimal associations with teacher-reported EF, suggesting that EF challenges related to internalizing symptoms are less visible in classroom contexts.

Gender differences were also observed: girls self-reported greater EF difficulties than boys, whereas teachers rated boys as having greater EF difficulties. Teacher-rated EF emerged as the strongest predictor of academic achievement, surpassing self-rated EF, internalizing symptoms, and NDD status. Additionally, suppression effect emerged in girls, where controlling for internalizing symptoms strengthened the link between self-rated EF difficulties and achievement, suggesting that such symptoms may mask EF-related challenges, possibly through compensatory behaviors like increased effort or perfectionism..

The findings underscore the importance of using both self- and teacher-reports when assessing adolescent EF. Doing so might be able to identify hidden difficulties linked to internalizing symptoms and to inform targeted support strategies in educational settings.

Discussion

The overarching aim of this thesis was to deepen understanding of behavioral EF in youth by examining the measurement properties of a key rating-based measure of EF, the clinical relevance of behavioral EF, and associations with mental health and academic achievement. EF was conceptualized in terms of daily functioning as assessed through multiple informants (self, parents, and teachers) using the Swedish adaptation of the *Behavior Rating Inventory of Executive Function – Second Edition* (BRIEF2). This research encompassed both clinical and community-based populations, integrating psychometric validation with applied investigations of how behavioral EF difficulties relate to real-world psychological and educational outcomes.

Confirmation of the Psychometric Soundness of the Swedish BRIEF2

As found in Study I, the Swedish BRIEF2 had generally good model fit and high internal consistency across all three forms (self-, parent-, and teacher-report forms), based on a large, gender- and age-balanced sample of Swedish youth. My inclusion of a psychometric study of the instrument in this thesis not only strengthens the interpretability of findings from the three other studies but also contributes to the broader field by providing the first psychometric evaluation of the Swedish version of the BRIEF2. To my knowledge, this is also the first evaluation conducted in a Nordic context. Evaluation of the Swedish BRIEF2 adds to a relatively limited but growing body of international research confirming the psychometric robustness of the BRIEF2 self-report form (e.g., Huizinga et al., 2023; Parhoon et al., 2022) as well as the parent- and teacher-report forms (e.g., Moura et al., 2023; Pino Muñoz & Arán Filippetti, 2021; Moradi & Hassababadi, 2021; Jimenez & Lucas-Molina, 2019; Shum et al., 2021). It also offers a contrasting perspective to previous studies that have suggested revisions to the original factor structure (e.g., Jacobson et al., 2020; Cumming et al., 2023). To my knowledge, only one previous European study—conducted in the Netherlands by Huizinga et al. (2023)—has confirmed the psychometric properties of all three forms of the BRIEF2. Including all three informant versions (self-, parent-, and teacher-report) in a single validation study is also rare in the existing literature, further highlighting the significance of this study.

As such, this work fills an important gap and provides a foundation for future Nordic and international research using behavioral assessments of EF.

While the findings of Study I supported the reliability and structural validity of the Swedish BRIEF2, they also raise questions concerning the construct validity. Beyond statistical fit and internal consistency, it is important to critically reflect on what the BRIEF2 actually measures. As previously discussed, the field of EF remains fragmented in terms of how EF is operationalized and the methodological approaches used to evaluate EF. The weak correlations between rating-based and test-based measures of EF (e.g. McAuley et al., 2010) further complicate the situation by limiting the ability of convergent measures. As such, the BRIEF2, with its multidimensional structure and behavioral basis, likely reflects a complex interplay of EF, emotional regulation, context-dependent behavior, and self-perception; it may therefore not be directly comparable to other conceptualizations of EF. It could be further argued that BRIEF2's operationalization of EF overlaps both conceptually and functionally with related constructs such as self-regulation, goal-directed behavior, and agency, which leads to difficulties in delineating the boundaries between these constructs (Diamond, 2013; Miyake & Friedman, 2012). Several BRIEF2 subscales and indices also show substantial conceptual overlap with diagnostic criteria for NDDs, particularly ADHD and ASD. For example, difficulties in inhibition, working memory, and emotional control as captured by the BRIEF2 closely resemble the core symptoms of ADHD. Similarly, scales related to the ability to shift, initiate tasks, and self-monitor reflect behaviors commonly associated with ASD. Although these overlaps were not specifically examined in any of the studies included in this thesis, it raises important questions about whether the BRIEF2 actually captures EF behaviors, or whether it in fact reflects behavioral manifestations of self-regulative behaviors in general. It may even suggest that NDD symptoms are inherently intertwined with EF difficulties.

Age- and Gender Differences in Behavioral EF

This thesis provides valuable insights into age- and gender-related differences in behavioral EF. Study I revealed notable patterns in adolescents' self-reported EF across age groups. Contrary to previous research, which reported no significant age-related differences in self-reported EF (e.g., Huizinga et al., 2023), we found that adolescents reported increasing EF difficulties with age—particularly among girls. In addition, both Studies I and Study IV identified gender differences in self-reported EF—girls consistently reported greater EF difficulties than did boys, particularly in areas such as emotional control, cognitive flexibility, and task initiation.

The effect sizes for the gender differences were small, which is consistent with prior findings (Huizinga et al., 2023). Moreover, scalar invariance was not fully achieved, indicating that gender differences in EF scores might in part be the result of differing response styles or social expectations rather than true differences in underlying ability. Boys may underreport EF difficulties because of social norms discouraging emotional disclosure, whereas girls—who often show greater self-awareness—might be more self-critical when evaluating their challenges (van Tetering et al., 2020; Rucklidge, 2010).

As detailed in Study I, these gender differences were most pronounced during mid-adolescence (ages 13–15), when girls reported significantly more difficulties than did boys in emotional control, flexibility (e.g., shifting attention – the Shift scale of the BRIEF2), and task completion. In contrast, younger children (ages 11–12) reported fewer or comparable EF difficulties across genders. These results suggest that gender disparities in behavioral EF might become more apparent as cognitive and emotional demands intensify with age, likely reflecting the growing academic pressures and heightened social expectations characteristic of *högstadiet* (junior high school) in the Swedish school system (Grades 7–9).

Another possible explanation for these findings is that girls exhibit heightened self-awareness and metacognitive insight, leading them to more readily recognize and report EF challenges (Zimmermann & Iwanski, 2014; van Tetering et al., 2020). Girls might also be more likely to internalize cognitive struggles, whereas boys externalize them, resulting in fewer self-reported difficulties despite comparable challenges (Rucklidge, 2010; Nolen-Hoeksema, 2012).

The discrepancies between our findings and those of Huizinga et al. (2023) may be due to differences in how age groups were defined across the studies. While Huizinga and colleagues employed four narrower age bands, we used broader age divisions from the Swedish school system. These methodological differences not only might account for the contrasting results but also might indicate that rating-based, contextualized methods of assessing EF generate different results depending on culture, educational system, values, and norms. These variations in cultural or educational context between countries might also contribute to differing patterns in self-reported EF, given potential variation in classroom expectations, support structures, and gender norms across countries, which might differently shape how adolescents experience and report EF in daily life.

As for teacher and parent reports, Studies I and IV overall support the findings of previous research (e.g., Huizinga et al., 2023; Moura et al., 2023; Jiménez & Lucas-Molina, 2019), with both informant groups reporting greater EF challenges in younger children. These observed patterns might reflect perceived developmental improvements over time. However, as these ratings are based on external observations, it is unclear whether they reflect genuine cognitive gains or increased use of compensatory strategies. Parental reports largely mirrored self-reports in that

boys showed greater EF difficulties, particularly in areas related to task management and organization (Jiménez & Lucas-Molina, 2019; Moura et al., 2023). By late adolescence (ages 16–18), gender differences in EF ratings from both parents and teachers diminished. However, girls continued to exhibit greater difficulties in emotional control, whereas boys more often struggled with task-oriented challenges. Thus, although overall EF difficulties tended to decline with age, gender-specific patterns in emotional regulation and task management persisted.

Although these results highlight differences in behavioral EF according to age and gender, it is important to remember that despite the strong ecological validity of scales like the BRIEF2, they are inherently contextual. Doebel (2020) highlights this complexity, emphasizing how we ought to rethink EF and take into consideration the impact of contextual factors such as values, beliefs, and prior knowledge. Doebel and Munakata (2018) have previously highlighted the role of social identity and norms in shaping self-regulation, potentially explaining developmental and group-level differences in EF. The fact that different informants (e.g., self, parents, teachers) rate behaviors in different settings may thus in part explain why age- and gender-related differences in EF are not uniform across different report forms. Although rating-based EF measures can reveal such differences, I argue that the focus of future studies should go beyond identifying *whether* these differences exist, instead placing more emphasis on their potential implications. This approach could help inform the design of future EF-based interventions. I therefore propose that further research is needed to explore how developmental and gender patterns relate to outcomes such as mental health, relationships, and academic achievement. Knowledge of cultural and contextual variations in EF also further underscores the need for a broader understanding of EF development—one that, as Doebel (2020) argues, moves beyond static models and incorporates context, meaning-making, and individual experience. I believe such research is of particular importance to inform future interventions.

EF in Clinical Populations: Associations to NDDs and Psychopathology

The findings from the two clinical studies—Studies II and III—highlight the presence of behavioral EF difficulties in youth with a range of psychiatric conditions and NDDs. Rather than indicating disorder-specific EF profiles, the results suggest transdiagnostic patterns of impairment, particularly in flexibility (the Shift scale of the BRIEF2), emotional regulation, and task initiation. These shared difficulties are consistent with prior research suggesting that EF deficits might serve as common

vulnerability markers for child and adolescent psychopathology (e.g., Snyder, 2015; Sadozai et al., 2024; Martel et al., 2017; Zelazo, 2020).

In Study II, youth diagnosed with OCD and anxiety disorders exhibited moderate EF deficits in comparison to normative data, with the most pronounced deficits appearing in the Shift, Emotional Control, and Initiate scales. The fact that similar deficits were observed in youth with anxiety disorders suggests that these deficits are not specific to OCD. Additionally, Study II did not find significant associations between EF and any of the OCD symptom dimensions, and EF scores did not predict treatment outcomes. Thus, while EF impairments may be evident in children and adolescents with OCD, they might not play a significant role in the clinical presentation or progression of the disorder. Instead, difficulties in flexibility and emotional regulation might function as general risk factors across internalizing disorders (Romer & Pizzagalli, 2021).

Study III extended this transdiagnostic perspective by comparing EF profiles among youth with NDDs, NDDs with psychiatric comorbidities, non-NDD psychiatric conditions, and matched community controls. The findings revealed significant EF deficits in youth with NDDs—particularly in those with co-occurring ADHD and ASD—which is consistent with recent evidence (Sadozai et al., 2024). The most pronounced deficits were seen on Inhibit, Shift, Working Memory, and Self-monitor, supporting findings that these domains are impaired in both ADHD and ASD (Demetriou et al., 2018; Willcutt et al., 2005). These findings align with developmental models proposing a hierarchical maturation of EF, where early deficits in basic functions such as inhibition might hinder the development of more complex abilities such as working memory and cognitive flexibility (Barkley, 1997; Tillman et al., 2015).

Interestingly, the presence of internalizing comorbidities did not appear to exacerbate EF deficits in youth with NDDs. This might suggest that anxiety, in some cases, could mitigate inhibition deficits—particularly in ADHD—through increased self-regulatory efforts. However, such compensatory regulation may also involve maladaptive strategies, as avoidance behavior is a central maintaining factor in anxiety disorders. This possibility aligns with studies suggesting that EF tends to be more strongly associated with depression than with anxiety in general population samples (e.g., Yang et al., 2022). Nevertheless, EF deficits remained substantial in all clinical groups compared to controls, underscoring the pervasive nature of EF impairments in both ADHD (e.g., Frazier et al., 2004; Pievsky & McGrath, 2018; Willcutt et al., 2005) and ASD (e.g. Gentil-Gutiérrez et al., 2022). One particularly important was that adolescents with non-NDD psychiatric diagnoses (e.g., anxiety or depression) also exhibited significant EF deficits relative to controls. Despite receiving considerably less attention in the EF literature compared to youth with NDDs, this group differed significantly from the control group on six of the eight EF domains, with the largest effect size observed for the Shift subscale (Cohen's d = 0.94), indicating pronounced difficulties in cognitive flexibility. These results

highlight that EF difficulties are not exclusive to NDDs and underscore the need for greater attention to EF in youth with internalizing psychiatric conditions, who are often neglected in EF-focused research and intervention planning. As such, in clinical practice, executive dysfunction is not specific to ADHD and may be present in a range of other conditions.

Inflexibility—as measured by the Shift scale—emerged as a central and consistent area of difficulty in both Studies II and III. Although traditionally associated with ASD and OCD, the prominence of inflexibility in a wide range of diagnostic groups—including anxiety, ADHD, and comorbid presentations—suggests that it serves as a transdiagnostic marker of executive dysfunction. This interpretation is further supported by developmental research indicating that cognitive flexibility is one of the most protracted EF components to mature, continuing to develop well into late adolescence and early adulthood (Diamond, 2013; Garon et al., 2008). Based on my clinical experience, considerable attention has been given to the importance of structure and predictability for supporting youth with EF difficulties; however, these results point to how it may be equally important to work strategically on strengthening flexibility and adaptability. Indeed, in psychotherapeutic approaches such as Acceptance and Commitment Therapy (ACT), psychological flexibility is a central therapeutic target that is actively cultivated to promote adaptive functioning and well-being, which to some extent, could be argued to mirror processes related to behavioral EF.

EF, Mental Health and Academic Achievement

Although research on the relationship between EF and academic achievement (e.g., Samuels, 2019; 2023), as well as on the developmental and gendered patterns of EF (e.g., Huizinga et al., 2023; Jiménez & Lucas-Molina, 2019; Moura et al., 2023), is relatively well established, there is a lack of studies examining how self- and teacher-reported EF predict academic outcomes when controlling for mental health. This gap in the literature underscores the need to better understand how EF difficulties, in relation to academic achievement, intersect with broader psychological challenges.

Study IV confirmed that EF difficulties, particularly those identified by teachers, strongly predicted lower academic achievement (Samuels et al., 2016; 2019; 2023). Self-reported EF difficulties also predicted academic outcomes, especially among girls. A suppression effect was observed, where internalizing symptoms amplified the link between EF difficulties and school performance. This suggests that internalizing symptoms might drive compensatory behaviors to sustain academic success, potentially at the cost of psychological well-being (Roeser et al., 1998; et

al., 2012). These findings challenge the assumption that internalizing symptoms uniformly impair academic performance, portraying a complex relationship where emotional distress might in some ways fuel academic effort, particularly in adolescent girls. These dynamics further highlight the need for educators and clinicians to look beyond grades, recognizing that high academic performance might actually mask significant emotional and cognitive struggles. Given the limited research on how EF and internalizing symptoms jointly influence academic performance, particularly in non-clinical adolescent populations, further studies are essential to inform early identification and targeted interventions.

For boys, EF difficulties remained strong predictors of poor academic performance even after controlling for internalizing symptoms and NDDs. This aligns with research showing that boys' EF difficulties tend to be more behaviorally visible and disruptive in classroom settings (Gaub & Carlson, 1997; Martel, 2013; Hill, 2004), which may help explain why teacher-reported EF difficulties show a stronger association with boys' academic performance than with girls'.. The visibility of EF difficulties in boys may also contribute to gender disparities in diagnosis and intervention, as such externalized behaviors are more readily identified (Skogli et al., 2013; Dai, 2019).

Study IV also replicated established patterns of EF impairment in adolescents with NDDs (Willcutt et al., 2005; Frazier et al., 2004; Demetriou et al., 2018). Notably, adolescents with NDDs rated their EF difficulties as less severe than did their teachers, reflecting limitations in self-awareness or contextual differences (Krieger et al., 2019; Kenworthy et al., 2022). Among younger girls with self-reported NDDs, elevated EF difficulties were observed, consistent with literature suggesting that girls with ADHD or ASD often present more internalized and overlooked symptoms (Rucklidge, 2010; Lai et al., 2015). These findings highlight the need for gender-sensitive EF assessments, particularly in younger adolescents, where compliance and verbal strengths might mask significant cognitive and emotional struggles.

While gender differences in EF appeared to diminish with age, the persistent association between self-reported EF difficulties and academic achievement must be viewed within the context of rising academic pressures and mental health concerns among Swedish youth. Since the 2011 school reform, increased academic demands have been linked to declining confidence and greater health complaints, particularly among girls (Folkhälsomyndigheten, 2024). This is paralleled by higher rates of anxiety, depression, and psychiatric medication use in adolescent girls (Socialstyrelsen, 2020; Folkhälsomyndigheten, 2023). The negative developmental trends observed among girls—including lower school satisfaction, increased stress, reduced confidence in mathematics, diminished perceptions of teacher support, heavier social media use, and broader declines in well-being—underscore the need for future research, systematic monitoring and targeted interventions (Skolverket, 2025).

Practical Implications

The findings of this thesis have direct relevance for clinical and educational practice, particularly in the identification and support of EF difficulties in youth. Based on four studies spanning community and clinical samples, and using a multi-informant, ecologically valid approach, this thesis has the following implications:

Utility of The Swedish BRIEF2 in Everyday Contexts

As shown in Study I, the Swedish version of the BRIEF2 has sound psychometric properties and is suitable for identifying EF difficulties in daily life in Sweden. Although not a diagnostic tool on its own, the BRIEF2 is sensitive to EF difficulties across a broad spectrum of groups, including adolescents with NDDs and those experiencing internalizing symptoms. Its applicability in school and community settings can support early identification and intervention in EF difficulties, which is particularly valuable given the long wait times for psychiatric assessments in Sweden. This makes the Swedish translation of the BRIEF2 a practical resource for educators, caregivers, and clinicians aiming to recognize functional difficulties related to everyday EF.

Importance of Multi-Informant and Gender-Sensitive EF Assessment

The findings from Studies I and IV emphasize the value of multi-informant EF assessments, as each perspective seems to capture different aspects of adolescent functioning. Teacher ratings were less attuned to internalizing symptoms, which could be captured in students' self-reports, particularly those of girls, alongside EF difficulties. Although the gender differences were relatively small and leveled out over time, the observed patterns in self-reported EF and internalizing symptoms highlight the importance of taking adolescents' own perspectives into account when assessing daily EF difficulties. Greater awareness is needed to identify challenges that might otherwise go unnoticed—particularly in adolescent girls, who might internalize their struggles in a way that can be difficult for external observers to identify.

Behavioral EF in Clinical Profiles and Complex Presentations

Studies II and III indicate that EF difficulties are prominent in young people across a range of psychiatric conditions but were most pronounced in adolescents with ADHD, ASD, and most importantly those with comorbid diagnoses. This underscores the necessity of individualized, EF-focused approaches in both clinical care and educational planning, particularly for young people with complex clinical

profiles requiring nuanced support strategies. Identifying EF difficulties through tools such as the BRIEF2 could help guide early, targeted interventions that ease young people's functional burdens while they await comprehensive diagnostic assessments.

EF and Academic Outcomes

Study IV revealed a strong link between EF difficulties—particularly in organization, initiation, and emotional control—and lower academic performance. While teacher-rated EF was the strongest predictor of academic performance, self-reported EF was also a notable predictor, especially when internalizing symptoms were considered; a pronounced suppression effect was observed among girls. These findings emphasize the importance of using both teacher and self-reports in schools, as teachers might overlook EF challenges linked to internalizing problems such as anxiety and depression. Integrating EF assessments into routine school evaluations, along with targeted teacher training, could help identify and support students—diagnosed or not—at risk of academic difficulties.

Methodological Considerations

A central methodological feature of this thesis was the use of the Swedish version of the BRIEF/BRIEF2 as the primary instrument across all four studies. Given that past BRIEF2 applications in Sweden have relied on American norms, this initial psychometric validation, including tests of factor structure, internal consistency, and measurement invariance, is essential for ensuring that subsequent findings were grounded in a tool calibrated for the Swedish context. The BRIEF2 also includes built-in validity indices (Inconsistency, Infrequency, and Negativity), which enhanced the instrument's research and clinical utility by helping detect careless or inconsistent responding.

One key challenge encountered was the discrepancy between the ratings provided by students, parents, and teachers. This divergence, while common in rating-based EF research, complicates interpretation and raises the question of whose perspective is most valid. Each informant observes behavior through a context-dependent lens: teachers in structured, academically demanding settings; parents in emotionally charged, less structured environments; and adolescents themselves through subjective, developmentally variable filters. These perspectives could differ due to factors such as metacognitive ability, social desirability, and response fatigue, underscoring the value of a multi-informant approach while also signaling interpretive caution. Additionally, bias known as the halo effect (e.g. Nisbett & Wilson, 1977) could have impacted the ratings. This cognitive bias might influence

raters' overall impression of a person, including how they perceive specific traits in that person. For example, if raters see someone as competent in one area, they are more likely to assume that the individual is good in other areas too. If a teacher thinks a student is hardworking and enthusiastic, they might, consciously or unconsciously, rate that student as having better EF and assign higher grades, since they are responsible for both assessments. This might also in part explain the gender differences observed, where parents and teachers reported girls as exhibiting better EF than boys, despite girls reporting the opposite patterns.

Importantly, EF abilities tend to be shaped by situational and cultural demands and norms (Doebel & Munakata, 2018; Doebel, 2020). The same individual might appear to function differently in a structured classroom versus at home, which enhances the ecological validity of ratings-based measures but complicates comparisons across settings. Similarly, there could be variation in EF over time, which could have impacted the results captured by the BRIEF2 scale. Thus, BRIEF2 could serve as a measure of current functionality rather than a measure of "pure" EF capacity.

Another methodological concern relates to response burden and questionnaire fatigue due to the questionnaire's length. The length of the BRIEF2, in combination the overall survey battery, might have led to disengagement among some students, particularly those with EF difficulties and/or NDDs, who may struggle with sustained attention and task completion. Although the BRIEF2 includes validity checks to flag inconsistent responses, those most affected might have been underrepresented because of dropout or incomplete data, potentially introducing selection bias. Language comprehension could also have posed a challenge. Despite careful translation of the BRIEF 2 into Swedish, certain item formulations—especially those involving double negatives—were, based on my observations, more difficult for younger students and non-native speakers to interpret. During data collection I observed how some students appeared to struggle with rating their behavior during in-class administration, even when support was available. On a similar note, students diagnosed with ASD or subclinical autistic traits, might have found it difficult to self-report by generalizing their behavior across time, or felt uncertain about frequency-based items such as "often" or "sometimes." Although the multi-informant approach applied in Studies I and IV yielded important insights, the overall thesis could have been strengthened by a broader multimethod design. Incorporating approaches such as interviews, classroom observations, or performance-based EF tasks might have deepened the interpretation of the findings and provided a more nuanced understanding of understanding of EF difficulties in relation to psychological and academic outcomes.

Finally, from a methodological perspective, it is crucial to return to the question of what the BRIEF2 actually captures. EF as measured by the BRIEF2 might not exclusively capture "pure" EF as traditionally proposed by influential frameworks such as that by Miyake et al. (2000). One of the most evident methodological

limitations of this thesis therefore concerns the construct validity of the BRIEF2 (i.e., what the instrument truly measures). While the BRIEF2 arguably offers a practical and ecologically valid assessment of EF in everyday life, it might also capture broader aspects of behavior, such as emotional reactivity, motivation, and self-perception, rather than executive processes per se. The absence of complementary or contrasting measures further limits our ability to disentangle EF from related cognitive or affective constructs. As mentioned before, the EF field has not yet reached consensus on the operationalization and methodology of EF. The BRIEF2, because of its multidimensional structure and behavioral focus, likely reflects a complex interplay of EF, emotional reactivity, context-dependent behavior, and self-perception. Moreover, it could be argued that the operationalization of EF in the BRIEF2 overlaps to a larger extent, both conceptually and functionally, with constructs such as self-regulation, goal-directed behavior, and even agency. This might make it difficult to delineate clear boundaries between these constructs and the EF construct (Diamond, 2013; Miyake & Friedman, 2012). This potential conceptual overlap might complicate interpretation of the findings of these studies, and limits the extent to which these findings generalize to the broader field of EF research. To avoid confusion, I consistently try to be clear that the results presented in the studies must be understood from a behavioral perspective of EF rather than a purely cognitive one.

Similarly, it could be argued that several of the BRIEF2 scales partially overlap with diagnostic criteria for NDDs, particularly ADHD and ASD. These conceptual overlaps are important to acknowledge when interpreting EF difficulties among individuals with NDDs, as certain items in the BRIEF2 might reflect behavioral expressions consistent with diagnostic symptom clusters, for example inhibition in ADHD or flexibility (Shift) in ASD. This again raises important questions about the construct validity of the BRIEF2—specifically, whether it "solely" captures EF or also reflects broader symptomatology associated with NDDs.

Strengths of the Thesis

A significant strength of this thesis is its psychometric validation of the BRIEF2 in a Swedish context. Study I provided support for the instrument's internal consistency, factorial structure, and measurement invariance across all three informant versions—self, parent, and teacher—while also generating Swedish normative data from a large gender- and age-balanced community sample. This work fills a critical gap in the field and enhances the contextual validity and utility of the Swedish BRIEF2 in both research and clinical practice. Another prominent strength is the inclusion of all three BRIEF2 forms, which provides a comprehensive, multi-informant perspective on EF in youth. This approach remains relatively rare in the existing literature as only one known study, conducted by Huizinga et al. (2023) in the Netherlands, has employed all three forms of the

BRIEF2 simultaneously. The use of multiple informants enhances the ecological validity of the findings and allows for a more nuanced understanding of how EF difficulties manifest across different contexts and observers. Additionally, the large and gender-balanced sample used in Study I allowed for a robust examination of gender differences in EF, further strengthening the reliability and applicability of the findings. The fact that this large sample was used as a control sample in Study II, one of the clinical studies, is another strength.

In the clinical studies (i.e. Study II and Study III), diagnostic accuracy was strengthened through use of comprehensive neuropsychological assessments conducted by licensed professionals. In Study II, this ensured that all participants were formally diagnosed with conditions such as ADHD or ASD. The rigorous diagnostic process, particularly in Study II, is therefore a strength, as was the availability of participant data, including background variables such as parental education and indicators of SES. These variables enabled more nuanced analyses and allowed for statistical control of key confounding factors, which is particularly important when studying EF in NDD groups.

Another important strength of Study II is the exclusion of participants with intellectual disability, which enhances the interpretability of the findings. Intellectual disability is typically associated with global cognitive impairments extending beyond EF, so including such participants might have introduced confounding effects unrelated to the specific constructs under investigation. Notably, none of the adolescents in the NDD group were receiving pharmaceutical treatment at the time of assessment, which minimizes the potential bias of medication effects on behavior or EF ratings. Furthermore, it is a considerable strength that both clinical samples included participants with comorbid conditions, as it better reflects the clinical reality in which many children and adolescents present with multiple co-occurring diagnoses. This increases the ecological validity of the findings and supports their relevance for real-world clinical settings.

The use of multi-informant data is also a strength, particularly in Studies I and IV where students, parents, and teachers participated. This approach enriched the interpretive depth of the studies and provided a more comprehensive understanding of how EF difficulties are expressed and observed across different settings by different informants in a non-clinical, educational context. Another strength is the inclusion of additional measurement variables beyond EF (Study IV), such as self-reported internalizing symptoms and academic performance. The ability to examine associations between behavioral EF, mental health, and academic performance represents a significant contribution to the literature, given the current scarcity of research integrating these domains. This multidimensional approach offers a holistic understanding of how EF difficulties are linked to both psychological well-being and academic outcomes in adolescence and are of important for future research, particularly for informing future EF interventions.

Limitations of the Thesis

Despite these strengths, several limitations should be acknowledged. In the clinical studies included in this thesis, considerable emphasis was placed on the robustness of NDD diagnoses, which were established through structured neuropsychiatric assessments. In contrast, in the community sample used in Study I, diagnostic data were less robust as self-reports were used to gather information about whether participants had undergone a neuropsychiatric evaluation and received an NDD diagnosis; a similar approach was used in Study IV. While self-reported NDD status is much less robust, it nonetheless provides useful information, particularly given the potential for NDDs to confound associations between EF and other outcomes. Still, relying solely on self-reported diagnostic status can be considered a limitation. An alternative approach could have been to include standardized screening measures of diagnostic symptom dimensions—such as the SNAP-IV for ADHD or the Autism Spectrum Quotient (AQ or ASQ) for ASD. Including such measures in future studies might offer a more nuanced understanding of how specific NDD symptom profiles relate to reported EF difficulties. In retrospect, this approach could have strengthened interpretations of group differences and dimensional associations between behavioral EF and NDD symptoms. The challenge of including such scales, however, lies in the increased burden on participants—including them would have significantly extended the length of the questionnaire, potentially contributing to response fatigue and reducing data quality.

Another limitation concerns the teacher ratings, since only a small group of teachers rated their students. This could have contributed to potential rater fatigue or reduced sensitivity to individual differences, given the length of the BRIEF2 and the cognitive load involved in assessing multiple students consecutively. It is possible that the quality or accuracy of the ratings might have been affected by the volume of assessments each teacher was required to complete. It might have been beneficial to allow multiple teachers (e.g., subject teachers or mentors) to rate the same student. Such an approach may have reduced potential individual rater burden and increased reliability through the triangulation of perspectives. Another alternative for future studies could be to include observations of classroom behaviors or even qualitative measures such as interviews as additional measures alongside BRIEF2 ratings. Finally, a major limitation is that teacher ratings were obtained only for adolescents aged 13–18 years, which restricted comparisons to parent ratings for the younger age groups (i.e., those aged 5–6, 7–9, or 10–12 years).

Ethical Considerations

Informed consent was obtained from parents or guardians for participants in the clinical sample, ensuring they were fully informed about the study's purpose, procedures, and any potential risks. For the non-clinical samples, all guardians were provided with detailed information about the study's purpose and procedures. However, only passive consent was required, as granted by the Swedish Ethical Review Authority. This procedure allowed parents to withdraw their children from participation at any point, without the need to provide a reason, by simply contacting the project leader or child's teacher. All guardians were informed well in advance and had the opportunity to ask questions about the study or opt out. However, despite these efforts, some parents or guardians might have missed this information. To ensure the well-being of participants, procedures were in place in case any student experienced distress while completing the survey. As a licensed clinical psychologist, I was present during data collection, and the school nurse was also informed and available to provide support if a student preferred to speak with a familiar adult. To our knowledge, none of the students required such support, but these measures ensured that help was readily available if needed. In addition, informed consent was obtained from all participants themselves, confirming that they voluntarily agreed to take part in the study after being fully briefed on its nature. These procedures were designed to adhere to ethical guidelines and ensure the protection of the well-being and rights of all participants throughout the study.

When administering the surveys in schools, I was personally present to provide clarification and support as needed. This was intended to safeguard the quality of the data while ensuring that participants' autonomy, comprehension, and well-being were respected.

All studies included in this thesis had received ethical approval from the Swedish Ethical Review Authority, ensuring compliance with ethical standards throughout the research process. Ethical procedures were rigorously followed throughout all studies, including obtaining informed consent from all participants and, where applicable, from their legal guardians.

Directions for Future Research

There are several promising directions for future research to build on the contributions of this thesis. The findings underscore the importance of developing a more nuanced, ecologically valid, and contextually grounded understanding of EF in youth—both in research and in practice. Following this perspective, I suggest advancing contextually grounded and ecologically valid measurement approaches to EF, in particular in non-clinical groups (due to the scarce research on non-clinical

populations). Rather than viewing EF as a set of isolated cognitive processes, we might need to rethink EF and conceptualize these abilities as adaptive, goal-directed behaviors that emerge in response to contextual, real-world challenges (Doebel, 2020).

There is also a clear need for further research to deepen our understanding of what rating-based, multi-informant assessments of EF such as the BRIEF2 actually capture. Future studies could investigate this by comparing EF ratings to ratings of related constructs, such as self-regulation, agency, and motivation, to clarify the conceptual boundaries of EF as measured by behavioral questionnaires.

Moreover, continued investigations of how behavioral EF relates to key outcomes such as mental health and academic performance are essential. Such insights could play a pivotal role in informing the development of more targeted and effective school-based interventions aimed at supporting cognitive and emotional functioning in adolescents. This is of particular importance since meta-analyses have indicated that isolated EF training has limited transfer effects (Kassai et al., 2019) and concerns remain about the long-term impact of such programs (Mattera et al., 2021; Rowe et al., 2021). Emerging approaches that emphasize metacognitive awareness (Stamenova & Levine, 2019), mindfulness (Cásedas et al., 2020), improving the teacher-student relationship (Sankalaite et al., 2021) and psychoeducation for parents and teachers (Rothschild et al., 2022; Dawson & Guare, 2018) might offer more sustainable outcomes. I suggest that future EF research aim to clarify these associations using ecologically valid methods and general student samples, given the inconsistencies in conceptualization and sample selection in previous EF intervention studies, as stated by Jacob & Parkinson (2015).

To bring in the contextual approach, additional variables such as classroom climate, stress exposure, peer relationships, sleep quality, and measures of physical activity and digital habits and usage of AI tools could also offer important insights alongside EF development across key transitions in adolescence. Such research could help identify sensitive developmental periods and clarify the mechanisms through which EF acts as a risk or protective factor in adolescent development, mental health, and academic achievement.

Following this risk and resilience perspective, I want to stress the importance of continued investigations of the gender differences in behavioral EF. The observed suppression effect in Study IV, wherein the results suggest that adolescent girls mask their EF difficulties in favor of social expectations and academic performance, should be further studied in Sweden and other countries. Additionally, following the contextual perspective of Doebel (2020), future research could include how gendered norms, coping strategies, and internalized expectations influence both the expression and detection of EF difficulties. In addition, there is also potential for cross-cultural comparisons, to help disentangle which aspects of EF development

are “more universal” and which are shaped by specific educational, cultural, or societal norms and expectations.

To obtain a more nuanced view of EF, it might be beneficial to use rating-based measures in combination with observational or qualitative methods. Collecting qualitative data through interviews or written reflections/diaries from youth, caregivers, and educators could enrich our understanding of how behavioral EF is experienced in relation to context. This could be important for understanding more of the underlying mechanisms that influence EF in daily life. Such a mixed-methods approach could also enable more participatory, bottom-up approaches in which young people themselves are invited to contribute to how daily EF is understood, and ultimately best supported through interventions. In the long term, I hope that such an approach could lay the groundwork for how EF interventions are designed and implemented in school settings, targeting EF abilities more effectively while also promoting mental health and academic achievement.

Finally, on the theme of EF interventions, I recommend that future research continue exploring *which* specific EF domains are most closely linked to mental health and academic achievement. Across the studies in this thesis, flexibility (Shift in the BRIEF2) consistently emerged as a key domain, suggesting that it warrants closer investigation in future research. There might be value in exploring whether flexibility can be improved through school-based EF interventions. Particularly since considerable attention has previously been given to the importance of structure and predictability for supporting youth with EF difficulties. Based on the results in this thesis, I state that it may be equally important to work strategically on strengthening flexibility and adaptability, not only for students with confirmed or suspected NDDs, but as part of more universal intervention strategies. Understanding more about these domain-specific links might support the development of more targeted, skills-based and contextually grounded interventions applicable to a range of clinical non-clinical and subclinical populations.

Concluding remarks

This thesis makes several important contributions to the field of behavioral EF in youth. First, it strengthens the theoretical and methodological basis for understanding behavioral, contextual, and multi-informant approaches to EF with the Swedish BRIEF2 serving as a central tool. It not only offers the first psychometric evaluation of the Swedish BRIEF2, which is important given the instrument’s widespread use in Sweden, but it also supports a paradigmatic shift away from viewing EF as isolated cognitive processes, toward conceptualizing EF from a more ecologically valid perspective, in line with ideas originally presented by Doebel (2020).

Second, the results of the clinical studies indicated that the Swedish BRIEF2 effectively distinguishes between diagnostic groups through identifying functional impairments, especially in NDD profiles. Youth with NDD, and in particular those with both ADHD and ASD, showed the most pronounced EF deficits compared to controls. Non-NDD psychiatric groups (i.e., those with anxiety and depression) had milder EF difficulties compared to those with NDDs; however, their differences from the control group were not only statistically significant but also of moderate to large magnitude across six of the nine EF domains; these meaningful functional impairments warrant greater attention in both research and clinical practice. The findings underscore the central role of behavioral EF in understanding everyday functioning among youth with diagnosed or suspected NDDs as well as non-NDD diagnoses. This insight has important implications for developing targeted interventions and support strategies. In a society where many children and adolescents face long waiting times for neuropsychiatric assessment, assessing EF through a multi-informant, ecologically valid measure could serve as a valuable first step for providing support. By identifying specific functional challenges early on, it might be possible to enhance everyday functioning, both at home and school, while children await formal diagnosis.

Regarding academic outcomes, this thesis indicated that stronger EF is associated with better academic achievement. Notably, teacher-rated EF emerged as the strongest predictor of academic achievement, surpassing self-rated EF, internalizing symptoms, and NDD status. A particularly intriguing finding is the suppression effect observed in girls, where the accounting for internalizing symptoms amplified the relationship between self-reported EF difficulties and academic achievement. This finding suggests that some girls engage in compensatory behaviors, such as heightened effort or perfectionism, which help them maintain academic success despite underlying EF challenges. This gendered pattern deserves further attention. Why do girls report more EF difficulties than boys, but perform better academically? Why do teachers and parents often rate girls as having stronger EF skills than do boys? Given that Sweden's academic expectations continue to rise while many adolescents, especially girls, report declining mental health and academic results, what are the long-term implications of these associations between internal struggles, EF and external performance?

Declaration of Conflicts of Interests

I hereby declare that I have not received any financial compensation or personal benefits related to the work associated with this dissertation apart from the monthly salary as a doctoral student employed by Lund University. During my doctoral project, I collaborated with Hogrefe Publishing Group, which owns and distributes the Swedish translation of BRIEF2. An agreement was established with the research group (i.e., supervisors Daiva Daukantaitė, Eva Hoff, and I) and Hogrefe Publishing Group, where we agreed to collect Swedish normative data using the BRIEF2. In return, we were granted permission to use the BRIEF2 free of charge. This arrangement was solely for data collection and has not affected the objectivity or outcomes of this work or its conclusions.

References

Alderman, N., Knight, C., & Henman, C. (2003). Ecological validity of a simplified version of the multiple errands shopping test. *Journal of the International Neuropsychological Society, 9*(1), 31–44. https://doi.org/10.1017/S1355617703910046

Alesi, M., Giordano, G., Ingoglia, S., & Inguglia, C. (2024). The association among executive functions, academic motivation, anxiety and depression: A comparison between students with specific learning disabilities and undiagnosed peers. *European Journal of Special Needs Education, 39*(5), 805–819. https://doi.org/10.1080/08856257.2023.2300172

Ahmed, S. F., Ellis, A., Ward, K. P., Chaku, N., & Davis-Kean, P. E. (2022). Working memory development from early childhood to adolescence using two nationally representative samples. *Developmental Psychology, 58*(10), 1962–1973. https://doi.org/10.1037/dev0001396

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

American Psychological Association. (2025a). *Anxiety*. In APA Dictionary of Psychology. Retrieved March 5, 2025, from https://www.apa.org/topics/anxiety

American Psychological Association. (2025b). *Depression.* In APA Dictionary of Psychology. Retrieved March 5, 2025, from https://www.apa.org/topics/depression

Andersson, U. (2008). Working memory as a predictor of written arithmetical skills in children: The importance of central executive functions. *British Journal of Educational Psychology, 78*(2), 181–203. https://doi.org/10.1348/000709907X209854

Armitage, J. M., Newlove, D. T., Ford, T., McManus, S., & Collishaw, S. (2025). Characteristics of children with a psychiatric disorder in 1999, 2004 and 2017: An analysis of the national child mental health surveys of England. *Journal of Child Psychology and Psychiatry*, *66*(2), 167–177. https://doi.org/10.1111/jcpp.14040

Baddeley, A. D., & Hitch, G. (1974). Working memory. *Psychology of Learning and Motivation, 8*, 47–89. https://doi.org/10.1016/S0079-7421(08)60452-1

Baddeley, A. (1996). Exploring the central executive. *The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology, 49*(1), 5–28. https://doi.org/10.1080/713755608

Baddeley, A. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences, 4*(11), 417–423. https://doi.org/10.1016/S1364-6613(00)01538-2

Baggetta, P., & Alexander, P. A. (2016). Conceptualization and operationalization of executive function. *Mind Brain and Education*, 10(1), 10-33. https://doi.org/10.1111/mbe.12100

Barkley, R. A. (1997). *ADHD and the nature of self-control*. Guilford press.

Barkley, R. A. (2012). *Executive functions: What they are, how they work, and why they evolved*. Guilford Press.

Best, J. R., Miller, P. H., & Jones, L. L. (2009). Executive functions after age 5: Changes and correlates. *Developmental Review, 29*(3), 180–200. https://doi.org/10.1016/j.dr.2009.05.002

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development*, *81*(6), 1641–1660. https://doi.org/10.1111/j.1467-8624.2010.01499.x

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327–336. https://doi.org/10.1016/j.lindif.2011.01.007

Biederman, J., Petty, C. R., Fried, R., Black, S., Faneuil, A., Doyle, A. E., Seidman, L. J., & Faraone, S. V. (2008). Discordance between psychometric testing and questionnaire-based definitions of executive function deficits in individuals with ADHD. J Atten Disord, 12(1), 92-102. https://doi.org/10.1177/1087054707305111

Bjorklund, D. F., & Harnishfeger, K. K. (1990). The resources construct in cognitive development: Diverse sources of evidence and a theory of inefficient inhibition. *Developmental Review, 10*(1), 48–71. https://doi.org/10.1016/0273-2297(90)90004-N

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Development and Psychopathology, 20*(3), 899–911. https://doi.org/10.1017/S0954579408000436

Blair, C., & Raver, C. C. (2015). School readiness and self-regulation: A developmental psychobiological approach. *Annual Review of Psychology, 66*, 711–731. https://doi.org/10.1146/annurev-psych-010814-015221

Bloemen, A. J. P., Oldehinkel, A. J., Laceulle, O. M., Ormel, J., Rommelse, N. N. J., & Hartman, C. A. (2018). The association between executive functioning and psychopathology: general or specific? Psychol Med, 48(11), 1787-1794. https://doi.org/10.1017/s0033291717003269

Blomqvist, I., Henje Blom, E. 1962, Hägglöf, B., & Hammarström, A. (2019). Increase of internalized mental health symptoms among adolescents during the last three decades. *European Journal of Public Health*, *29*(5), 925–931. https://doi.org/10.1093/eurpub/ckz028

Bora, E., Yucel, M., & Pantelis, C. (2009). Cognitive endophenotypes of bipolar disorder: A meta-analysis of neuropsychological deficits in euthymic patients and their first-degree relatives. *Journal of Affective Disorders, 113*(1–2), 1–20. https://doi.org/10.1016/j.jad.2008.06.009

Brieant, A., King-Casas, B., & Kim-Spoon, J. (2022). Transactional relations between developmental trajectories of executive functioning and internalizing and externalizing symptomatology in adolescence. *Development and Psychopathology, 34*(1), 213–224. doi: 10.1017/S0954579420001054

Brocki, K. C., & Bohlin, G. (2004). Executive functions in children aged 6 to 13: A dimensional and developmental study. *Developmental Neuropsychology, 26*(2), 571–593. https://doi.org/10.1207/s15326942dn2602_3

Brydges, C. R., Fox, A. M., Reid, C. L., & Anderson, M. (2014). The differentiation of executive functions in middle and late childhood: A longitudinal latent-variable analysis. *Intelligence, 47*, 34–43. https://doi.org/10.1016/j.intell.2014.08.010

Brydges, C. R., Reid, C. L., Fox, A. M., & Anderson, M. (2012). A unitary executive function predicts intelligence in children. *Intelligence, 40*(5), 458–469. https://doi.org/10.1016/j.intell.2012.05.006

Bull, R., Johnson, R. S., & Roy, J. A. (1999). Exploring the roles of the visuo-spatial sketchpad and central executive in children's arithmetical skills: Views from cognition and developmental neuropsychology. *Developmental Neuropsychology, 15*(3), 421–442. https://doi.org/10.1207/S15326942DN1503_3

Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, shifting and working memory. *Developmental Neuropsychology, 19*(3), 273–293. https://doi.org/10.1207/S15326942DN1903_3

Burgess, P. (1997). Theory and methodology in executive function research. In P. Rabbitt (Ed.), *Methodology of frontal executive function* (pp. 81–116). Psychology Press.

Burgess, P. W., Alderman, N., Evans, J., Emslie, H., & Wilson, B. A. (2006). The ecological validity of tests of executive function. *Journal of Neuropsychological Rehabilitation, 16*(1), 1–9. https://doi.org/10.1017/s1355617798466037

Burgess, P. W., & Simons, J. S. (2005). Theories of frontal lobe executive function: Clinical applications. In P. W. Halligan & D. T. Wade (Eds.), *Effectiveness of rehabilitation for cognitive deficits* (pp. 211–231). Oxford University Press.

Carlson, S. M., & Moses, L. J. (2001). Individual differences in inhibitory control and children's theory of mind. *Child Development, 72*(4), 1032–1053. https://doi.org/10.1111/1467-8624.00333

Cásedas, L., Pirruccio, V., Vadillo, M. A., & Lupiáñez, J. (2020). Does mindfulness meditation training enhance executive control? A systematic review and meta-analysis of randomized controlled trials in adults. *Mindfulness, 11*(2), 411–424. https://doi.org/10.1007/s12671-019-01279-4

Cervin, M., Perrin, S., Olsson, E., Claesdotter-Knutsson, E., & Lindvall, M. (2019). Validation of an interview-only version of the Dimensional Yale-Brown Obsessive Compulsive Scale (DY-BOCS) in treatment-seeking youth with obsessive-compulsive disorder. *Psychiatry Research, 271*, 171–177. https://doi.org/10.1016/j.psychres.2018.11.061

Cervin, M., OCD Severity Benchmark Consortium, & Mataix-Cols, D. (2022). Empirical severity benchmarks for obsessive-compulsive disorder across the lifespan. *World Psychiatry, 21*(2), 315–316. https://doi.org/10.1002/wps.20987

Chang, S., Yang, L., Wang, Y., & Faraone, S. V. (2020). Shared polygenic risk for ADHD, executive dysfunction and other psychiatric disorders. *Translational Psychiatry, 10*(1), 182. https://doi.org/10.1038/s41398-020-00872-9

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal, 14*(3), 464-504. https://doi.org/10.1080/10705510701301834

Chung, K. K. H., & McBride-Chang, C. (2011). Executive functioning skills uniquely predict Chinese word reading. *Journal of Educational Psychology, 103*(4), 909–921. https://doi.org/10.1037/a0024514

Compas, B. E., Jaser, S. S., Bettis, A. H., Watson, K. H., Gruhn, M. A., Dunbar, J. P., Williams, E., & Thigpen, J. C. (2017). Coping, emotion regulation, and psychopathology in childhood and adolescence: A meta-analysis and narrative review. *Psychological Bulletin, 143*(9), 939–991. https://doi.org/10.1037/bul0000110

Corbett, B. A., Constantine, L. J., Hendren, R., Rocke, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry Research, 166*(2–3), 210–222. https://doi.org/10.1016/j.psychres.2008.02.005

Crone, E. A., & Dahl, R. E. (2012). Understanding adolescence as a period of social–affective engagement and goal flexibility. *Nature Reviews Neuroscience, 13*(9), 636–650. https://doi.org/10.1038/nrn3313

Crone, E. A., Wendelken, C., Donohue, S. E., van Leijenhorst, L., & Bunge, S. A. (2006). Neurocognitive development of the ability to manipulate information in working memory. *Proceedings of the National Academy of Sciences of the United States of America, 103*(24), 9315–9320. https://doi.org/10.1073/pnas.0510088103

Cumming, M. M., Poling, D. V., Qiu, Y., Pham, A. V., Daunic, A. P., Corbett, N., & Smith, S. W. (2023). A validation study of the BRIEF2 among kindergarteners and first graders at-risk for behavior problems. *Assessment, 30*(1), 3–21. https://doi.org/10.1177/10731911211032289

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review, 31*(6), 965–982. https://doi.org/10.1016/j.cpr.2011.06.001

Dai, D. Y. (2019). The impact of gender on ADHD diagnosis and treatment: A review of the literature. *Journal of Attention Disorders, 23*(5), 435–444. https://doi.org/10.1177/1087054716649585

Dajani, D. R., Llabre, M. M., Nebel, M. B., Mostofsky, S. H., & Uddin, L. Q. (2016). Heterogeneity of executive functions among comorbid neurodevelopmental disorders. *Scientific Reports, 6*, 36566. https://doi.org/10.1038/srep36566

Damasio, H., Grabowski, T., Frank, R., Galaburda, A. M., & Damasio, A. R. (1994). The return of Phineas Gage: Clues about the brain from the skull of a famous patient. *Science, 264*(5162), 1102–1105. https://doi.org/10.1126/science.8178168

Darowski, E. S., Helder, E., Zacks, R. T., Hasher, L., & Hambrick, D. Z. (2008). Age-related differences in cognition: The role of distraction control. *Neuropsychology, 22*(5), 638–644. https://doi.org/10.1037/0894-4105.22.5.638

Davidsson, M., Hult, N., Gillberg, C., Särneö, C., Gillberg, C., & Billstedt, E. (2017). Anxiety and depression in adolescents with ADHD and autism spectrum disorders: Correlation between parent- and self-reports and with attention and adaptive functioning. *Nordic Journal of Psychiatry, 71*(8), 614–620. https://doi.org/10.1080/08039488.2017.1346140

Dawson, P., & Guare, R. (2018). *Executive skills in children and adolescents: A practical guide to assessment and intervention* (3rd ed.). Guilford Publications.

Dehili, V. M., Prevatt, F., & Coffman, T. P. (2013). An analysis of the Barkley Deficits in Executive Functioning Scale in a college population: Does it predict symptoms of ADHD better than a visual-search task? *Journal of Attention Disorders, 21*(7), 567–574. https://doi.org/10.1177/1087054713498932

Dekker M. C., Ziermans T. B., Spruijt A. M., Swaab H. (2017). Cognitive, parent and teacher rating measures of executive functioning: Shared and unique influences on school achievement. *Frontiers in Psychology*, 8, 1–13. https://doi.org/10.3389/fpsyg.2017.00048

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., Hickie, I. B., & Guastella, A. J. (2018). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry, 23*(5), 1198–1204. https://doi.org/10.1038/mp.2017.75

Dempster, F. N. (1992). The rise and fall of the inhibitory mechanism: Toward a unified theory of cognitive development and aging. *Developmental Review, 12*(1), 45–75. https://doi.org/10.1016/0273-2297(92)90003-K

De Panfilis, C., Meehan, K. B., Cain, N. M., & Clarkin, J. F. (2013). The relationship between effortful control, current psychopathology and interpersonal difficulties in adulthood. *Comprehensive Psychiatry, 54*(5), 454–461. https://doi.org/10.1016/j.comppsych.2012.12.016

DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Sage Publications.

Diamond, A. (1990). Developmental time course in human infants and infant monkeys, and the neural bases of inhibitory control in reaching. *Annals of the New York Academy of Sciences, 608*(1), 637–676. https://doi.org/10.1111/j.1749-6632.1990.tb48913.x

Diamond, A. (2006). The early development of executive functions. In E. Bialystok & F. I. M. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (pp. 70–96). Oxford University Press.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Diamond, A., & Kirkham, N. Z. (2005). Not quite as grown-up as we like to think: Parallels between cognition in childhood and adulthood. *Psychological Science, 16*(4), 291–297. https://doi.org/10.1111/j.0956-7976.2005.01530.x

Doebel, S., & Munakata, Y. (2018). Group influences on engaging self-control: Children delay gratification and value it more when their in-group delays and their out-group doesn't. *Psychological Science, 29*(5), 738–748. https://doi.org/10.1177/0956797617747367

Doebel, S. (2020). Rethinking executive function and its development. *Perspectives on Psychological Science, 15*(4), 942–956. https://doi.org/10.1177/1745691620904771

Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality, 45*(3), 259–268. https://doi.org/10.1016/j.jrp.2011.02.004

Duncan, J. (1995). Attention, intelligence, and the frontal lobes. *Trends in Cognitive Sciences, 1*(2), 95–100.

Ebesutani, C., Reise, S. P., Chorpita, B. F., Ale, C., Regan, J., & Young, J. (2012). The Revised Child Anxiety and Depression Scale–Short Version: Scale reduction via exploratory bifactor modeling of the broad anxiety factor. *Psychological Assessment, 24*(4), 833–845. https://doi.org/10.1037/a0027283

Eisenberg, N., Spinrad, T. L., & Eggum, N. D. (2010). Emotion-related self-regulation and its relation to children's maladjustment. *Annual Review of Clinical Psychology, 6*, 495–525. https://doi.org/10.1146/annurev.clinpsy.121208.131208

Espy, K. A. (2004). Using developmental, cognitive, and neuroscience approaches to understand executive control in young children. *Developmental Neuropsychology, 26*(1), 379–384. https://doi.org/10.1207/s15326942dn2601_1

Ersche, K. D., Turton, A. J., Chamberlain, S. R., Müller, U., Bullmore, E. T., & Robbins, T. W. (2012). Cognitive dysfunction and anxious-impulsive personality traits are endophenotypes for drug dependence. *American Journal of Psychiatry, 169*(9), 926–936. https://doi.org/10.1176/appi.ajp.2012.11091421

Falkowski, J., Atchison, T., DeButte-Smith, M., Weiner, M. F., & O'Bryant, S. (2014). Executive functioning and the metabolic syndrome: A Project FRONTIER study. *Archives of Clinical Neuropsychology, 29*(1), 47–53. https://doi.org/10.1093/arclin/act078

Ferguson, H. J., Brunsdon, V. E., & Bradford, E. E. (2021). The developmental trajectories of executive function from adolescence to old age. *Scientific Reports, 11*(1), 1382. https://doi.org/10.1038/s41598-020-80866-1

Francés, L., Quintero, J., Fernández, A., Ruiz, A., Caules, J., Fillon, G., Hervás, A., & Soler, C. V. (2022). Current state of knowledge on the prevalence of neurodevelopmental disorders in childhood according to the DSM-5: A systematic review in accordance with the PRISMA criteria. *Child and Adolescent Psychiatry and Mental Health, 16*(1), 27. https://doi.org/10.1186/s13034-022-00462-1

Frazier, T. W., Demaree, H. A., & Youngstrom, E. A. (2004). Meta-analysis of intellectual and neuropsychological test performance in attention-deficit/hyperactivity disorder. *Neuropsychology, 18*(3), 543–555. https://doi.org/10.1037/0894-4105.18.3.543

Friedman, N. P., Miyake, A., Corley, R. P., Young, S. E., DeFries, J. C., & Hewitt, J. K. (2006). Not all executive functions are related to intelligence. *Psychological Science, 17*(2), 172–179. https://doi.org/10.1111/j.1467-9280.2006.01681.x

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex, 86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

Folkhälsomyndigheten. (2023). *Skolbarns hälsovanor i Sverige 2021/22: Nationella resultat* (Rapport 22228). https://www.folkhalsomyndigheten.se/publicerat-material/publikationsarkiv/s/skolbarns-halsovanor-i-sverige-202122/

Folkhälsomyndigheten. (2024). *Skolstress, självrapporterade hälsobesvär och livstillfredsställelse bland skolbarn* (Artikelnummer 24049). https://www.folkhalsomyndigheten.se/publicerat-material/publikationsarkiv/s/skolstress-halsobesvar-livstillfredsstallelse-skolbarn-skolbarnshalsovanor/

Föräldranätverket Rätten till Utbildning. (2023, April 22). *Pressmeddelande: Antalet hemmasittare har ökat lavinartat från 8 500 elever till 17 000 elever på fyra år* [Press release]. Föräldranätverket Rätten till Utbildning. https://www.rattentillutbildning.se/wp-content/uploads/2023/05/Pressmeddelande-fran-Foraldranatverket-Ratten-till-Utbildning-2.pdf

Garcia-Barrera, M. A., Kamphaus, R. W., & Bandalos, D. (2011). Theoretical and statistical derivation of a screener for the behavioral assessment of executive functions in children. *Psychological Assessment, 23*(1), 64–79. https://doi.org/10.1037/a0021143

Garon, N., Bryson, S. E., & Smith, I. M. (2008). Executive function in preschoolers: A review using an integrative framework. *Psychological Bulletin, 134*(1), 31–60. https://doi.org/10.1037/0033-2909.134.1.31

Gathercole, S. E., & Pickering, S. J. (2000). Assessment of working memory in six- and seven-year-old children. *Journal of Educational Psychology, 92*(2), 377–390. https://doi.org/10.1037/0022-0663.92.2.377

Gaub, M., & Carlson, C. L. (1997). Gender differences in ADHD: A meta-analysis and critical review. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(8), 1036–1045. https://doi.org/10.1097/00004583-199708000-00011

Genet, J. J., & Siemer, M. (2011). Flexible control in processing affective and non-affective material predicts individual differences in trait resilience. *Cognition and Emotion, 25*(2), 380–388. https://doi.org/10.1080/02699931.2010.491647

Gentil-Gutiérrez, A., Santamaría-Peláez, M., Mínguez-Mínguez, L. A., González-Santos, J., Fernández-Solana, J., & González-Bernal, J. J. (2022). Executive functions in children and adolescents with autism spectrum disorder, grade 1 and 2, vs. neurotypical development: A school view. *International Journal of Environmental Research and Public Health, 19*(13), 7987. https://doi.org/10.3390/ijerph19137987

Gilhooly, K. J., & Fioratou, E. (2009). Executive functions in insight versus non-insight problem solving: An individual differences approach. *Thinking & Reasoning, 15*(4), 355–376. https://doi.org/10.1080/13546780903178615

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function*. Psychological Assessment Resources.

Gioia, G. A., Isquith, P. K., Retzlaff, P. D., & Espy, K. A. (2002). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF) in a clinical sample. *Child Neuropsychology, 8*(4), 249–257. https://doi.org/10.1076/chin.8.4.249.13513

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2015). *Behavior Rating Inventory of Executive Function–2 (BRIEF2)*. Psychological Assessment Resources.

Glisky, E. L., Alexander, G. E., Hou, M., Kawa, K., Woolverton, C. B., Zigman, E. K., Nguyen, L. A., Haws, K., Figueredo, A. J., & Ryan, L. (2021). Differences between young and older adults in unity and diversity of executive functions. *Neuropsychology and Cognition*, *28*(6), 829–854. https://doi.org/10.1080/13825585.2020.1830936

Golden, C. J. (1978). *Stroop color and word test: A manual for clinical and experimental uses*. Chicago, IL: Stoelting Co.

Goldstein, S., Naglieri, J. A., & Princiotta, D. (2013). Introduction: A history of executive functioning as a theoretical and clinical construct. In S. Goldstein & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 1–12). Springer. https://doi.org/10.1007/978-1-4614-8106-5_1

Gopnik, A., & Rosati, A. (2001). Duck or rabbit? Reversing ambiguous figures and understanding ambiguous representations. *Developmental Science, 4*(2), 175–183. https://doi.org/10.1111/1467-7687.00163

Gravetter, F. J., & Wallnau, L. B. (2014). *Statistics for the behavioral sciences* (9th ed.). Cengage Learning.

Gravråkmo, S., Olsen, A., Lydersen, S., Ingul, J. M., Henry, L., & Øie, M. G. (2023). Associations between executive functions, intelligence and adaptive behaviour in children and adolescents with mild intellectual disability. *Journal of Intellectual Disabilities, 27*(3), 715–727. https://doi-org.ludwig.lub.lu.se/10.1177/17446295221095

Green, B., Shirk, S., Hanze, D., & Wanstrath, J. (1994). The Children's Global Assessment Scale in clinical practice: An empirical evaluation. *Journal of the American Academy of Child & Adolescent Psychiatry, 33*(8), 1158–1164. https://doi.org/10.1097/00004583-199410000-00011

Gupta, R., Kar, B. R., & Srinivasan, N. (2009). Development of task switching and post-error slowing in children. *Behavior and Brain Functions, 5*, Article 38. https://doi.org/10.1186/1744-9081-5-38

Guy, S. C., Gioia, G. A., & Isquith, P. K. (2004). *Behavior Rating Inventory of Executive Function: Self-report version*. Psychological Assessment Resources.

Hahs-Vaughn, D. L. (2016). *Applied multivariate research: Design and interpretation*. Sage Publications.

Hall, P. A., Elias, L. J., & Crossley, M. (2006). Neurocognitive influences on health behavior in a community sample. *Health Psychology, 25*(6), 778–782. https://doi.org/10.1037/0278-6133.25.6.778

Halse, M., Steinsbekk, S., Hammar, Å., & Wichstrøm, L. (2022). Longitudinal relations between impaired executive function and symptoms of psychiatric disorders in childhood. *Journal of Child Psychology and Psychiatry, 63*(12), 1574–1582. https://doi.org/10.1111/jcpp.13622

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). The Guilford Press.

Heidary, S., Hashemi, Z., Jamali, S. M., & Ebrahim, N. A. (2024). Quantitative and qualitative analysis of executive functions: A bibliometric approach. *Current Psychology, 43*(11), 10029–10047. https://doi.org/10.1007/s12144-023-05033-x

Henderson, H. A., & Wachs, T. D. (2007). Temperament and development. In R. M. Lerner (Ed.), *Handbook of child psychology* (6th ed., Vol. 3, pp. 395–438). Wiley.

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences, 8*(1), 26–32. https://doi.org/10.1016/j.tics.2003.11.003

Hooper, D., Coughlan, J., & Mullen, M. (2008). Structural equation modelling: Guidelines for determining model fit. *Electronic Journal of Business Research Methods, 6*(1), 53-60.

Howell, D. C. (2009). *Statistical methods for psychology* (7th ed.). Cengage Learning.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55. https://doi.org/10.1080/10705519909540118

Huizinga, M., Smidts, D. P., Baeyens, D., & Kan, K.-J. (2023). The Dutch version of the Behavior Rating Inventory of Executive Function-2 (BRIEF2). *Psychological Test Adaptation and Development*, *4*(1), 97–115. https://doi.org/10.1027/2698-1866/a000038

Ibbotson, P. (2023). The development of executive function: Mechanisms of change and functional pressures. *Journal of Cognition and Development, 24*(2), 172–190. https://doi.org/10.1080/15248372.2022.2160719

Isquith, P. K., Gioia, G. A., & Espy, K. A. (2004). Executive function in preschool children: Examination through everyday behavior. *Developmental Neuropsychology, 26*(1), 403–422. https://doi.org/10.1207/s15326942dn2601_3

Isquith, P. K., Roth, R. M., Kenworthy, L., & Gioia, G. (2014). Contribution of rating scales to intervention for executive dysfunction. *Applied Neuropsychology: Child*, *3*(3), 197–204. https://doi-org.ludwig.lub.lu.se/10.1080/21622965.2013.870014

Jablonska, B., Ohlis, A., Dal, H., & Gubi, E. (2024). *Autismspektrumtillstånd och adhd bland barn och ungdomar i Stockholms län: Förekomst av diagnoser i befolkningen samt vårdkonsumtion.* Centrum för epidemiologi och samhällsmedicin, Region Stockholm. https://www.ces.regionstockholm.se/globalassets/verksamheter/forskning-och-utveckling/centrum-for-epidemiologi-och-samhallsmedicin/folkhalsoguiden/rapporter-och-faktablad/rapport-2022.5-autismspektrumtillstand-och-adhd-bland-barn-och-ungdomar-i-stockholms-lan.pdf

Jacob, R., & Parkinson, J. (2015). The potential for school-based interventions that target executive function to improve academic achievement: A review. *Review of Educational Research, 85*(4), 512–552. https://doi.org/10.3102/0034654314561338

Jacobson, L. A., Kalb, L. G., & Mahone, E. M. (2020). When theory met data: Factor structure of the BRIEF2 in a clinical sample. *The Clinical Neuropsychologist*, *34*(1), 243–258. https://doi.org/10.1080/13854046.2019.1571634

Jiménez, A., & Lucas-Molina, B. (2019). Dimensional structure and measurement invariance of the BRIEF2 across gender in a socially vulnerable sample of primary school-aged children. *Child Neuropsychology*, *25*(5), 636–647. https://doi.org/10.1080/09297049.2018.1512962

Kassai, R., Futo, J., Demetrovics, Z., & Takacs, Z. K. (2019). A meta-analysis of the experimental evidence on the near- and far-transfer effects among children's executive function skills. *Psychological Bulletin, 145*(2), 165–188. https://doi.org/10.1037/bul0000180

Kavanaugh, B. C., Cancilliere, M. K., Fryc, A., Tirrell, E., Oliveira, J., Oberman, L. M., ... & Spirito, A. (2019). Measurement of executive functioning with the National Institute of Health Toolbox and the association to anxiety/depressive symptomatology in childhood/adolescence. *Child Neuropsychology, 26*(5), 754–769. https://doi.org/10.1080/09297049.2019.1708295

Kenworthy, L., Anthony, L. G., Alexander, K. C., Werner, M. A., & Wallace, G. L. (2021). Adding the missing voice: How self-report of autistic youth enhances understanding of their executive functioning challenges. *Autism, 25*(5), 1261–1273. https://doi-org.ludwig.lub.lu.se/10.1177/13623613211029117

Klefsjö, U., Kantzer, A. K., Gillberg, C., & Billstedt, E. (2021). The road to diagnosis and treatment in girls and boys with ADHD–gender differences in the diagnostic process. *Nordic journal of psychiatry*, *75*(4), 301-305. https://doi.org/10.1080/08039488.2020.1850859

Kofler, M. J., Rapport, M. D., Sarver, D. E., Raiker, J. S., Orban, S. A., Friedman, L. M., & Kolomeyer, E. G. (2013). Reaction time variability in ADHD: A meta-analytic review of 319 studies. *Clinical Psychology Review, 33*(6), 795–811. https://doi.org/10.1016/j.cpr.2013.06.001

Krieger, V., Amador-Campos, J. A., & Peró-Cebollero, M. (2019). Interrater agreement on behavioral executive function measures in adolescents with attention deficit hyperactivity disorder. *International Journal of Clinical and Health Psychology, 19*(2), 141–149. https://doi.org/10.1016/j.ijchp.2019.02.007

Lai, M. C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *The Lancet Psychiatry, 6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Lawson, R. A., Papadakis, A. A., Higginson, C. I., Barnett, J. E., Wills, M. C., Strang, J. F., Wallace, G. L., & Kenworthy, L. (2015). Everyday executive function impairments predict comorbid psychopathology in autism spectrum and attention deficit hyperactivity disorders. *Neuropsychology, 29*(3), 445–453. https://doi.org/10.1037/neu0000145

Levy, F., Pipingas, A., Harris, E. V., Farrow, M., & Silberstein, R. B. (2018). Continuous performance task in ADHD: Is reaction time variability a key measure?. *Neuropsychiatric disease and treatment*, 781-786. http://dx.doi.org/10.2147/NDT.S158308

Leyfer, O. T., Folstein, S. E., Bacalman, S., Davis, N. O., Dinh, E., Morgan, J., ... & Lainhart, J. E. (2006). Comorbid psychiatric disorders in children with autism: Interview development and rates of disorders. *Journal of autism and developmental disorders*, *36*, 849-861.

Lipszyc, J., & Schachar, R. (2010). Inhibitory control and psychopathology: A meta-analysis of studies using the stop signal task. *Journal of the International Neuropsychological Society, 16*(6), 1064–1076. https://doi.org/10.1017/s1355617710000895

Lundh, A., Kowalski, J., Sundberg, C. J., Gumpert, C., & Landén, M. (2010). Children's Global Assessment Scale (CGAS) in a naturalistic clinical setting: Inter-rater reliability and comparison with expert ratings. *Psychiatry Research, 177*(1–2), 206–210. https://doi.org/10.1016/j.psychres.2010.02.006

Luria, A. R. (2012). *Higher cortical functions in man*. Springer Science & Business Media.

Malloy, P., & Grace, J. (2005). A review of rating scales for measuring behavior change due to frontal systems damage. *Cognitive and Behavioral Neurology, 18*(1), 18–27.

Mattera, S., Rojas, N. M., Morris, P. A., & Bierman, K. (2021). Promoting EF with preschool interventions: Lessons learned from 15 years of conducting large-scale studies. *Frontiers in Psychology, 12*, Article 640702. https://doi.org/10.3389/fpsyg.2021.640702

Martel, M. M. (2013). Individual differences in attention deficit hyperactivity disorder symptoms and associated executive dysfunction and traits: sex, ethnicity, and family income. *American Journal of Orthopsychiatry*, *83*(2-3), 165.

Martel, M. M., Pan, P. M., Hoffmann, M. S., Gadelha, A., do Rosário, M. C., Mari, J. J., Manfro, G. G., Miguel, E. C., Paus, T., Bressan, R. A., Rohde, L. A., & Salum, G. A. (2017). A general psychopathology factor (P factor) in children: Structural model analysis and external validation through familial risk and child global executive function. *Journal of Abnormal Psychology, 126*(1), 137–148. https://doi.org/10.1037/abn0000205

Mayes, S. D., Calhoun, S. L., Chase, G. A., Mink, D. M., & Stagg, R. E. (2009). ADHD subtypes and co-occurring anxiety, depression, and oppositional-defiant disorder: Differences in Gordon diagnostic system and Wechsler working memory and processing speed index scores. *Journal of Attention Disorders, 12*(6), 540–550. https://doi-org.ludwig.lub.lu.se/10.1177/1087054708320402

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function?. *Journal of the International Neuropsychological Society*, *16*(3), 495-505.

Meinzer, M. C., Pettit, J. W., & Viswesvaran, C. (2014). The co-occurrence of attention-deficit/hyperactivity disorder and unipolar depression in children and adolescents: a meta-analytic review. *Clinical psychology review*, *34*(8), 595-607. https://doi.org/10.1016/j.cpr.2014.10.002

Miller, M., Nevado-Montenegro, A. J., & Hinshaw, S. P. (2012). Childhood executive function continues to predict outcomes in young adult females with and without childhood-diagnosed ADHD. *Journal of abnormal child psychology*, *40*, 657-668.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience, 24*, 167–202. https://doi.org/10.1146/annurev.neuro.24.1.167

Mitchison, G. M., & Njardvik, U. (2019). Prevalence and gender differences of ODD, anxiety, and depression in a sample of children with ADHD. *Journal of Attention Disorders, 23*(11), 1339–1345. https://doi.org/10.1177/1087054717733953

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49-100. https://doi.org/10.1006/cogp.1999.0734

Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current Directions in Psychological Science, 21*(1), 8-14. https://doi.org/10.1177/0963721411429458

Moradi, A., & Hassanabadi, H. (2021). Psychometric properties of the Persian version of the Behavior Rating Inventory of Executive Function, (BRIEF-2) in primary school-aged children. *Advances in Cognitive Science*, *23*(1), 1-12. http://dx.doi.org/10.30514/icss.23.1.1

Moura, O., P. Albuquerque, C., Pereira, M., Major, S., Lopes, A. F., Vilar, M., ... & Simões, M. R. (2023). Factor structure and measurement invariance of the BRIEF2 Parent Form across gender in a Portuguese sample. *Child Neuropsychology*, *29*(4), 628-643. https://doi.org/10.1080/09297049.2022.2105313

Mulder, H., Verhagen, J., Van der Ven, S. H., Slot, P. L., & Leseman, P. P. M. (2017). Early executive function at age two predicts emergent academic skills at age five. *Frontiers in Psychology, 8*, Article 1706. https://doi.org/10.3389/fpsyg.2017.01706

Müller, U., & Kerns, K. (2015). The development of executive function. In L. S. Liben, U. Müller, & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science: Cognitive processes* (7th ed., Vol. 2, pp. 571–623). Wiley.

Mullin, B. C., Perks, E. L., Haraden, D. A., Snyder, H. R., & Hankin, B. L. (2020). Subjective executive function weaknesses are linked to elevated internalizing symptoms among community adolescents. *Assessment*, *27*(3), 560-571. https://doi-org.ludwig.lub.lu.se/10.1177/1073191118820133

Munkvold, L. H., Manger, T., & Lundervold, A. J. (2014). Conners' continuous performance test (CCPT-II) in children with ADHD, ODD, or a combined ADHD/ODD diagnosis. *Child Neuropsychology, 20*(1), 106–126. https://doi.org/10.1080/09297049.2012.753997

National Board of Health and Welfare. (2024). *National guidelines: ADHD and autism*. Socialstyrelsen. https://www.socialstyrelsen.se

Nichols, S. L., & Waschbusch, D. A. (2004). A review of the validity of laboratory cognitive tasks used to assess symptoms of ADHD. *Child Psychiatry and Human Development, 34*(4), 297–315. https://doi.org/10.1023/b:chud.0000020681.06865.97

Nigg, J. T., Wong, M. M., Martel, M. M., Jester, J. M., Puttler, L. I., & Zucker, R. A. (2006). Poor response inhibition as a predictor of problem drinking and illicit drug use in adolescents at risk for alcoholism and other substance use disorders. *Journal of the American Academy of Child & Adolescent Psychiatry, 45*(4), 468–475. https://doi.org/10.1097/01.chi.0000199028.76452.a9

Nigg, J. T. (2017). Annual Research Review: On the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of child psychology and psychiatry*, *58*(4), 361-383. https://doi.org/10.1111/jcpp.12675

Nisbett, R. E., & Wilson, T. D. (1977). The halo effect: Evidence for unconscious alteration of judgments. *Journal of Personality and Social Psychology, 35*(4), 250–256. https://doi.org/10.1037/0022-3514.35.4.250

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical Psychology, 8*, 161–187. https://doi.org/10.1146/annurev-clinpsy-032511-143109

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

O'Hearn, K., Asato, M., Ordaz, S., & Luna, B. (2008). Neurodevelopment and executive function in autism. *Development and psychopathology*, *20*(4), 1103-1132. https://doi.org/10.1017/S0954579408000527

Organisation for Economic Co-operation and Development. (2023). *PISA 2022 results: Sweden's performance in international comparison*. OECD. https://www.oecd.org/publications/pisa-2022-results-country-note-sweden.pdf

Parhoon, K., Aita, S. L., Parhoon, H., Moradi, A., & Roth, R. M. (2022). Psychometric properties of the Behavior Rating Inventory of Executive Function, second edition (BRIEF2) self-report form in Iranian adolescents. *Applied Neuropsychology: Child*, *0*(0), 1–7. https://doi.org/10.1080/21622965.2022.2106437

Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Brière, N. M. (2001). Associations among perceived autonomy support, forms of self-regulation, and persistence: A prospective study. *Motivation and Emotion, 25*(4), 279–306. https://doi.org/10.1023/A:1014805132406

Pievsky, M. A., & McGrath, R. E. (2018). The Neurocognitive Profile of AttentionDeficit/Hyperactivity Disorder: A Review of Meta-Analyses. Arch Clin Neuropsychol, 33(2), 143-157. https://doi.org/10.1093/arclin/acx055

Pino Muñoz, M., & Arán Filippetti, V. (2021). Confirmatory factor analysis of the BRIEF-2 parent and teacher form: Relationship to performance-based measures of executive functions and academic achievement. *Applied Neuropsychology: Child*, *10*(3), 219-233. https://doi.org/10.1080/21622965.2019.1660984

Pnevmatikos, D., & Trikkaliotis, I. (2013). Intraindividual differences in executive functions during childhood: The role of emotions. *Journal of experimental child psychology*, *115*(2), 245-261. https://doi.org/10.1016/j.jecp.2013.01.010

Preston, A. S., Fennell, E. B., & Bussing, R. (2005). Utility of a CPT in diagnosing ADHD among a representative sample of high-risk children: A cautionary study. *Child Neuropsychology, 11*(5), 459–469. https://doi.org/10.1080/09297040591001067

Pribram, K. H. (1973). The primate frontal cortex—Executive of the brain. In *Psychophysiology of the frontal lobes* (pp. 293–314). Academic Press.

Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental review*, *41*, 71-90. https://doi.org/10.1016/j.dr.2016.06.004

Ramos, A. A., Hamdan, A. C., & Machado, L. (2020). A meta-analysis on verbal working memory in children and adolescents with ADHD. *The Clinical Neuropsychologist, 34*(5), 873–898. https://doi.org/10.1080/13854046.2019.1604998

Reynolds, G. D., Courage, M. L., & Richards, J. E. (2013). The development of attention. In D. Reisberg (Ed.), *The Oxford Handbook of cognitive psychology* (pp. 1000–1013). New York: Oxford University Press. https://doi.org/10.1093/oxfordhb/9780195376746.013.0063

Ribner, A. D., Willoughby, M. T., & Blair, C. B. (2017). Executive function buffers the association between early math and later academic skills. *Frontiers in Psychology, 8*, Article 869. https://doi.org/10.3389/fpsyg.2017.00869

Rock, P. L., Roiser, J. P., Riedel, W. J., & Blackwell, A. D. (2014). Cognitive impairment in depression: A systematic review and meta-analysis. *Psychological Medicine, 44*(10), 2029–2040. https://doi.org/10.1017/S0033291713002535

Roeser, R. W., Eccles, J. S., & Sameroff, A. J. (1998). Academic and emotional functioning in early adolescence: Longitudinal relations, patterns, and prediction by experience in middle school. *Development and psychopathology*, *10*(2), 321-352. https://doi.org/10.1017/S0954579498001631

Rosario-Campos, M. C., Miguel, E. C., Quatrano, S., Chacon, P., Ferrao, Y., Findley, D., ... & Scahill, L. (2006). The Dimensional Yale–Brown Obsessive–Compulsive Scale (DY-BOCS): An instrument for assessing obsessive–compulsive symptom dimensions. *Molecular Psychiatry, 11*(5), 495–504. https://doi.org/10.1038/sj.mp.4001798

Roth, R. M., Isquith, P. K., & Gioia, G. A. (2005). *Behavior rating inventory of executive function-Adult version*. Psychological Assessment Resources, Inc.

Rothschild, L. B., Ratto, A. B., Kenworthy, L., Hardy, K. K., Verbalis, A., Pugliese, C., Strang, J. F., Safer-Lichtenstein, J., Anthony, B. J., Anthony, L. G., Guter, M. M., & Haaga, D. A. (2022). Parents matter: Parent acceptance of school-based executive functions interventions relates to improved child outcomes. *Journal of Clinical Psychology, 78*(7), 1388–1406. https://doi.org/10.1002/jclp.23309

Rowe, A., Titterington, J., Holmes, J., Henry, L., & Taggart, L. (2021). Interventions targeting working memory in 4–11 year olds within their everyday contexts: A systematic review. *Developmental Review, 52*, 1–23. https://doi.org/10.1016/j.dr.2019.02.001

Rubia, K. (2011). The neurobiology of ADHD and its treatment. *Dialogues in Clinical Neuroscience, 13*(3), 369–379.

Rucklidge, J. J. (2010). Gender differences in attention-deficit/hyperactivity disorder. *The Psychiatric Clinics of North America, 33*(2), 357–373. https://doi.org/10.1016/j.psc.2010.01.006

Sadozai, A. K., Sun, C., Demetriou, E. A., Lampit, A., Munro, M., Perry, N., ... & Guastella, A. J. (2024). Executive function in children with neurodevelopmental conditions: a systematic review and meta-analysis. *Nature Human Behaviour*, 1-10. https://doi-org.ludwig.lub.lu.se/10.1038/s41562-024-02000-9

Samuels, W. E., Tournaki, N., Blackman, S., & Zilinski, C. (2016). Executive functioning predicts academic achievement in middle school: A four-year longitudinal study. *The Journal of Educational Research, 109*(5), 478–490. https://doi.org/10.1080/00220671.2014.979913

Samuels, W. E., Tournaki, N., Blackman, S., & Zilinski, C. (2019). Teachers' and students' ratings of executive functioning: An examination of convergence and predictability of academic outcomes. *Journal of Research in Special Educational Needs, 19*(1), 30–42. https://doi.org/10.1111/1471-3802.12417

Samuels, W. E., Tournaki, N., Sacks, S., Blackman, S., Peterford, T., Sacks, J. A., & Byalin, K. (2023). Executive Functioning and Adolescents' Academic Performance on Standardized Exams. *Journal of Educational and Developmental Psychology*, *13*(2), 10-62. http://doi.org/10.5539/jedp.v13n2p10

Sankalaite, S., Huizinga, M., Dewandeleer, J., Xu, C., de Vries, N., Hens, E., & Baeyens, D. (2021). Strengthening Executive Function and Self-Regulation Through Teacher-Student Interaction in Preschool and Primary School Children: A Systematic Review. Frontiers in psychology, 12, 718262. https://doi.org/10.3389/fpsyg.2021.718262

Sass, D. A. (2011). Testing measurement invariance and comparing latent factor means within a confirmatory factor analysis framework. *Journal of Psychoeducational Assessment*, *29*(4), 347-363.

Scahill, L., Riddle, M. A., McSwiggin-Hardin, M., Ort, S. I., King, R. A., Goodman, W. K., & Leckman, J. F. (1997). Children's Yale-Brown Obsessive Compulsive Scale: Reliability and validity. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(6), 844–852. https://doi.org/10.1097/00004583-199706000-00023

Schachar, R. J. (2023). Fifty years of executive control research in attention-deficit/hyperactivity disorder: What we have learned and still need to know. *Neuroscience & Biobehavioral Reviews*, 155, 105461. https://doi.org/10.1016/j.neubiorev.2023.105461

Schatz, A. M., Ballantyne, A. O., & Trauner, D. A. (2001). Sensitivity and specificity of a computerized test of attention in the diagnosis of attention-deficit/hyperactivity disorder. *Assessment*, 8(4), 357-365.

Shaffer, D., Gould, M. S., Brasic, J., Ambrosini, P., Fisher, P., Bird, H., & Aluwahlia, S. (1983). A Children's Global Assessment Scale (CGAS). *Archives of General Psychiatry, 40*, 1228–1231. https://doi.org/10.1001/archpsyc.1983.01790100074010

Shanmugan, S., Wolf, D. H., Calkins, M. E., Moore, T. M., Ruparel, K., Hopson, R. D., Vandekar, S. N., Roalf, D. R., Elliott, M. A., Jackson, C., Gennatas, E. D., Leibenluft, E., Pine, D. S., Shinohara, R. T., Hakonarson, H., Gur, R. C., Gur, R. E., & Satterthwaite, T. D. (2016). Common and dissociable mechanisms of executive system dysfunction across psychiatric disorders in youth. *The American Journal of Psychiatry, 173*(5), 517–526. https://doi.org/10.1176/appi.ajp.2015.15060725

Sheehan, D. V., Sheehan, K. H., Shytle, R. D., Janavs, J., Bannon, Y., Rogers, J. E., & Wilkinson, B. (2006). *The Mini International Neuropsychiatric Interview for children and adolescents (MINI-KID), version 6.0*. University of South Florida.

Sheehan, D. V., Sheehan, K. H., Shytle, R. D., Janavs, J., Bannon, Y., Rogers, J. E., ... & Wilkinson, B. (2010). Reliability and validity of the Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-KID). *Journal of Clinical Psychiatry, 71*(3), 313–326. https://doi.org/10.4088/JCP.09m05305whi

Shulman, E. P., Smith, A. R., Silva, K., Icenogle, G., Duell, N., Chein, J., & Steinberg, L. (2016). The dual systems model: Review, reappraisal, and reaffirmation. *Developmental Cognitive Neuroscience, 17*, 103–117. https://doi.org/10.1016/j.dcn.2015.12.010

Shallice, T. (1982). Specific impairments in planning. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 298*(1089), 199–209. https://doi.org/10.1098/rstb.1982.0082

Shallice, T. I. M., & Burgess, P. W. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain, 114*(2), 727–741. https://doi.org/10.1093/brain/114.2.727

Shum, K. K. M., Zheng, Q., Chak, G. S., Kei, K. T. L., Lam, C. W. C., Lam, I. K. Y., ... & Tang, J. W. Y. (2021). Dimensional structure of the BRIEF2 and its relations with ADHD symptoms and task performance on executive functions in Chinese children. *Child Neuropsychology*, *27*(2), 165-189. https://doi.org/10.1080/09297049.2020.1817355

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry, 47*(8), 921–929. https://doi.org/10.1097/CHI.0b013e318179964f

Skogli, E. W., Teicher, M. H., Andersen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys: Gender differences in co-existing symptoms and executive function measures. *BMC Psychiatry, 13*, 298. https://doi.org/10.1186/1471-244X-13-298

Skolverket. (2025). *Könsskillnader i skolresultat* (Rapport 2025:17; ISSN 1103-2421; ISRN SKOLV-R-2025:17-SE) [PDF]. Skolverket. https://www.skolverket.se/download/18.6b970af5198c5d3f7cee84e/1755870402348/pdf13305.pdf

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology*, *6*, 328. https://doi.org/10.3389/fpsyg.2015.00328

Socialstyrelsen. (2020). *Inrapporterade depressioner och ångestsyndrom bland barn och unga vuxna – utvecklingen till och med 2018*. Socialstyrelsen. Retrieved from https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/2020-6-6768.pdf

Socialstyrelsen. (2024). *Begrepp inom området psykisk hälsa* (Artikelnummer 2024-6-9186). https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/ovrigt/2024-6-9186.pdf

Socialstyrelsen. (2024). *Nationella riktlinjer 2024: Adhd och autism. Prioriteringsstöd till dig som beslutar om resurser i hälso- och sjukvården eller socialtjänsten* (Artikelnummer 2024-3-8958). Socialstyrelsen. https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/nationella-riktlinjer/2024-3-8958.pdf

Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem solving in children at risk and not at risk for serious math difficulties. *Journal of Educational Psychology, 96*(3), 471–491. https://doi.org/10.1037/0022-0663.96.3.471

Spiegel, J. A., Goodrich, J. M., Morris, B. M., Osborne, C. M., & Lonigan, C. J. (2021). Relations between executive functions and academic outcomes in elementary school children: A meta-analysis. *Psychological bulletin*, *147*(4), 329. https://psycnet.apa.org/doi/10.1037/bul0000322

Sprague, J., Verona, E., Kalkhoff, W., & Kilmer, A. (2011). Moderators and mediators of the stress-aggression relationship: executive function and state anger. *Emotion*, *11*(1), 61. https://psycnet.apa.org/doi/10.1037/a0021788

Stamenova, V., & Levine, B. (2019). Effectiveness of Goal Management Training® in improving executive functions: A meta-analysis. *Neuropsychological Rehabilitation, 29*(5), 762–785. https://doi.org/10.1080/09602011.2018.1438294

Stuss, D. T., & Alexander, M. P. (2000). Executive functions and the frontal lobes: A conceptual view. *Psychological Research, 63*(3), 289–298. https://doi.org/10.1007/s004269900007

Tan, A., Delgaty, L., Steward, K., & Bunner, M. (2018). Performance-based measures and behavioral ratings of executive function in diagnosing attention-deficit/hyperactivity disorder in children. *Attention Deficit and Hyperactivity Disorders, 10*(4), 309–316. https://doi.org/10.1007/s12402-018-0256-y

Theodoraki, T. E., McGeown, S. P., Rhodes, S. M., & MacPherson, S. E. (2019). Developmental changes in executive functions during adolescence: A study of inhibition, shifting, and working memory. *British Journal of Developmental Psychology*, 38(1), 74–89. https://doi.org/10.1111/bjdp.12307

Thorell, L. B., Eninger, L., Brocki, K. C., & Bohlin, G. (2010). Childhood Executive Function Inventory (CHEXI): A promising measure for identifying young children with ADHD?. *Journal of clinical and experimental neuropsychology*, *32*(1), 38-43. https://doi.org/10.1080/13803390902806527

Thorell, L. B., & Nyberg, L. (2008). The Childhood Executive Functioning Inventory (CHEXI): A new rating instrument for parents and teachers. *Developmental neuropsychology*, *33*(4), 536-552. https://doi.org/10.1080/87565640802101516

Tillman, C., Brocki, K. C., Sørensen, L., & Lundervold, A. J. (2015). A longitudinal examination of the developmental executive function hierarchy in children with externalizing behavior problems. *Journal of Attention Disorders, 19*(6), 496–506. https://doi.org/10.1177/1087054713488439

Toll, S. W., Van der Ven, S. H., Kroesbergen, E. H., & Van Luit, J. E. (2011). Executive functions as predictors of math learning disabilities. *Journal of learning disabilities*, *44*(6), 521-532. https://doi-org.ludwig.lub.lu.se/10.1177/0022219410387302

Toplak, M. E., Bucciarelli, S. M., Jain, U., & Tannock, R. (2009). Executive functions: Performance-based measures and the behavior rating inventory of executive function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology, 15*(1), 53–72. https://doi.org/10.1080/09297040802070929

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

Valiente, C., Eisenberg, N., Spinrad, T. L., Haugen, R. G., Thompson, M. S., & Kupfer, A. (2013). Effortful control and impulsivity as concurrent and longitudinal predictors of school performance. *The Journal of Early Adolescence, 33*(7), 946–972. https://doi.org/10.1177/0272431613477239

van den Bos, W., Rodriguez, C. A., Schweitzer, J. B., & McClure, S. M. (2015). Adolescent impatience decreases with increased frontostriatal connectivity. *Proceedings of the National Academy of Sciences, 112*(29), E3765–E3774. https://doi.org/10.1073/pnas.1423095112

van Tetering, M. A. J., van der Laan, A. M., de Kogel, C. H., de Groot, R. H. M., & Jolles, J. (2020). Sex differences in self-regulation in early, middle, and late adolescence: A large-scale cross-sectional study. *PLOS ONE, 15*(1), e0227607. https://doi.org/10.1371/journal.pone.0227607

Vink, M., Gladwin, T. E., Geeraerts, S., Pas, P., Bos, D., Hofstee, M., Durston, S., & Vollebergh, W. (2020). Towards an integrated account of the development of self-regulation from a neuro-cognitive perspective: A framework for current and future longitudinal multi-modal investigations. *Developmental Cognitive Neuroscience, 45*, 100829. https://doi.org/10.1016/j.dcn.2020.100829

Welsh, M. C. (2002). Developmental and clinical variations in executive functions. In D. L. Molfese & V. J. Molfese (Eds.), *Developmental variations in learning: Applications to social, executive function, language, and reading skills* (pp. 139–185). Lawrence Erlbaum Associates.

Wiebe, S. A., Sheffield, T., Nelson, J., Clark, C. C., Chevalier, N., & Espy, K. (2011). The structure of executive function in 3-year-olds. *Journal of Experimental Child Psychology, 108*, 436–452. https://doi.org/10.1016/j.jecp.2010.08.008

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry, 57*(11), 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006

World Health Organization (WHO, 2021). Adolescent Mental Health. Accessed from: https://www.who.int/newsroom/fact-sheets/detail/adolescent-mental-health

Yang, Y., Shields, G. S., Zhang, Y., Wu, H., Chen, H., & Romer, A. L. (2022). Child executive function and future externalizing and internalizing problems: A meta-analysis of prospective longitudinal studies. *Clinical Psychology Review, 97*, 102194. https://doi.org/10.1016/j.cpr.2022.102194

Zabelina, D. L., Friedman, N. P., & Andrews-Hanna, J. (2019). Unity and diversity of executive functions in creativity. *Consciousness and Cognition, 68*, 47–56. https://doi.org/10.1016/j.concog.2018.12.005

Zelazo, P. D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., ... & Carlson, S. M. (2003). The development of executive function in early childhood. *Monographs of the society for research in child development*, i-151.

Zelazo, P. D., Carter, A., Reznick, J., & Frye, D. (1997). Early development of executive functions: A problem-solving framework. *Review of General Psychology, 1*(2), 198–226. https://doi.org/10.1037/1089-2680.1.2.198

Zelazo, P. D. (2020). Executive function and psychopathology: A neurodevelopmental perspective. *Annual Review of Clinical Psychology, 16*, 431-454. https://doi.org/10.1146/annurev-clinpsy-072319-024242

Zeman, J., Cassano, M., Perry-Parrish, C., & Stegall, S. (2006). Emotion regulation in children and adolescents. *Journal of Developmental and Behavioral Pediatrics, 27*(2), 155–168. https://doi.org/10.1097/00004703-200604000-00014

Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood and middle adulthood: Age differences, gender differences, and emotion-specific developmental variations. *International Journal of Behavioral Development, 38*(2), 182–194. https://doi.org/10.1177/0165025413515405

findings in the original BRIEF2 (Gioia et al., 2015). In the American normative sample, the weakest agreement was observed between self- and parent-reports, suggesting that patterns of informant discrepancy may vary across cultural and contextual settings.

Beyond overall inter-rater correlations, we also examined gender differences in informant agreement. Our findings suggest that boys' self-reports aligned more closely with parent ratings but showed very low agreement with teacher ratings. In contrast, girls' self-reports correlated more strongly with teacher ratings than those of boys, although their highest inter-rater correlations were still with parent ratings. Notably, boys' ratings showed particularly low agreement with teacher reports. One possible explanation for these discrepancies is that boys' EF difficulties—particularly those related to inhibitory control—tend to be more overtly expressed and thus more readily observed by parents and teachers, whereas girls' emotional regulation challenges may be less externally visible, reflecting broader patterns seen in studies on gender differences in ADHD symptom recognition (Skogli et al., 2013). The BRIEF2 Interpretive Report (Isquith et al., 2022) also notes that the Inhibit scale reflects an individual's ability to manage impulses and regulate behaviors appropriately. When impaired, these difficulties often manifest externally through behaviors such as interrupting others, struggling to stay in line, or failing to remain in place in the classroom, all of which require increased adult supervision (Isquith et al., 2022). This aligns with our findings, where teachers may more readily identify inhibitory control difficulties in boys, while emotional regulation challenges in girls may be less behaviorally observable in structured school environments.

The discrepancies found between informants underscore the complexity of assessing EF across different contexts, as informants capture distinct aspects of EF behaviors depending on the setting, relationship to the child, and their own perceptual biases. Ultimately, inter-rater correlations in our study may diverge from those reported in other countries due to differences in home and school structures, academic workload, behavioral expectations, gender roles, and social pressures. More research is needed to consolidate these findings and to establish the validity of multi-informant EF assessments within a Nordic context—particularly for teacher ratings, given our small teacher sample and the high number of students each teacher evaluated, which may have further reduced the validity of these ratings. Cross-cultural studies comparing informant agreement and gender differences in EF ratings could provide valuable insights into whether the EF construct is perceived and assessed similarly across cultural settings. Given our findings on gender-related differences in informant agreement, including gender as a key variable in future inter-rater reliability analyses is crucial for improving our understanding of how EF is assessed in day-to-day contexts.

Age Differences

Consistent with our previous findings, EF differences across age groups varied by informant. According to self-reports, older adolescents reported significantly greater EF challenges in several areas, contrary to the general expectation that EF difficulties decrease with age. These results contrast with those of Huizinga et al. (2023), who found no significant age-related differences in self-reported EF difficulties. One potential explanation for this discrepancy is the different age categorization methods used in the studies. The Dutch study divided self-reports into four groups (11–12, 13–14, 15–16, and 17–18 years), whereas our study categorized participants into three groups that align with the Swedish educational system (11–12, 13–15, and 16–18 years). These methodological differences may have influenced our results and contributed to divergence from previous findings.

It is also important to consider that within the Swedish educational system, significant changes occur between the ages of 12 and 16, with increasing expectations and academic demands. Grades are first assigned in sixth grade (~12 years), marking a shift in academic accountability, and final grades are awarded in ninth grade (~15 years), a critical stage that influences students' future educational pathways. Additionally, the transition to middle school (~13 years) and the subsequent three years at this stage are often perceived as a period of intensified academic and organizational demands, requiring students to develop greater independence, time management, and executive functioning skills. Our findings that this age group, and older adolescents in general, reported more behavioral EF problems could also be linked to increased self-awareness and metacognition, enabling them to better recognize their own EF challenges. When interpreting questionnaire-based assessments of behavioral EF, it is crucial to acknowledge that these assessments require the informant to reflect on their thoughts and behaviors, drawing on introspective and metacognitive abilities (Metcalfe, 1996).

For parent- and teacher-reported EF, we found significant age-related differences, as expected, with EF difficulties rated as lower in older age groups. These findings align with previous research (e.g., Huizinga et al., 2023; Moura et al., 2023; Jiménez & Lucas-Molina, 2019), which also identified higher EF difficulties in younger children. Both parent and teacher ratings indicated that older adolescents exhibited fewer difficulties compared to younger age groups, suggesting developmental improvements in EF, as observed by external informants. However, since our data is based on external observations, it remains unclear whether the apparent EF improvements in older adolescents genuinely reflect cognitive development or if they are instead due to the amelioration of compensatory strategies. Adolescents may develop better coping mechanisms to manage EF challenges, leading parents and teachers to perceive fewer difficulties, while the adolescents themselves continue to experience EF-related struggles. This could explain the discrepancy between informants, where self-reports indicated greater EF difficulties with age,

while parent and teacher ratings suggested the opposite. Additionally, in our study, teacher ratings were provided by a small number of teachers and were available only for two age groups (13–15 years and 16–18 years), which makes these results less certain and limits the ability to examine teacher-rated age-related differences in EF across a broader developmental span. This limitation underscores the need for future research to include a larger and more diverse teacher sample, as well as younger age groups, in order to gain a more comprehensive understanding of how EF challenges evolve across developmental stages.

Gender Differences

Our results regarding gender differences in EF were generally as expected, though patterns varied depending on informant source and developmental stage. Self-reports indicated that gender differences in self-perceived EF were most pronounced during mid-adolescence (13–15 years), with girls reporting greater difficulties than boys across multiple scales. In contrast, in the younger age group (11–12 years), girls reported either fewer or very similar EF difficulties compared to boys, except for Emotional Control. This pattern suggests that gender disparities in EF may emerge or become more pronounced as cognitive and emotional demands increase during adolescence. These differences in self-reported EF may be shaped by developmental and social factors. One explanation is that adolescent girls experience greater internal and external demands, which may lead to heightened self-awareness and metacognitive abilities, increasing their recognition and reporting of EF difficulties (Zimmermann & Iwanski, 2014; van Tetering et al., 2020). Additionally, girls may be more likely to internalize cognitive struggles, perceiving them as personal shortcomings rather than external challenges, which could further contribute to their higher self-reported EF difficulties (Rucklidge, 2010; Nolen-Hoeksema, 2012). This internalization process may contrast with boys' externalizing tendencies, which could result in fewer self-reported EF difficulties despite comparable challenges in everyday functioning.

Parental ratings generally aligned with previous research, indicating that boys were perceived as experiencing greater EF challenges, particularly in task management, and organization (e.g., Jiménez & Lucas-Molina, 2019; Moura et al., 2023). However, an interesting exception was observed in the youngest age group (5–6 years), where parents rated girls as having more EF difficulties than boys in several domains, including Inhibit, Self-Monitor, and, more predictably, Emotional Control. This finding may reflect early developmental patterns, where both boys and girls exhibit relatively immature EF abilities, but certain regulatory behaviors in girls may be perceived as more problematic at this stage.

Teacher-reported ratings provided similar patterns to parent ratings, although the significance of differences varied. Boys were generally rated as struggling more with diverse EF difficulties, particularly among younger adolescents (ages 13–15).

These findings reinforce the recurring pattern observed in previous research, where boys are more frequently rated as having difficulties in behavioral regulation and organizational skills when assessed by external informants (e.g., Huizinga et al., 2023).

By late adolescence (16–18 years), gender differences in parent- and teacher-rated EF diminished across several scales, yet remained significant for emotional control (with girls exhibiting more difficulties) and task-related challenges (where boys were rated as struggling more). This suggests that while EF difficulties tend to decrease with age as cognitive abilities mature, certain gender-specific patterns persist, particularly in domains related to emotion regulation and sustained task management.

However, it is important to note that effect sizes for all gender differences were mostly small, aligning with the small but significant differences reported in the Dutch study by Huizinga et al. (2023). This suggests that while boys may be perceived as experiencing more EF difficulties in certain domains, the overall magnitude of these differences remains relatively modest. These patterns may be influenced by contextual and social factors, such as variations in behavioral expectations for boys and girls in both school and home environments, as well as differences in how EF challenges are recognized and interpreted by different informants.

Furthermore, scalar invariance was not fully achieved, particularly across gender groups, indicating potential differences in how boys and girls interpret or respond to BRIEF2 items. This suggests that observed gender differences in EF scores may not solely reflect true differences in EF abilities, but could also be influenced by response tendencies, social expectations, or measurement artifacts. For example, boys may underreport EF difficulties due to social norms emphasizing independence and self-sufficiency, while girls, who often exhibit greater self-awareness and metacognition, may be more attuned to and critical of their own EF challenges.

While our sample represents a community population of typically developing children, continued investigation into these gender-related EF patterns is important. Prior studies have shown that boys' EF difficulties tend to be more readily detected by external observers, such as teachers and parents, whereas girls' EF challenges—such as task avoidance, emotional dysregulation, or self-criticism—are more likely to be internalized and misinterpreted as disengagement or a lack of effort (van Tetering et al., 2020; Rucklidge, 2010). This highlights the importance of considering multiple informants and assessment methods when evaluating EF difficulties, as well as recognizing how gendered behavioral norms may shape perceptions of executive functioning.

Future research should further explore the interplay between gender, EF development, and social context by incorporating multi-method approaches,

including objective task-based EF measures and qualitative assessments. Understanding how boys and girls conceptualize and experience EF difficulties in their daily lives could provide valuable insights into the development of gender-sensitive intervention strategies.

Strengths and Limitations

This study has several notable strengths. First, the large, age- and gender-balanced sample provides a solid foundation for robust psychometric evaluation and meaningful subgroup analyses. Second, the use of a multi-informant approach—incorporating self-, parent-, and teacher-reports—allows for a comprehensive assessment of behavioral EF across multiple settings. This design captures the perspectives of individuals who interact with the child in different contexts, thereby increasing the generalizability and real-world relevance of the findings.

Despite its notable strengths, this study has several limitations that should be acknowledged.

First, limitations related to the overall sample. We relied on self- or parent-reported NDD to identify and exclude youths with these diagnoses, as no practical means or ethical approval was obtained to verify the conditions through medical records. In most cases, the youth and/or their parents specified the type of diagnosis, providing some degree of validation; however, this approach may still introduce bias, and the sample cannot be considered fully representative of typically developing children. Furthermore, information on school grade was not available for all participants, as our focus was on age and gender as primary demographic variables; this limits certain aspects of sample characterization.

Second, limitations related to the teacher-report data. The number of participating teachers was small (N = 38), and the number of students each rated varied widely (from 2 to 30). This small sample and uneven distribution may have introduced potential bias and reduced the reliability of the teacher-report data. Although the psychometric properties of the teacher ratings in our study closely aligned with findings from previous international validation studies, the limited teacher sample and variability in ratings per teacher create additional uncertainty regarding the robustness and generalizability of these results. These factors warrant caution in interpreting the teacher-report findings. Further research with larger and more evenly distributed teacher samples is needed to strengthen the validity of teacher ratings for Swedish youth.

A further limitation of the teacher-report data is that ratings were not obtained for younger age groups (5–6, 7–9, and 10–12 years), which limited our ability to conduct age-comparative analyses across the full developmental span. In contrast, the parent-report data covered the entire age range of 5 to 18 years, enabling more comprehensive age-related analyses within that informant group. The absence of

teacher ratings for younger children restricts our capacity to assess age-related trends in behavioral EF based on teacher observations and to directly compare patterns across informants.

Importantly, the limitation related to the uneven and wide distribution of teacher ratings highlights broader challenges in collecting teacher-report data in school-based research. Teachers often face considerable time constraints and competing responsibilities, making it difficult to complete detailed behavioral assessments for multiple students without adding substantially to their workload. This reality can lead to reduced participation and less balanced samples. To address these barriers, future research should consider strategies to enhance feasibility and participation—such as adopting shorter rating forms, integrating EF assessments into existing school procedures, or utilizing user-friendly digital platforms that streamline data collection while preserving measurement accuracy. Such innovations may not only reduce burden on teachers but also help ensure more representative and comprehensive data across age groups and educational settings.

Finally, scalar invariance was not fully achieved, particularly across gender groups, suggesting that boys and girls may interpret BRIEF2 items differently. Gender differences in EF scores may reflect response tendencies, social expectations, or measurement artifacts rather than actual EF differences. Boys may underreport EF difficulties due to social norms favoring independence, while girls, with potential greater self-awareness and metacognition, may be more likely to recognize and report EF challenges. These findings underscore the need for further examination of gendered response patterns in EF assessments.

Implications for Clinical and Educational Practice

The findings of this study are particularly relevant given the widespread use of the BRIEF2 in comprehensive assessments across both educational and clinical contexts, including evaluations of academic difficulties, learning challenges, and NDDs such as ADHD and ASD. Recent national guidelines from Sweden's National Board of Health and Welfare (Socialstyrelsen, 2024) emphasize the importance of early, individualized, and multidisciplinary assessment and intervention for NDDs, recommending the use of evidence-based tools—including behavior rating inventories like the BRIEF2—as part of evaluations conducted by both healthcare and educational professionals. These guidelines further stress that support should not be delayed while awaiting formal diagnostic assessments, and that timely interventions—based on the individual's strengths, challenges, and functional abilities—are essential for preventing long-term negative outcomes such as school absenteeism, internalizing symptoms, and harmful behaviors.

In educational settings, the BRIEF2 can support the early identification of students with EF difficulties and guide the development of targeted interventions while

awaiting formal diagnostic assessments. By providing Swedish norms and validating the BRIEF2 across informants, the current study offers a culturally relevant and psychometrically sound foundation for more equitable and accurate assessments in Swedish schools, where professionals have previously relied on American norms.

Similarly, in clinical neuropsychological practice, the BRIEF2's multi-informant format allows for multi-informant perspectives and the identification of context-specific EF challenges and insights. These can be especially valuable in complex cases or where symptoms may be masked, such as among girls with internalizing difficulties. These data, along with the updated Swedish norms, can help inform differential diagnosis, case conceptualization, and individualized intervention planning, and support decisions across healthcare, education, and social services.

Conclusions

This study is the first in the Nordic countries to evaluate the psychometric properties of the BRIEF2 across all three informant forms—self-, parent-, and teacher-reports—in a large, age- and gender-balanced sample of Swedish children and adolescents. Our findings support the three-factor model of EF (Behavioral, Emotional, and Cognitive Regulation Indexes), though the difference in fit indices compared to the two-factor model was small, indicating the need for further structural validation.

Internal consistency was acceptable to high across all versions, but the particularly high reliability of the parent- and teacher-reports suggests possible item redundancy. This highlights the potential for a shorter version of the BRIEF2, particularly for teachers, to enhance efficiency while maintaining reliability.

Inter-rater reliability analyses revealed moderate agreement between self- and parent-reports, but weaker correlations between self- and teacher-reports, emphasizing the complexity of assessing EF across different contexts. Gender differences varied by informant, with girls reporting greater EF difficulties during mid-adolescence, particularly in emotional control, whereas boys were more frequently rated by parents and teachers as having greater EF challenges, particularly in self-regulation and organization.

Age-related differences showed that self-reported EF difficulties increased with age, while parent and teacher ratings indicated improvements over time. These discrepancies suggest that older adolescents may develop compensatory strategies that reduce observable difficulties, despite continuing to experience EF challenges.

While this study confirms the robust psychometric properties of the Swedish BRIEF2, supporting its use across multiple informants, future research should explore objective EF measures, extend teacher-report assessments by involving a

larger sample of teachers and including younger children (5–12 years), and incorporate qualitative approaches to better understand informant differences in perceiving and reporting EF difficulties.

References

Baggetta, P., & Alexander, P. A. (2016). Conceptualization and operationalization of executive function. *Mind Brain and Education*, 10(1), 10-33. https://doi.org/10.1111/mbe.12100

Barkley, R. A. (2006). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment* (3rd ed.). Guilford Press.

Barkley, R. A. (2012). *Executive functions: What they are, how they work, and why they evolved*. Guilford Press.

Barkley, R. A., & Fischer, M. (2011). Predicting impairment in major life activities and occupational functioning in hyperactive children as adults: Self-reported executive function (EF) deficits versus EF tests. *Developmental Neuropsychology, 36*(2), 137–161. https://doi.org/10.1080/87565641.2010.549877

Bausela-Herreras, E. (2018). BRIEF-P: Analysis of executive functions according to informant / BRIEF-P: análisis de las funciones ejecutivas en función del informante. *Estudios de Psicología, 39*(2–3), 503–547. https://doi.org/10.1080/02109395.2018.1507096

Bull, R., & Scerif, G. (2001). Executive functioning as a predictor of children's mathematics ability: Inhibition, shifting and working memory. *Developmental Neuropsychology, 19*(3), 273–293.

Bull, R., Johnson, R. S., & Roy, J. A. (1999). Exploring the roles of the visuo-spatial sketchpad and central executive in children's arithmetical skills: Views from cognition and developmental neuropsychology. *Developmental Neuropsychology, 15*, 421–442.

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling, 14*(3), 464–504. https://doi.org/10.1080/10705510701301834

Cumming, M. M., Poling, D. V., Qiu, Y., Pham, A. V., Daunic, A. P., Corbett, N., & Smith, S. W. (2023). A validation study of the BRIEF2 among kindergarteners and first graders at-risk for behavior problems. *Assessment, 30*(1), 3–21. https://doi.org/10.1177/10731911211032289

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review, 31*(6), 965–982. https://doi.org/10.1016/j.cpr.2011.06.001

Cyders, M. A., & Coskunpinar, A. (2011). Measurement of constructs using self-report and behavioral lab tasks: Is there overlap in nomothetic span and construct representation for impulsivity? *Clinical Psychology Review, 31*(6), 965–982. https://doi.org/10.1016/j.cpr.2011.06.001

De Los Reyes, A., & Kazdin, A. E. (2005). Informant discrepancies in the assessment of childhood psychopathology: A critical review, theoretical framework, and recommendations for further study. *Psychological Bulletin, 131*(4), 483–509. https://doi.org/10.1037/0033-2909.131.4.483

DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). Sage Publications.

Diamond, A. (2013). Executive functions. *Annual Review of Psychology, 64*(1), 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality, 45*(3), 259–268. https://doi.org/10.1016/j.jrp.2011.02.004

Egeland, J., & Fallmyr, Ø. (2010). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF): Support for a distinction between emotional and behavioral regulation. *Child Neuropsychology, 16*(4), 326–337. https://doi.org/10.1080/09297041003601590

Ferguson, H. J., Brunsdon, V. E., & Bradford, E. E. (2021). The developmental trajectories of executive function from adolescence to old age. *Scientific Reports, 11*(1), 1382. https://doi.org/10.1038/s41598-020-80866-1

Fournet, N., Moreaud, O., Roulin, J. L., Naegele, B., & Pellat, J. (2015). Behavioral assessment of dysexecutive syndrome in elderly patients using the Behavioral Rating Inventory of Executive Function (BRIEF): Normative data and diagnostic accuracy. *The Clinical Neuropsychologist, 29*(3), 456–473. https://doi.org/10.1080/13854046.2015.1032416

Gioia, G. A., & Isquith, P. K. (2004). Ecological assessment of executive function in traumatic brain injury. *Developmental Neuropsychology, 25*(1–2), 135–158. https://doi.org/10.1080/87565641.2004.9651925

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function: Professional manual*. Psychological Assessment Resources.

Gioia, G. A., Isquith, P. K., Kenworthy, L., & Barton, R. M. (2002). Profiles of everyday executive function in acquired and developmental disorders. *Child Neuropsychology, 8*(2), 121–137.

Gioia, G. A., Isquith, P. K., Retzlaff, P. D., & Espy, K. A. (2002). Confirmatory factor analysis of the Behavior Rating Inventory of Executive Function (BRIEF) in a clinical sample. *Child Neuropsychology, 8*(4), 249–257. https://doi.org/10.1076/chin.8.4.249.13513

Guy, S. C., Gioia, G. A., & Isquith, P. K. (2004). *Behavior Rating Inventory of Executive Function: Self-Report Version (BRIEF-SR)*. Psychological Assessment Resources.

Hahs-Vaughn, D. L. (2016). *Applied multivariate research: Design and interpretation*. Sage Publications.

Halvorsen, M., Mathiassen, B., Amundsen, T., Ellingsen, J., Brøndbo, P. H., Sundby, J., … Martinussen, M. (2018). Confirmatory factor analysis of the behavior rating inventory of executive function in a neuro-pediatric sample and its application to mental disorders. *Child Neuropsychology*, *25*(5), 599–616. https://doi.org/10.1080/09297049.2018.1508564

Hamilton, A., Tallberg, P., Ilahi, F., Hoff, E., Ahmadi, B., & Daukantaitė, D. (2024). Behavioral manifestations of executive functioning in Swedish youth with ADHD, autism, and psychiatric comorbidity: A comparative analysis with community controls. *Child Neuropsychology*, *30*(1), 1–20. https://doi.org/10.1080/09297049.2024.2434736

Howell, D. C. (2009). *Statistical methods for psychology* (7th ed.). Cengage Learning.

Huizinga, M., & Smidts, D. P. (2010). Age-related changes in executive function: A normative study with the Dutch version of the Behavior Rating Inventory of Executive Function (BRIEF). *Child Neuropsychology, 17*(1), 51–66. https://doi.org/10.1080/09297049.2010.509715

Huizinga, M., Dolan, C. V., & van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia, 44*(11), 2017–2036. https://doi.org/10.1016/j.neuropsychologia.2006.01.010

Huizinga, M., Smidts, D. P., Baeyens, D., & Kan, K.-J. (2023). The Dutch version of the Behavior Rating Inventory of Executive Function-2 (BRIEF2). *Psychological Test Adaptation and Development, 4*(1), 97–115. https://doi.org/10.1027/2698-1866/a000038

Isquith, P. K., Gioia, G. A., Guy, S. C., Kenworthy, L., & PAR Staff. (2022). *BRIEF2 interpretive report for clinicians: Parent form*. PAR.

Jablonska, B., Ohlis, A., Dal, H., & Gubi, E. (2024). *Autism spectrum disorders and ADHD among children and adolescents in Stockholm County: Prevalence of diagnoses in the population and healthcare consumption. Follow-up report 2024*. Centrum för epidemiologi och samhällsmedicin, Region Stockholm. https://www.folkhalsoguiden.se

Jacobson, L. A., Kalb, L. G., & Mahone, E. M. (2020). When theory met data: Factor structure of the BRIEF2 in a clinical sample. *The Clinical Neuropsychologist, 34*(1), 243–258. https://doi.org/10.1080/13854046.2019.1571634

Jiménez, A., & Lucas-Molina, B. (2019). Dimensional structure and measurement invariance of the BRIEF2 across gender in a socially vulnerable sample of primary school-aged children. *Child Neuropsychology, 25*(5), 636–647. https://doi.org/10.1080/09297049.2018.1512962

Maldonado, J., García-Banda, G., Servera, M., & Baillés, E. (2017). Confirmatory factor analysis of the BRIEF in a Spanish sample of children with ADHD. *Journal of Attention Disorders, 21*(14), 1210–1219. https://doi.org/10.1177/1087054713518237

Metcalfe, J., & Shimamura, A. P. (Eds.). (1994). *Metacognition: Knowing about knowing*. MIT Press.

Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research, 3*(1), 111–121. https://doi.org/10.21500/20112084.857

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology, 41*(1), 49–100. https://doi.org/10.1006/cogp.1999.0734

Moradi, A., & Hassanabadi, H. (2021). Psychometric properties of the Persian version of the Behavior Rating Inventory of Executive Function (BRIEF2) in primary school-aged children. *Advances in Cognitive Science, 23*(1), 1–12.

Moura, O., Albuquerque, C. P., Pereira, M., Major, S., Lopes, A. F., Vilar, M., & Simões, M. R. (2022). Factor structure and measurement invariance of the BRIEF2 parent form across gender in a Portuguese sample. *Child Neuropsychology, 29*(4), 628–643. https://doi.org/10.1080/09297049.2022.2105313

National Board of Health and Welfare. (2024). *National guidelines: ADHD and autism*. Socialstyrelsen. https://www.socialstyrelsen.se

Nelson, T. D., Kidwell, K. M., Nelson, J. M., Tomaso, C. C., Hankey, M., & Espy, K. A. (2018). Preschool executive control and internalizing symptoms in elementary school. *Journal of Abnormal Child Psychology, 46*(7), 1509–1520. https://doi.org/10.1007/s10802-017-0395-1

Nolen-Hoeksema, S. (2012). Emotion regulation and psychopathology: The role of gender. *Annual Review of Clinical Psychology, 8*, 161–187. https://doi.org/10.1146/annurev-clinpsy-032511-143109

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). McGraw-Hill.

Parhoon, K., Aita, S. L., Parhoon, H., Moradi, A., & Roth, R. M. (2022). Psychometric properties of the Behavior Rating Inventory of Executive Function, second edition (BRIEF2) self-report form in Iranian adolescents. *Applied Neuropsychology: Child, 0*(0), 1–7. https://doi.org/10.1080/21622965.2022.2106437

Petrovic, P., & Castellanos, F. X. (2016). Top-down dysregulation—From ADHD to emotional instability. *Frontiers in Behavioral Neuroscience, 10*, 70. https://doi.org/10.3389/fnbeh.2016.00070

Pino Muñoz, M., & Arán Filippetti, V. (2021). Confirmatory factor analysis of the BRIEF2 parent and teacher form: Relationship to performance-based measures of executive functions and academic achievement. *Applied Neuropsychology: Child, 10*(3), 219–233. https://doi.org/10.1080/21622965.2019.1660984

Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: A review and recommendations for psychological research. *Developmental Review, 41*, 71–90. https://doi.org/10.1016/j.dr.2016.06.004

Rucklidge, J. J. (2010). Gender differences in attention-deficit/hyperactivity disorder. *The Psychiatric Clinics of North America, 33*(2), 357–373. https://doi.org/10.1016/j.psc.2010.01.006

Sass, D. A. (2016). Testing measurement invariance and comparing latent factor means within a confirmatory factor analysis framework. *Journal of Psychoeducational Assessment, 34*(6), 514–529. https://doi.org/10.1177/0734282915621496

Shallice, T., & Burgess, P. (1991). Deficits in strategy application following frontal lobe damage in man. *Brain, 114*(2), 727–741. https://doi.org/10.1093/brain/114.2.727

Sharma, L., Markon, K. E., & Clark, L. A. (2014). Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures. *Psychological Bulletin, 140*, 374–408. https://doi.org/10.1037/a0034418

Shi, R., Sharpe, L., & Abbott, M. (2019). A meta-analysis of the relationship between anxiety and attentional control. *Clinical Psychology Review, 72*, 101754. https://doi.org/10.1016/j.cpr.2019.101754

Shum, K. K. M., Zheng, Q., Chak, G. S., Kei, K. T. L., Lam, C. W. C., Lam, I. K. Y., & Tang, J. W. Y. (2021). Dimensional structure of the BRIEF2 and its relations with ADHD symptoms and task performance on executive functions in Chinese children. *Child Neuropsychology, 27*(2), 165–189. https://doi.org/10.1080/09297049.2020.1788644

Skogli, E. W., Teicher, M. H., AnArán Filippettirsen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys: Gender differences in co-existing symptoms and executive function measures. *BMC Psychiatry, 13*, 298. https://doi.org/10.1186/1471-244X-13-298

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology, 6*, Article 328. https://doi.org/10.3389/fpsyg.2015.00328

Socialstyrelsen. (2024). *Nationella riktlinjer 2024: Adhd och autism. Prioriteringsstöd till dig som beslutar om resurser i hälso- och sjukvården eller socialtjänsten* (Artikelnummer 2024-3-8958). Socialstyrelsen. https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/nationella-riktlinjer/2024-3-8958.pdf

Streiner, D. L. (2003). Starting at the beginning: An introduction to coefficient alpha and internal consistency. *Journal of Personality Assessment, 80*(1), 99–103. https://doi.org/10.1207/S15327752JPA8001_18

Suchy, Y., DesRuisseaux, L. A., Gereau Mora, M., Brothers, S. L., & Niermeyer, M. A. (2024a). Conceptualization of the term "ecological validity" in neuropsychological research on executive function assessment: A systematic review and call to action. *Journal of the International Neuropsychological Society, 30*(5), 499–522. https://doi.org/10.1017/S1355617723000735

Suchy, Y., Gereau Mora, M., Brothers, S. L., & DesRuisseaux, L. A. (2024b). Six elements test vs D-KEFS: What does "ecological validity" tell us? *Journal of the International Neuropsychological Society, 30*(4), 350–359. https://doi.org/10.1017/S1355617723000723

Tervo-Clemmens, B., Calabro, F. J., Parr, A. C., Fedor, J., Foran, W., & Luna, B. (2023). A canonical trajectory of executive function maturation from adolescence to adulthood. *Nature Communications, 14*(1), 6922. https://doi.org/10.1038/s41467-023-42540-8

Toll, S. W. M., Van der Ven, S. H. G., Kroesbergen, E. H., & Van Luit, J. E. H. (2011). Executive functions as predictors of math learning disabilities. *Journal of Learning Disabilities, 44*(6), 521–532. https://doi.org/10.1177/0022219410387302

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance-based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry, 54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

van Tetering, M. A. J., van der Laan, A. M., de Kogel, C. H., de Groot, R. H. M., & Jolles, J. (2020). Sex differences in self-regulation in early, middle, and late adolescence: A large-scale cross-sectional study. *PLOS ONE, 15*(1), e0227607. https://doi.org/10.1371/journal.pone.0227607

Vandenbroucke, L., Spilt, J., Verschueren, K., Piccinin, C., & Baeyens, D. (2018). The classroom as a developmental context for cognitive development: A meta-analysis on the importance of teacher–student interactions for children's executive functions. *Review of Educational Research, 88*(1), 125–164. https://doi.org/10.3102/0034654317743200

Waschl, N., Khng, K. H., Bull, R., Ng, E. L., Sun, H., & Chan, W. T. (2023). Screening for executive function difficulties: An evaluation of the Behavior Rating Inventory of Executive Function-Screener, Teacher Report (BRIEF2-TS). *Psychological Assessment, 35*(4), 366–379. https://doi.org/10.1037/pas0001227

Zimmermann, P., & Iwanski, A. (2014). Emotion regulation from early adolescence to emerging adulthood and middle adulthood: Age differences, gender differences, and emotion-specific developmental variations. *International Journal of Behavioral Development, 38*(2), 182–194. https://doi.org/10.1177/0165025413515405

Supplementary Material

Table S1.
Percentile Scores and Classifications for the BRIEF2 Inconsistency Scale

Percentile and protocol classification	Self-Report Form	Parent Form	Teacher Form
≤ 98 Acceptable	≤4	≤4	≤2
99 Questionable	5	5	3
>99 Inconsistent	≥6	≥6	≥4

Table S2.
Percentile Scores and Classifications for the BRIEF2 Negativity Scale

Percentile and protocol classification	Self-Report Form	Parent Form	Teacher Form
≤ 98 Acceptable	≤4	≤4	≤3
99 Elevated	5	5	4
>99 Highly elevated	≥6	≥6	≥5

Table S3.
Percentile Scores and Classifications for the BRIEF2 Infrequency Scale

Percentile and protocol classification	Self-Report Form	Parent Form	Teacher Form
99 Acceptable	2	2	0
>99 Questionable	3	3	1

Table S4.
Comparing Configural, Metric and Scalar Invariance Across Gender Groups for Self-Report Form

Invariance	χ^2	*df*	*p*	CFI	RMSEA	|Δ|	$\Delta\chi^2$	*p* för $\Delta\chi^2$	ΔCFI	ΔRMSEA
Across gender groups (girl/boy)										
1. Configural	118.92	18	<.001	.984	.094					
2. Metric	122.92	22	<.001	.984	.085	|Δ| 2-1	4.00	.406	.000	.009
3. Scalar	238.74	26	<.001	.966	.114	|Δ| 3-2	115.82	<.001	.018	.029
Across age groups (11-12, 13-15 and 16-18)										
1. Configural	134.95	27	<.001	.983	.098					
2. Metric	155.01	35	<.001	.981	.090	|Δ| 2-1	20.07	.002	.002	.008
3. Scalar	185.03	43	<.001	.977	.089	|Δ| 3-2	30.01	<.001	.004	.001

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation.

Table S5.
Comparing Configural, Metric and Scalar Invariance Across Gender Groups for Parent Form

Invariance	χ^2	*df*	*p*	CFI	RMSEA	|Δ|	$\Delta\chi^2$	*p* för $\Delta\chi^2$	ΔCFI	ΔRMSEA
Across gender groups (girl/boy)										
1. Configural	205.15	42	<.001	.985	.076					
2. Metric	217.38	48	<.001	.984	.073	|Δ| 2-1	12.23	.057	.001	.003
3. Scalar	299.90	54	<.001	.977	.082	|Δ| 3-2	82.52	<.001	.006	.009
Across age groups (5-6, 7-9, 10-12, 13-15 and 16-18)										
1. Configural	244.88	105	<.001	.987	.071					
2. Metric	301.71	129	<.001	.984	.071	|Δ| 2-1	56.83	<.001	.002	.004
3. Scalar	505.89	153	<.001	.967	.093	|Δ| 3-2	204.18	<.001	.014	.019

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation.

Table S6.
Comparing Configural, Metric and Scalar Invariance Across Gender Groups for Teacher Form

Invariance	χ^2	*df*	*p*	CFI	RMSEA	|Δ|	$\Delta\chi^2$	*p* för $\Delta\chi^2$	ΔCFI	ΔRMSEA
Across gender groups (girl/boy)										
1. Configural	313.69	42	<.001	.950	.159					
2. Metric	340.82	48	<.001	.947	.155	|Δ| 2-1	27.13	<.001	.003	.002
3. Scalar	395.28	54	<.001	.938	.157	|Δ| 3-2	54.46	<.001	.009	.002
Across age groups (13-15/16-18)										
1. Configural	397.84	42	<.001	.940	.174					
2. Metric	412.87	48	<.001	.938	.165	|Δ| 2-1	15.04	.020	.002	.009
3. Scalar	421.44	54	<.001	.938	.156	|Δ| 3-2	8.57	.199	.000	.009

Note. CFI = comparative fit index; RMSEA = root mean square error of approximation.

Study II

Rydqvist *et al. BMC Psychiatry* (2023) 23:622
https://doi.org/10.1186/s12888-023-05111-1

BMC Psychiatry

RESEARCH Open Access

Everyday executive functioning in pediatric obsessive-compulsive disorder: diagnostic specificity, clinical correlations, and outcome

Frida Rydqvist[1], Eva Hoff[1], Daiva Daukantaitė[1] and Matti Cervin[2*]

Abstract

Background Obsessive-compulsive disorder (OCD) typically onsets during childhood or adolescence and difficulties with executive functioning (EF) may be involved in its onset and maintenance. Yet, few studies have examined everyday EF difficulties in youth with OCD and no study has compared EF in youth with OCD to EF in youth with anxiety disorders, leaving the diagnostic specificity of EF unclear.

Methods In this study, parents of treatment-seeking children and adolescents with OCD ($n = 96$, $M_{age} = 13.3$, $SD = 2.7$, 59% girls) or anxiety disorders ($n = 67$, $M_{age} = 14.0$, $SD = 2.6$, 78% girls) reported on their children's everyday EF using the Behavior Rating Inventory of Executive Function (BRIEF) measure.

Results Compared to community youth, the two clinical groups showed moderately elevated EF deficits but did not differ significantly from each other. EF deficits were not associated with the major symptom dimensions of OCD, age of OCD symptom onset, duration of OCD symptoms, and OCD severity, and did not predict treatment outcome in OCD.

Conclusions Compared to peers, youth with OCD show moderate difficulties with EF, but very similar difficulties are seen in youth with anxiety disorders, and it is unclear whether these difficulties are of clinical relevance. Among youth with OCD, EF difficulties were not differentially associated with the major symptom dimensions of OCD, which is inconsistent with findings from adults. Difficulties with EF did not predict treatment outcome, indicating that integrating EF modules into OCD treatment may be of limited value, although EF may be important for treatment planning in individual cases.

Keywords OCD, Children, Adolescents, executive functioning, anxiety, Anxiety disorders, Treatment

*Correspondence:
Matti Cervin
matti.cervin@med.lu.se
[1]Department of Psychology, Lund University, Lund, Sweden
[2]Faculty of Medicine, Department of Clinical Sciences Lund, Child and Adolescent Psychiatry, Lund University, Sofiavägen 2D, Lund SE-22241, Sweden

Background

Obsessive-compulsive disorder (OCD) is a mental disorder with an estimated prevalence of 1–3% in the general population [1, 2]. OCD is characterized by distressing and intrusive thoughts, urges or images (obsessions), resulting in compulsive acts carried out to reduce the discomfort, distress or anxiety caused by obsessions [3–5]. More than half of all individuals with OCD experience their first symptoms before adulthood [6], making research on pediatric OCD important. Pediatric OCD is known for its heterogeneity, but symptoms can be divided into thematically coherent symptom dimensions, with the most replicated dimensions being disturbing thoughts/checking, contamination/cleaning, and symmetry/ordering [7–9]. Co-occurring mental disorders are common in pediatric OCD and often include anxiety disorders, depressive disorders, and neurodevelopmental disorders such as attention deficit hyperactivity disorder (ADHD) and autism spectrum disorder [2].

It has been proposed that behavioral and executive dysregulation may be core deficits underlying OCD, and that cognitive control may be a key endophenotype in OCD [10]. Cognitive flexibility, as well as cognitive and behavioral control and regulation, all belong under the umbrella term known as executive functions (EF), which are a set of self-regulatory, higher cognitive functions responsible for emotional and behavioral regulation and the ability to execute goal-directed actions related to every-day functioning and long-term goals [11]. EF is described as a multidimensional construct and includes several interconnected, yet distinguishable neurocognitive processes [12, 13] closely intertwined with the ability to exhibit self-control in areas such as organization, planning, affect regulation, initiation and overall attention [11].

EF develops and matures over time, from early childhood into early adulthood [14], suggesting that younger children tend to experience more EF-related difficulties compared to adolescents and adults [15]. Given the early onset of OCD, research on EF in pediatric OCD may provide important insight into processes and mechanisms involved in the onset and maintenance of the disorder.

Previous research on pediatric OCD and EF is limited and with contradictory results, often contrasting results found in adults with OCD. A systematic review and meta-analysis synthesized 11 studies on EF in pediatric OCD [16]. Results were categorized into nine EF subdomains: planning, response inhibition/interference control, set shifting/cognitive flexibility, verbal memory, nonverbal memory, processing speed, working memory, visuospatial functions, and attention. All included studies measured EF through performance-based neuropsychological tasks and did not include rating scales of everyday EF skills. Small degrees of underperformance on most subdomains were identified, except for the response inhibition and interference control subdomains, where performances were similar in the OCD group and comparison groups from the general population. While there were some indications of a small to moderate degree of underperformance in planning in youth with OCD, no meta-analytic comparison was statistically significant, leading to the conclusion that task-based neuropsychological deficits in EF seem to have no clear association with pediatric OCD. However, the study also acknowledged that few studies were available and that more research is needed to consolidate the understanding of neuropsychological functioning and EF in youth with OCD [16]. A recent study, also using performance-based EF tasks, investigated several neurocognitive domains in youth with OCD, their unaffected siblings, and parents [17]. Results showed that cognitive flexibility and inhibitory control may be two candidate endophenotypes in pediatric OCD, while no significant familial effects were found for the other EF subdomains.

Consequently, research on EF in pediatric OCD shows inconsistent results. A potential explanation is the lack of a consensus regarding how to define and measure EF, which is a multidimensional construct [18]. EF is typically measured through performance-based tasks [11], a method that is not always optimal. For example, patients with frontal lobe damage and clear daily life impairments have managed to perform normally or above normal on traditional neuropsychological tasks of language, memory, perception, and EF [19]. Thus, real-world, observational tasks have been suggested to be a more effective and ecologically valid method to capture EF impairments than the sole use of performance-based EF tasks conducted in lab-settings [20]. Generally, performance-based EF tasks do not seem to capture the same constructs as rating scales or direct observations of EF in daily life [20]. This is important since distinct EF processes (e.g., response inhibition) have been suggested as candidate endophenotypes in OCD [10]. Thus, conflicting results regarding EF and pediatric OCD may be explained by the extensive reliance on performance-based EF measures.

Further, no previous studies have compared EF in pediatric OCD to other EF in other mental disorders, leaving it uncertain whether deficits in EF are linked to OCD specifically or are transdiagnostic in nature (i.e., related to many different forms of symptoms and disorders). Moreover, associations between EF and the known symptom heterogeneity of pediatric OCD remain unclear but could help explain inconsistent and conflicting results in previous research. Differences in EF across different OCD symptom dimensions have been observed in adults [21], but few studies have examined EF across OCD symptom dimensions in pediatric OCD. However, a recent study that included parent ratings of EF using the

Behavior Rating Inventory of Executive Function (BRIEF) [22] in combination with EF tasks, showed no support for the relevance of EF in relation to the symptom heterogeneity of pediatric OCD [23]. Last, few studies have examined whether EF predicts treatment outcome for youth with OCD, with current studies yielding inconsistent results [24–26]. The association between EF and treatment outcome is important as such an association could imply that integrating EF modules into OCD treatment may improve outcomes.

Regarding diagnostic specificity of EF in relation to pediatric OCD, a comparison to pediatric anxiety disorders is of relevance. OCD was long considered an anxiety disorder but was included in its own chapter in DSM-5, where it was acknowledged that OCD shares features with anxiety disorders (fear, anxiety, and avoidance), but that there are also elements that make OCD distinct from anxiety disorders (e.g., compulsivity). Comparing EF in youth with OCD to EF in youth with anxiety disorders can help improve the understanding of the role of EF in OCD and whether some EF features are specific to OCD. Research on EF in youth with anxiety disorders is sparse compared to research on EF in pediatric OCD. The available studies suggest that pediatric anxiety disorders may be associated with some EF deficits, particularly inhibition difficulties, although findings are mixed [27].

As mentioned, research on rating-based EF in youth with OCD is limited, but the few published studies have shown worse EF among youth with OCD compared to healthy controls [23, 26]. For example, one study [23] found that all three subgroups of youth with OCD (symmetry/hoarding, harm/sexual, and contamination/cleaning symptoms) had increased parent-reported difficulties with inhibition and shifting compared to healthy controls, while no associations were found between EF scores (ratings or task-based performance) and symptom dimensions. A recent study [28] used both EF tasks and rating scales (BRIEF) to assess EF in OCD and found that youth with OCD demonstrated greater executive dysfunction in real-life contexts (as measured with BRIEF) compared to their EF ability on performance-based tasks in controlled settings. This finding provides further support for the notion that EF difficulties in youth with OCD may be underestimated when relying solely on performance-based EF. Further, youth with OCD had significantly higher EF scores (indicating more difficulties) than healthy controls, with large effect sizes for Shift (Cohen's $d=1.36$), Working memory (Cohen's $d=0.92$), Planning (Cohen's $d=0.89$), and Inhibition (Cohen's $d=0.78$). Of note, BRIEF scores were not associated with OCD severity.

The aim of this study is to investigate everyday EF in pediatric OCD. We will analyze parent-ratings of everyday EF using the BRIEF in a sample of children and adolescents with OCD and compare their scores to norm scores from peers and scores from a sample of youth with anxiety disorders but no OCD. We will also examine whether EF deficits are more common in certain OCD symptom dimensions (i.e., disturbing thoughts/checking, contamination/cleaning and symmetry/ordering), with symptom dimensions being assessed using a validated interview. Finally, we will examine whether EF predicts treatment outcome in OCD. Based on previous research [28], we expect that EF deficits are elevated among youth with OCD compared to peers and that differences are largest for the EF domains of Shift, Working memory, Planning, and Inhibition. Based on previous research [23, 28], we do not expect EF to be statistically significantly linked to OCD symptom dimensions. With respect to the comparison to youth with anxiety disorders and treatment outcome for youth with OCD, we proceed without predefined hypotheses based on non-existent studies (comparison to youth with anxiety disorders) and inconsistent results in previous studies (treatment outcome).

Methods

Participants

Participants were 163 children and adolescents recruited from a specialized child and adolescent outpatient clinic in southern Sweden where they were part of a larger project examining emotional and cognitive processes in pediatric OCD. Approximately two thirds (67%) were female, and the mean age was 13.6 years (SD=2.7). Ninety-six participants had OCD as their principal disorder and 67 had an anxiety disorder as their principal disorder (generalized anxiety disorder: 38%, panic disorder: 11%, separation anxiety disorder: 11%, specific phobia: 12%, social anxiety disorder: 28%). None of the participants with an anxiety disorder met diagnostic criteria for OCD. Thirty-four participants (21%) had co-existing neurodevelopmental disorders: autism spectrum disorder (6%) and ADHD (18.0%). Sociodemographic and clinical information for the OCD and anxiety disorder samples are presented in Table 1. All participants and their caregiver/s provided written informed consent/assent, and the study was approved by the regional ethics committee at Lund University, Lund, Sweden (Dnr 2015/663) and all study procedures were performed in accordance with relevant guidelines and regulations.

Measures

MINI-KID. MINI-KID is a structured diagnostic interview that assesses the most common mental disorders in youth [29]. In the present study, the MINI-KID was used to assess diagnostic status for all participants at intake, including the presence of major depression, and the interview was carried out by clinical psychologists trained in using the instrument.

Table 1 Sociodemographic and clinical data across groups

	OCD	Anxiety Disorders	Total
n	96	67	163
Girls, *n* (%)	57 (59%)	52 (78%)	109 (67%)
Age, *M* (*SD*)	13.3 (2.7)	14.0 (2.6)	13.6 (2.6)
Any neurodevelopmental disorder, *n* (%)	22 (23%)	12 (18%)	34 (21%)
ADHD, *n* (%)	17 (18%)	11 (17%)	28 (17%)
Autism spectrum disorder, *n* (%)	7 (7%)	2 (3%)	9 (6%)
Ongoing major depression, *n* (%)	10 (11%)	17 (26%)	28 (17%)
CGAS	51.5 (3.1)	54.1 (5.6)	52.4 (4.3)
CY-BOCS, *M* (*SD*)	23.2 (4.2)	-	-
OCD severity according to CY-BOCS at intake			
Mild	34 (37%)	-	-
Moderate	52 (57%)	-	-
Severe	6 (7%)	-	-
CY-BOCS, follow-up, *M* (*SD*) [*n* = 83]	15.7 (6.5)		
Anxiety disorders, *n* (%)	47 (50%)	67 (100%)	114 (70%)
Family economy, good or better, *n* (%)*	72 (80%)	40 (78%)	112 (79%)
Living with both parents, *n* (%)**	66 (69%)	38 (66%)	101 (68%)
Age at OCD symptom onset, *M* (*SD*)	8.02 (2.73)	-	-
Duration of OCD symptoms, *M* (*SD*)	5.23 (3.14)	-	-

Notes. * Self-reported by parents to indicate the overall economic situation around the child; missing data for 6 participants in the OCD group and 16 participants in the anxiety disorders group. ** Self-reported by parents or youth indicating the living arrangement of the participant, other options include joint custody, seeing one parent only on weekends, no contact with one of the parents, and other living arrangement (e.g., foster care); missing data for 9 participants in the anxiety disorders group. ADHD = Attention Deficiency Hyperactivity Disorder. CY-BOCS = Children's Yale-Brown Obsessive Compulsive Scale

Children's global assessment scale (CGAS). As part of the clinical interview, each participant was scored using the CGAS. The CGAS is a measure of psychosocial functioning ranging from 1 to 100 that integrates psychological, social, and academic functioning into an overall impairment score which is not restricted to specific symptoms. The measure has shown adequate validity and reliability in youth with mental disorders [30].

BRIEF. The BRIEF is a rating scale for the assessment of EF in 5-18-year-old children and adolescents [22]. The BRIEF has three versions: a self-report form, a parent-report form, and a teacher-report form, with eight scales included in each version (Inhibit, Shift, Emotional control, Initiate, Working memory, Plan/Organize, Organization of materials, Monitor), two broader indexes (Behavioral regulation and Metacognition) as well as an overall score, the Global Executive Composite. In this study, the parent version was used. Both raw scores and age and sex-adjusted normative scores transformed to t scores ($M = 50$, $SD = 10$) were analyzed. The BRIEF was completed by parents at intake. The parent-version of the BRIEF has previously been subject for evaluation among clinical youth samples and an exploratory factor analysis has supported an 8-factor model with two second order factors in both typically developing and mixed clinical samples [22].

To the best of our knowledge, the psychometric properties of the BRIEF has not been examined in a Swedish clinical context and we conducted a psychometric evaluation using the present samples (see the Supplementary for a methodological description). In short, the proposed BRIEF factor structure (8 first-order factors and 2 broader factors) had adequate to good model/data fit and much better fit than a unidimensional factor structure. It also had a similar fit to a model where all first-order factors were allowed to correlate freely, see the Supplementary for detailed results. The internal consistency of the items of the 8 first-order factors was good to excellent for all factors: Inhibit ($a = 0.93$), Shift ($a = 0.85$), Emotional control ($a = 0.94$), Initiate ($a = 0.84$), Working memory ($a = 0.94$), Plan/ Organize ($a = 0.93$), Organization of materials ($a = 0.92$), and Monitor ($a = 0.86$).

Children's Yale-Brown Obsessive Compulsive Scale (CY-BOCS). The CY-BOCS is the most common severity measure of OCD in youth [31]. It rates obsessions and compulsions separately according to time, distress, impairment, resistance, and control using 0–4 Likert items (5 items for obsessions and 5 for compulsions). This yields a total score of 0 to 40, with higher scores indicating more severe OCD. The clinical threshold of OCD is 14 points, scores above 21 correspond to moderate OCD, and scores between 30 and 40 indicate severe OCD [32].

For participants with OCD, trained interviewers conducted CY-BOCS at intake and at follow-up. In all cases, children/adolescents were present during the interview and in most cases, one or both parents were also present.

Dimensional Yale-Brown Obsessive Compulsive Scale (DY-BOCS). The DY-BOCS is an interview-based measure that assesses OCD symptom severity across the major symptom dimensions of OCD [33, 34]. In the present study, severity scores for disturbing thoughts/checking, symmetry/ordering, and contamination/cleaning were used. In DY-BOCS, the interviewer scores the severity within each symptom dimension using three 0–5 items capturing time, interference and distress. This generates a total score of 0–15 for each symptom dimension with higher scores indicating more severe symptoms within that dimension. Symptoms within each dimension were assessed at intake using a semi-structured interview that has showed validity and utility in Swedish youth with OCD [33]. During the DY-BOCS interview, age at OCD symptom onset was also assessed.

Procedure

The diagnostic status of participants was examined at intake using the MINI-KID [29]. All participants with OCD were assessed with the CY-BOCS at intake and at follow-up (n=83, 90% of OCD participants). The average follow-up time for OCD participants was 13.31 months (SD=6.69). All OCD participants had been offered exposure-based cognitive behavioral therapy (CBT), 78% had engaged in CBT, and 31% had been treated with a combination of CBT and selective serotonin reuptake inhibitors. The mean number of CBT sessions was 9.3 (SD=6.1).

Statistical analysis

To examine whether the OCD and anxiety disorder groups differed from peers, we used one-sample t-tests in which we compared the age- and sex-based BRIEF T-scores to a normative T-score of 50, which is the mean of the population. T-scores are a special kind of standardized scores, with a mean of 50 and a standard deviation of 10, which is often used for psychological normative data and result from transforming raw scores to standardized scores. A 95% confidence interval (CI) for the difference was used to examine whether the groups differed statistically significantly from the mean of the general population. Analyses were run with and without participants with neurodevelopmental disorders (ADHD and/or autism spectrum disorder) to examine whether the presence of these disorders could explain possible differences compared to the general population.

To examine whether the OCD and anxiety groups differed on the different EF domains, linear regression analyses accounting for age, sex, and the presence of neurodevelopmental disorders were conducted using each of the EF domains (raw scores) as the dependent variable and group (OCD vs. anxiety disorders), age, sex, and the presence of neurodevelopmental disorders as independent variables. To examine whether EF was associated with the major OCD symptom dimensions (i.e., disturbing thoughts/checking, symmetry/ordering, and contamination/cleaning measured via DY-BOCS), regression analyses were conducted where the DY-BOCS dimensional severity scores were regressed onto the BRIEF factors (raw scores), age and sex. These analyses were only conducted in the OCD group as only these participants had severity scores for the OCD dimensions. Associations between OCD severity at intake, age at OCD symptom onset, and duration of OCD symptoms and EF was examined by correlating these variables with all EF scores. T-scores were used to account for age and sex effects.

To predict treatment outcome, we conducted linear regression with the post-treatment CY-BOCS score as the dependent variable and BRIEF, age, sex, neurodevelopmental status, and the CY-BOCS intake severity as independent variables. To adjust for multiple comparisons, we used an alpha value of 0.01 as an indicator of statistical significance in all models.

Results

Differences compared to peers

Age- and sex-transformed BRIEF T-scores for the OCD and anxiety disorder groups were compared to a general T-score of 50 (the population mean) using one-sample t-tests. Results are presented in Table 2, and in Fig. 1 is an illustration of the BRIEF profiles for youth with OCD and anxiety disorders. Youth with OCD and anxiety disorders differed significantly from the general population on all EF domains except Organization of materials (both groups) and Inhibit (anxiety disorders). In both groups, effect sizes were largest for Shift (d=0.90 and 0.95 for the OCD and anxiety disorder groups, respectively), Emotional control (d=0.77 and 0.68), and Initiate (d=0.82 and 0.70).

When excluding those with neurodevelopmental disorders, effect sizes were somewhat reduced but largely intact and there was still a statistically significant difference compared to the mean of the general population (except that Inhibition in the OCD group was no longer statistically significantly different from this mean). To examine the possibility that major depression could impact EF scores, we conducted independent samples t-tests comparing those with versus without major depression (full clinical sample) on all EF variables. No significant differences emerged (all ps>0.19). We also examined whether EF was associated with overall

Table 2 Results from one-sample t-tests for the OCD and anxiety groups EF T-scores compared to a normative score of T = 50

Executive functioning domain	OCD (*n* = 92–96)*, *M* (*SD*)	*p* for Comparison with T = 50	Cohen's *d*	Cohen's *d* without neurodevelopmental
Inhibit	52.87 (9.69)	0.005	0.30	0.16
Shift	60.29 (11.47)	< 0.001	0.90	0.79
Emotional Control	59.23 (11.97)	< 0.001	0.77	0.70
Initiate	60.03 (12.23)	< 0.001	0.82	0.72
Working memory	57.85 (12.16)	< 0.001	0.65	0.56
Plan/organize	56.24 (12.10)	< 0.001	0.52	0.36
Organization of materials	51.63 (10.53)	0.134	0.15	0.42
Monitor	58.25 (17.91)	< 0.001	0.46	0.29
Behavior Regulation Index	58.29 (10.31)	< 0.001	0.80	0.70
Metacognition Index	57.21 (11.38)	< 0.001	0.63	0.49
Global Executive Composite Index	58.11 (10.85)	< 0.001	0.75	0.59
	Anxiety Disorder (*n* = 66–67)*, *M* (*SD*)			
Inhibit	50.49 (11.51)	0.727	0.04	-0.15
Shift	61.85 (12.44)	< 0.001	0.95	0.85
Emotional Control	58.64 (12.70)	< 0.001	0.68	0.62
Initiate	58.36 (11.99)	< 0.001	0.70	0.60
Working memory	55.05 (11.40)	< 0.001	0.44	0.31
Plan/organize	54.82 (11.19)	< 0.001	0.43	0.28
Organization of materials	52.72 (11.16)	0.05	0.24	0.16
Monitor	57.38 (15.91)	< 0.001	0.46	0.33
Behavior Regulation Index	57.77 (11.81)	< 0.001	0.66	0.56
Metacognition index	56.00 (11.12)	< 0.001	0.46	0.40
Global Executive Composite Index	57.03 (11.19)	< 0.001	0.66	0.50

Notes. * Participants with missing data on more than two items per subscale were excluded

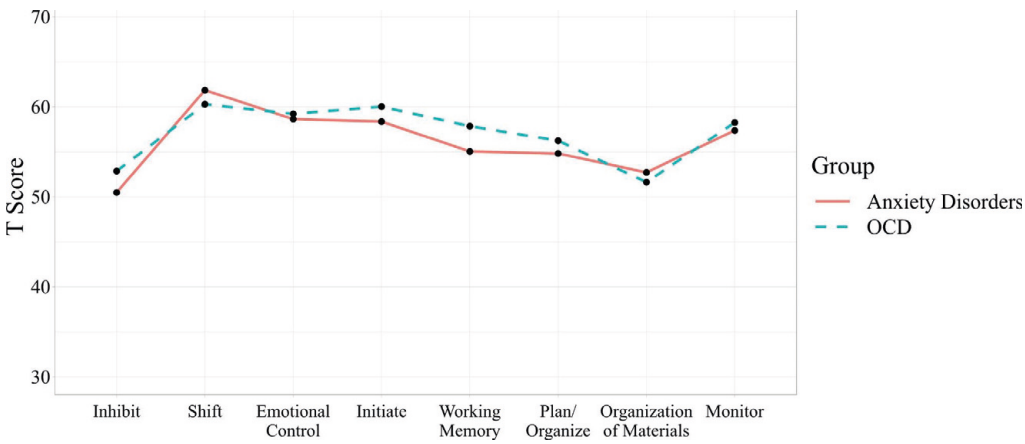


Fig. 1 BRIEF profiles for the OCD and anxiety disorder groups; the population mean is 50

functioning (CGAS) and no significant associations were present ($rs = -0.15$ to -0.02., all $ps > 0.07$).

Differences between those with OCD and those with anxiety disorders

Regression models accounting for differences in age, sex, and the presence of neurodevelopmental disorders showed that the OCD and anxiety disorders groups did not differ significantly from each other on any EF domain (raw scores were used and positive β values indicate more EF difficulties in the OCD group): inhibit ($\beta = 0.05$, $p = .54$), shift (β = -0.08, $p = .32$), emotional control ($\beta = 0.01$, $p = .95$), initiate ($\beta = 0.02$, $p = .84$), working memory ($\beta = 0.09$, $p = .25$), plan/organize ($\beta = 0.03$, $p = .66$), organization of materials (β = -0.08, $p = .29$), monitor (β = -0.02, $p = .84$), behavior regulation index (β = -0.01, $p = .88$), metacognitive index ($\beta = 0.02$, $p = .81$), global executive composite index ($\beta = 0.01$, $p = .95$).

Because around half of the participants with OCD also met criteria for an anxiety disorder, we divided the full sample into three groups: [a] OCD and a co-occurring anxiety disorder, [b] an anxiety disorder but no OCD, and [c] OCD but no anxiety disorder. We conducted one-way ANOVAs to compare the three groups. No significant differences on any EF domain emerged (all $ps > 0.07$).

Clinical correlates among youth with OCD

The results for associations between EF and the major symptom dimensions of OCD showed no statistically significant associations: disturbing thoughts/checking (all $ps > 0.22$), symmetry/ordering (all $ps > 0.08$), contamination/cleaning (all $ps > 0.18$). None of the EF domains was significantly correlated with OCD severity at intake (CY-BOCS total score; $rs = -0.16$ to 0.19, all $ps > 0.07$), age of OCD symptom onset ($rs = -0.19$ to 0.04, all $ps > 0.07$), or duration of OCD symptoms ($rs = -0.04$ to 0.13, all $ps > 0.23$).

EF as a predictor of naturalistic treatment outcome

Each EF domain (raw scores) as well as the broad EF indexes were included alongside age, sex, the presence of a neurodevelopmental disorder, and OCD severity at intake as predictors of post-treatment OCD severity (CY-BOCS) in 11 separate models (one for each EF domain/index). None of the EF domains/indexes was a statistically significant predictor of treatment outcome (all $\beta s < 0.18$; all $ps > 0.11$).

Discussion

The present study examined everyday EF in youth with OCD. To our knowledge, this is the first study to compare EF difficulties in pediatric OCD to EF difficulties in youth with anxiety disorders. First, compared to norm scores from peers, youth with OCD and anxiety disorders showed significant differences on all domains except Organization of materials (both groups) and Inhibition (youth with anxiety disorders). However, differences were mostly moderate, with the largest effect sizes for both groups emerging for Shift, Emotional control, and Initiate. Only Shift was included in our hypotheses about which EF difficulties would be most elevated in OCD and this finding is in line with a recent study where OCD probands, their unaffected siblings and parents showed deficiencies in cognitive flexibility and inhibitory control [17]. In our study, cognitive flexibility is mirrored by the Shift subscale, which assesses the ability to adjust behavior flexibly to changing demands of a situation [22]. A meta-analysis on cognitive inflexibility in adults with OCD found deficits in cognitive flexibility [35], which is also in line with our findings. The link between cognitive flexibility and OCD is intuitive as OCD is characterized by non-flexible behaviors [3–5]. However, in the present study, youth with anxiety disorders showed similar deficits in cognitive flexibility, indicating that this is not unique to pediatric OCD.

Moderate deficits compared to peers were found for Emotional control and Initiate in both groups. These scales capture abilities related to modulation of emotional responses (Emotional control), the ability to begin a task or activity as well as the capacity to independently generate ideas or problem-solving strategies (Initiate) [22]. Research on problem-solving strategies in OCD is scarce, however, one study revealed no impaired problem-solving strategies in adults with OCD, measured using performance-based EF tasks [36]. Regarding emotion regulation, our findings are in line with evidence indicating that difficulties with emotion regulation is related to several psychiatric disorders in adults, including OCD, where it is often characterized by diminished reappraisal abilities and increased use of suppression strategies [37]. Our results expand this body of research by showing that overall EF deficits are not specific for OCD but extend to pediatric anxiety disorders.

Of note, the BRIEF profiles for the OCD and anxiety disorder groups were very similar with almost identical mean scores across the different subscales, with most elevated scores on Shift, Emotional Control, and Initiate. When controlling for co-occurring neurodevelopmental disorders (i.e., ADHD and autism spectrum disorder), effect sizes were slightly decreased but differences remained statistically significant compared to peers, except for Inhibition in OCD. These results indicate that even when EF in youth with neurodevelopmental disorders, where EF difficulties are prominent [38], are accounted for, youth with OCD and anxiety disorders still exhibit EF difficulties compared to peers. It is unclear whether these difficulties are directly linked to OCD/

anxiety disorders, expressions of subclinical neurodevelopmental traits, or both.

No differences in EF were found when comparing youth with OCD and anxiety disorders. In fact, both groups showed very similar EF profiles. There is some evidence that the major symptom dimensions of OCD are underpinned by partly different neural substrates [39], and hypotheses for EF deficits in OCD largely stem from observed deviations in neural circuits known to be involved in EF [40]. However, in line with a previous study on EF and symptom dimensions in pediatric OCD [23], we found no significant associations between the two. This contrasts findings in adults, where contamination/cleaning symptoms have been associated with better EF [21].

Overall, the findings of the present study do not indicate a strong link between EF and pediatric OCD. First, youth with OCD and anxiety disorders did not differ from each other. Second, differences compared to peers were generally moderate. Third, there was no association with overall OCD severity or the major OCD symptom dimensions. Fourth, EF was not linked to naturalistic treatment outcome. Taken together, these results suggest that EF deficits may be more transdiagnostic than disorder-specific, which is largely in line with research about the role of EF in mental disorders in children and adolescents [41]. That EF did not predict treatment outcome indicates that integrating EF modules into OCD treatment may be of limited value. However, in individual cases, EF deficits may be important for treatment planning. Our results about EF and treatment outcome partially contrast findings from a recent study, where difficulties with emotion regulation were associated with a poorer response to treatment in youth with OCD [42].

Several limitations merit mentioning. First, we only used parent-rated measures of EF. Future research should consider combining different raters and measures (e.g., teachers, self-report, observational measures, and tasks), not the least since ratings of EF in daily life have been shown to differ substantially from EF measured using performance-based tasks [20]. Second, treatment was not delivered under controlled conditions and follow-up assessments were carried out on average more than a year after treatment initiation. Although this makes it hard to draw conclusions about whether EF moderates outcome of highly structured and time-limited OCD interventions, it provides evidence for that EF does not seem to moderate more long-term outcomes of broader naturalistic treatment of youth with OCD. Third, we used normative scores derived from an American youth population. A comparison group of Swedish community children and adolescents or Swedish normative scores would have been preferred but was not available and the resources available to the project did not allow for producing Swedish norm scores. An alternative would have been to recruit a non-clinical comparison group, but such an approach has drawbacks as it is challenging to secure representativity. Fourth, to examine whether neurodevelopmental status explained group differences in EF, we used established neurodevelopmental diagnoses, which do not appreciate the dimensional nature of neurodevelopmental symptoms in youth and the study did not collect dimensional scores on neurodevelopmental traits [43].

Conclusions

This study showed that youth with OCD have deficits in everyday EF compared to peers and that these differences are not fully explained by the presence of neurodevelopmental disorders. Nevertheless, our results suggest only moderate EF deficits, which are equally apparent in youth with anxiety disorders, not associated with OCD severity or the major symptom dimensions of OCD, and not associated with naturalistic treatment outcome. Taken together, our findings indicate that EF deficits may have little relevance for the clinical management of pediatric OCD, and while prospective studies are needed, it is unclear whether EF can offer unique insights into its etiology.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12888-023-05111-1.

Supplementary Material 1: Everyday executive functioning in pediatric obsessive-compulsive disorder

Acknowledgements
We would like to thank Elin Olsson for helping collect the data and Christina Henriksson for helping summarize the data.

Authors' contributions
Rydqvist and Cervin conceived the study, analyzed the data, and drafted the manuscript. Daukantaitė and Hoff edited the manuscript.

Funding
Open access funding provided by Lund University. The study was funded by research grants awarded to Cervin from L.J. Boëthius Foundation, Lindhaga Foundation, Jerring Foundation, and Region Skåne. The funding sources had no role in study design, data collection, or analysis and interpretation of the data.

Data Availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests
The authors declare no competing interests.

Ethics approval and consent to participate
All participants and their caregiver/s provided written informed consent/assent, the study was approved by the regional ethics committee at Lund University, Lund, Sweden (Dnr 2015/663), and all study procedures were performed in accordance with relevant guidelines and regulations.

Consent for publication
NA.

Received: 15 February 2023 / Accepted: 13 August 2023
Published online: 24 August 2023

References

1. Fawcett EJ, Power H, Fawcett JM. Women are at greater risk of OCD than men: a meta-analytic review of OCD prevalence worldwide. J Clin Psychiatry. 2020;81(4):0.
2. Geller DA, Biederman J, Faraone S, Agranat A, Cradock K, Hagermoser L, et al. Developmental aspects of obsessive compulsive disorder: findings in children, adolescents, and adults. J Nerv Ment Dis. 2001;189(7):471–7.
3. World Health Organization. International statistical classification of diseases and related health problems (11th ed.)2019.
4. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders. 5th ed. Washington, DC2013.
5. American Psychiatric Association. Diagnostic and statistical manual of mental disorders, fifth edition, text revision. Washington: American Psychiatric Association; 2022.
6. Brakoulias V, Starcevic V, Belloch A, Brown C, Ferrao YA, Fontenelle LF, et al. Comorbidity, age of onset and suicidality in obsessive-compulsive disorder (OCD): an international collaboration. Compr Psychiatry. 2017;76:79–86.
7. Bloch MH, Landeros-Weisenberger A, Rosario MC, Pittenger C, Leckman JF. Meta-analysis of the symptom structure of obsessive-compulsive disorder. Am J Psychiatry. 2008;165(12):1532–42.
8. Cervin M, Miguel EC, Güler AS, Ferrão YA, Erdoğdu AB, Lazaro L et al. Towards a definitive symptom structure of obsessive – compulsive disorder: a factor and network analysis of 87 distinct symptoms in 1366 individuals. Psychol Med. 2021:1–13.
9. Mataix-Cols D, Rosario-Campos MC, Leckman JF. A multidimensional model of obsessive-compulsive disorder. Am J Psychiatry. 2005;162(2):228–38.
10. Chamberlain SR, Menzies L. Endophenotypes of obsessive–compulsive disorder: rationale, evidence and future potential. Expert Rev Neurother. 2009;9(8):1133–46.
11. Barkley RA. Executive functions: what they are, how they work, and why they evolved. Guilford Press; 2012.
12. Garon N, Bryson SE, Smith IM. Executive function in preschoolers: a review using an integrative framework. Psychol Bull. 2008;134(1):31.
13. Zelazo PD, Carlson SM. Hot and cool executive function in childhood and adolescence: development and plasticity. Child Dev Perspect. 2012;6(4):354–60.
14. Best JR, Miller PH, Jones LL. Executive functions after age 5: changes and correlates. Dev Rev. 2009;29(3):180–200.
15. Huizinga M, Smidts DP. Age-related changes in executive function: a normative study with the dutch version of the Behavior rating inventory of executive function (BRIEF). Child Neuropsychol. 2010;17(1):51–66.
16. Abramovitch A, Abramowitz JS, Mittelman A, Stark A, Ramsey K, Geller DA. Research Review: neuropsychological test performance in pediatric obsessive-compulsive disorder–a meta-analysis. J Child Psychol Psychiatry. 2015;56(8):837–47.
17. Abramovitch A, De Nadai AS, Geller DA. Neurocognitive endophenotypes in pediatric OCD probands, their unaffected parents and siblings. Prog Neuropsychopharmacol Biol Psychiatry. 2021;110:110283.
18. Banich MT. Executive function: the search for an integrated account. Curr Dir Psychol Sci. 2009;18(2):89–94.
19. Shallice T, Burgess PW. Deficits in strategy application following frontal lobe damage in man. Brain. 1991;114(2):727–41.
20. Alderman N, Knight C, Henman C. Ecological validity of a simplified version of the multiple errands shopping test. J Int Neuropsychol Soc. 2003;9(1):31–44.
21. Leopold R, Backenstrass M. Neuropsychological differences between obsessive-compulsive washers and checkers: a systematic review and meta-analysis. J Anxiety Disord. 2015;30:48–58.
22. Gioia GA, Isquith PK, Retzlaff PD, Espy KA. Confirmatory factor analysis of the Behavior rating inventory of executive function (BRIEF) in a clinical sample. Child Neuropsychol. 2002;8(4):249–57.
23. Hybel KA, Mortensen EL, Højgaard DRMA, Lambek R, Hove Thomsen P. Symptom profiles and executive function in childhood obsessive-compulsive disorder. J Obsessive-Compulsive Relat Disorders. 2017;14:36–46.
24. Hybel KA, Mortensen EL, Lambek R, Højgaard D, Thomsen PH. Executive function predicts cognitive-behavioral therapy response in childhood obsessive-compulsive disorder. Behav Res Ther. 2017;99:11–8.
25. Flessner CA, Allgair A, Garcia A, Freeman J, Sapyta J, Franklin ME, et al. The impact of neuropsychological functioning on treatment outcome in pediatric obsessive-compulsive disorder. Depress Anxiety. 2010;27(4):365–71.
26. McNamara J, Reid A, Balkhi A, Bussing R, Storch E, Murphy T, et al. Self-regulation and other executive functions relationship to Pediatric OCD Severity and Treatment Outcome. J Psychopathol Behav Assess. 2014;36(3):432–42.
27. Faber J. The role of executive function in childhood anxiety disorders. University of Minnesota; 2019.
28. Negreiros J, Best JR, Yamin DF, Belschner L, Lin S, Stewart SE. Test-based versus parent ratings of executive function in pediatric obsessive-compulsive disorder. J Obsessive-Compulsive Relat Disorders. 2020;24:100495.
29. Sheehan DV, Sheehan KH, Shytle RD, Janavs J, Bannon Y, Rogers JE, et al. Reliability and validity of the Mini International Neuropsychiatric interview for children and adolescents (MINI-KID). J Clin Psychiatry. 2010;71(3):313–26.
30. Green B, Shirk S, Hanze D, Wanstrath J. The children's Global Assessment Scale in clinical practice: an empirical evaluation. J Am Acad Child Adolesc Psychiatry. 1994;33(8):1158–64.
31. Scahill L, Riddle MA, McSwiggin-Hardin M, Ort SI, King RA, Goodman WK, et al. Children's Yale-Brown Obsessive compulsive scale: reliability and validity. J Am Acad Child Adolesc Psychiatry. 1997;36(6):844–52.
32. Cervin M, OCD Severity Benchmark Consortium, Mataix-Cols D. Empirical severity benchmarks for obsessive-compulsive disorder across the lifespan. World Psychiatry. 2022;21(2):315–6.
33. Cervin M, Perrin S, Olsson E, Claesdotter-Knutsson E, Lindvall M. Validation of an interview-only version of the Dimensional Yale-Brown obsessive-compulsive scale (DY-BOCS) in treatment-seeking youth with obsessive-compulsive disorder. Psychiatry Res. 2019;271:171–7.
34. Rosario-Campos MC, Miguel EC, Quatrano S, Chacon P, Ferrao Y, Findley D, et al. The Dimensional Yale-Brown obsessive-compulsive scale (DY-BOCS): an instrument for assessing obsessive-compulsive symptom dimensions. Mol Psychiatry. 2006;11(5):495–504.
35. Gruner P, Pittenger C. Cognitive inflexibility in obsessive-compulsive disorder. Neuroscience. 2017;345:243–55.
36. Schmidtke K, Schorb A, Winkelmann G, Hohagen F. Cognitive frontal lobe dysfunction in obsessive-compulsive disorder. Biol Psychiatry. 1998;43(9):666–73.
37. Ferreira S, Pêgo JM, Morgado P. A systematic review of behavioral, physiological, and neurobiological cognitive regulation alterations in obsessive-compulsive disorder. Brain Sci. 2020;10(11):797.
38. Berenguer C, Roselló B, Colomer C, Baixauli I, Miranda A. Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, theory of mind, and behavioral problems. Res Dev Disabil. 2018;83:260–9.
39. van den Heuvel OA, Remijnse PL, Mataix-Cols D, Vrenken H, Groenewegen HJ, Uylings HB, et al. The major symptom dimensions of obsessive-compulsive disorder are mediated by partially distinct neural systems. Brain. 2009;132(Pt 4):853–68.
40. Pauls DL. The genetics of obsessive-compulsive disorder: a review. Dialogues Clin Neurosci. 2010;12(2):149–63.
41. Martel MM, Pan PM, Hoffmann MS, Gadelha A, do Rosário MC, Mari JJ, et al. A general psychopathology factor (P factor) in children: structural model analysis and external validation through familial risk and child global executive function. J Abnorm Psychol. 2017;126(1):137–48.
42. McKenzie ML, Donovan CL, Mathieu SL, Hyland WJ, Farrell LJ. Variability in emotion regulation in paediatric obsessive-compulsive disorder: Associations with symptom presentation and response to treatment. J Obsessive-Compulsive Relat Disorders. 2020;24:100502.
43. Knott R, Johnson BP, Tiego J, Mellahn O, Finlay A, Kallady K, et al. The Monash Autism-ADHD genetics and neurodevelopment (MAGNET) project design and methodologies: a dimensional approach to understanding neurobiological and genetic aetiology. Mol autism. 2021;12(1):1–24.

Publisher's Note

Study III

CHILD NEUROPSYCHOLOGY
https://doi.org/10.1080/09297049.2024.2434736

Routledge
Taylor & Francis Group

Behavioral manifestations of executive functioning in Swedish youth with ADHD, autism, and psychiatric comorbidity: a comparative analysis with community controls

Annelie Hamilton[a], Pia Tallberg[a,b], Frida Ilahi[b], Eva Hoff[b], Bahar Ahmadi[a] and Daiva Daukantaitė[b]

[a]Child and Adolescent, Psychiatric Clinic in Helsingborg, Helsingborg, Sweden; [b]Department of Psychology, Lund University, Lund, Sweden

ABSTRACT

While several rating scales reliably and cost-effectively assess behavioral executive functioning (EF) in youths with neurodevelopmental disorders (NDDs), questions remain about the impact of comorbidities and dual NDDs on EF as measured by these scales in clinical samples. This study compared behavioral EF profiles among youths with NDDs, both with and without psychiatric comorbidities, non-NDDs (e.g. anxiety), and controls, as well as youths with single versus dual NDDs. The comparisons were made using the Swedish version of the Behavior Rating Inventory of Executive Function (BRIEF-2) parent form. Participants included 79 youths (mean [SD] age 12.1 [3.0]; 50.6% girls) diagnosed with various psychiatric conditions, and 151 matched controls (mean [SD] age 12.4 [2.8]; 51.7% girls). Results showed significant differences with very large effect sizes in all behavioral EF domains among youths with NDDs, regardless of whether they had non-NDD psychiatric comorbidities, compared to youths with non-NDDs or controls. The latter two groups differed in six of eight behavioral EF domains, with the Shift domain showing the largest effect size (Cohen's d = 0.94). Surprisingly, no significant differences were found between the NDD-only group and the NDD group with non-NDD psychiatric comorbidities. Youths with dual NDDs had more deficits in four of the nine behavioral EF domains compared to those with a single NDD, with the Shift domain again showing the largest effect size (Cohen's d = 0.91). This study highlights the essential role of NDD in distinguishing clinically significant parent-rated behavioral EF deficits in youths, regardless of other psychiatric diagnoses.

ARTICLE HISTORY
Received 1 July 2024
Accepted 21 November 2024

KEYWORDS
Executive functioning; attention deficit hyperactivity disorder (ADHD); autism (ASD); non- neurodevelopmental disorders (non-NDDs); BRIEF-2

Executive functioning (EF) is a critical framework representing a complex array of cognitive processes essential for purposeful actions. This multifaceted concept encompasses the composition of behavioral, emotional, and cognitive functions supporting intricate objectives, particularly evident in situations necessitating active and innovative problem-solving approaches (Baggetta & Alexander, 2016; Barkley, 2012). Numerous

CONTACT Daiva Daukantaitė Daiva.Daukantaite@psy.lu.se Department of Psychology, Lund University, Lund 221 00, Sweden

Supplemental data for this article can be accessed at https://doi.org/10.1080/09297049.2024.2434736

children and adolescents with executive dysfunction face difficulties in their daily lives, not the least in their academic pursuits. Among these individuals, many are diagnosed with neurodevelopmental disorders (NDDs), such as attention deficit hyperactivity disorder (ADHD) or autism (ASD), which impact various developmental domains, either broadly or specifically, leading to difficulties in daily functioning at school, in social interactions, and within the family context (Biederman et al., 2004; Jangmo et al., 2019). ADHD primarily impacts attention and behavior regulation and is prevalent in 5–11% of the childhood population (Francés et al., 2022). In contrast, ASD primarily affects social communication reciprocity and mental/behavioral flexibility, with a prevalence of 0.7–3% in the childhood population (Francés et al., 2022). Furthermore, NDDs are strongly associated with EF impairments, through a reciprocal interaction between EF and these conditions, both genetically (e.g., Chang et al., 2020) and symptomatically (Biederman et al., 2004; Corbett et al., 2009; Shanmugan et al., 2016). Various meta-analyses have consistently revealed that children diagnosed with ADHD exhibit impairments across multiple EF domains, including working memory, attention, inhibition, and planning skills (Frazier et al., 2004; Ramos et al., 2020; Schachar, 2023; Willcutt et al., 2005). Similarly, children diagnosed with ASD commonly display difficulties in flexibility, working memory, and inhibitory control, among other EF domains (Demetriou et al., 2018; Lai et al., 2019).

NDD is pervasive, enduring, and most often presented with comorbidity of multiple NDDs (Francés et al., 2022). Notably, among individuals with ASD, ADHD stands out as the most prevalent comorbid condition, affecting approximately 28% of individuals (Lai et al., 2019). The impact on academic performance and treatment needs appears to be more pronounced in children grappling with both ASD and ADHD compared to those with either condition alone (Antshel & Russo, 2019; Benallie et al., 2021; Rosello et al., 2023; Stark et al., 2021; Zablotsky et al., 2020). Other common comorbidities for individuals with ASD include anxiety disorders (20%), sleep – wake disorders (13%), disruptive, impulse-control, and conduct disorders (12%), depressive disorders (11%), and obsessive-compulsive disorder (OCD) (9%) (Lai et al., 2019). Conversely, among individuals with ADHD, the most prevalent comorbid conditions are conduct disorders, affecting approximately 16% of individuals, followed by specific developmental disorders encompassing language, learning, and motor development (15.4%), autism spectrum disorders (12.4%), and intellectual disability (7.9%) (Jensen & Steinhausen, 2015).

Considering the mutual relationship between NDDs, EF deficits, and academic underachievement – which can contribute to a detrimental cycle culminating in early school dropout (Esch et al., 2014) – there is a need for evidence-based, cost-effective and comprehensive assessment methods. These methods should be evaluated at various levels of care, such as in school health care and child and adolescent psychiatry (CAP), to provide insight into EF variation across the youth population (Barican et al., 2022; Kern et al., 2015). This knowledge can be used to detect children with EF problems early and provide them with the necessary support. While research outcomes related to EF tend to vary based on the assessment method (Toplak et al., 2008, 2013), recent research (Pollastri et al., 2022) suggests that rating scales of behavioral manifestations of EF, such as the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000), offer valuable insights into children's school functioning beyond clinical diagnoses and performance-based tests. Therefore, rating scales of behavioral EF may be considered

superior in terms of cost-effectiveness, ease of administration, and ecological validity, offering a contextual method for assessing EF behaviors necessary for coping with the challenges of everyday life in school or family situations (Gioia et al., 2015). Moreover, the BRIEF has further been shown to be sensitive in identifying EF difficulties in children with NDD, effectively distinguishing them from typically developed children (e.g., Tallberg et al., 2023; Bodnar et al., 2007; Gilotty et al., 2002; Hovik et al., 2017; Hummer et al., 2011; Mahone et al., 2002; McAuley et al., 2010; McCandless & O'Laughlin, 2007; Skogli et al., 2013; Toplak et al., 2008). Recent studies on the latest version, BRIEF-2 (Gioia et al., 2015), show promising alignment with previous findings, indicating increased sensitivity to everyday behavioral executive dysfunction in specific clinical groups, including ADHD and ASD (e.g., Gentil-Gutiérrez et al., 2022; Huizinga et al., 2023; Jacobson et al., 2020; Lace et al., 2022; Parhoon et al., 2022).

Emerging evidence suggests that EF behaviors measured by the BRIEF may provide insights into the development of comorbid conditions in children with ADHD and ASD (Lawson et al., 2015). For example, previous studies highlight that behavioral EF deficits in children with ASD are associated with greater inflexibility, which is linked to symptoms of anxiety and depression (Lawson et al., 2015). In contrast, behavioral EF deficits in children with ADHD are correlated with disinhibition, which predicts aggressive behavior (Lawson et al., 2015). However, the literature on the relationship between ADHD and anxiety presents inconsistent results (Tallberg et al., 2022; Jarrett, 2016; Sørensen et al., 2011) emphasizing the need for further investigation. Jarrett (2016) found that youth with ADHD and comorbid anxiety rated themselves more impaired concerning self-regulation of emotions and self-organization compared to youth with ADHD only in emerging adults, whereas Sørensen et al. (2011) reported greater impairment in self-rated inhibition in youths with ADHD and anxiety relative to those with ADHD only. In a Swedish study examining long-term associations between parent-rated EF and emotional symptoms in children with ADHD, Tallberg et al. (2022) found that deficits in parent-rated planning and organizing were correlated with self-rated anxiety, while impaired parent-rated emotional control was linked to self-rated internalized feelings of anger. Thus, the inconsistency of results necessitates further research to better understand behavioral EF deficit presentation in a clinical sample encompassing both NDDs and other psychiatric conditions, examining the specific domains affected and the extent to which comorbid non-NDDs such as anxiety and depression exacerbate EF deficits. To begin with, there is a scarcity of research utilizing rating scales such as the BRIEF-2 to measure behavioral EF in non-NDD psychiatric populations, despite its common use as an adjunct diagnostic tool, highlighting this research gap. Additionally, there remains an incomplete understanding of how behavioral EF, as assessed by the BRIEF-2, differs among individuals with multiple NDDs, whether accompanied by non-NDD psychiatric comorbidity or not. This understanding is crucial for clinicians, educators and school health teams in shaping intervention strategies and preventing adverse outcomes, such as early school dropout (Esch et al., 2014). Furthermore, the absence of Nordic validation for BRIEF-2 emphasizes the importance of ongoing research in this area, as it highlights the potential impact of environmental and cultural influences on behavior rating scales (Stevanovic et al., 2017). Addressing these gaps is essential for developing comprehensive, evidence-based assessment methods related

to the behavioral, context-dependent, and everyday expressions of EF. Such methods can be effectively used in school healthcare and CAP to support children with NDDs and other psychiatric conditions.

The present study

In the present study, we have two primary aims. Firstly, we aim to compare parent-rated behavioral EF profiles using the Swedish translation of the BRIEF-2 among youths with NDD, both with and without co-occurring psychiatric disorders, as well as to those with only non-NDDs or community controls. Secondly, we aim to investigate differences in parent-rated behavioral EF deficit severity by comparing youths with a single NDD diagnosis to those with dual NDDs, with or without co-occurring psychiatric disorders, to discern the impact of psychiatric comorbidity on everyday EF functioning.

With regards to the first aim, building on previous research (e.g., Gentil-Gutiérrez et al., 2022; Jacobson et al., 2020; Lace et al., 2022), we anticipate that the community control group will demonstrate a more favorable behavioral EF profile compared to the clinical sample as a whole, as well as to more specific clinical groups, such as youths solely diagnosed with NDD and those with both NDD and non-NDD psychiatric comorbidity. However, due to inconsistent findings (e.g., Tallberg et al., 2022; Jarrett, 2016; Sørensen et al., 2011), we are less certain about the extent and specific domains in which individuals with only NDD differ from those with both NDD and non-NDD psychiatric comorbidities including the direction of these differences. To account for this ambiguity, we will apply two-tailed testing for these comparisons. Additionally, given the scarcity of research on everyday EF assessed through rating scales in clinical samples solely comprising non-NDDs, we abstain from forming specific hypotheses regarding the differences in EF deficits between youths with solely non-NDDs and typically developed youths. We will also apply two-tailed testing to this comparison to maintain consistency.

Regarding the second aim, which involves examining differences in the severity of behavioral EF deficits between youths with a single NDD diagnosis and those with multiple NDDs, we draw from prior research (Antshel & Russo, 2019; Benallie et al., 2021; Rosello et al., 2023) and expect that youths with a single NDD diagnosis will exhibit lower levels of everyday EF dysfunction compared to those with multiple NDDs.

Method

Study design

This cross-sectional study includes four groups of participants: (1) youths with only NDDs such as ADHD and/or ASD, (2) youths with NDDs and co-occurring psychiatric disorders, (3) youths with only non-NDD psychiatric disorders such as anxiety, and (4) a community control group. The diagnostic procedures for the first three groups, as well as the selection criteria for the control group, are detailed below. Parent-rated assessments of behavioral EF were conducted using the Swedish translation of the BRIEF-2. This design allows for comparisons across groups to explore differences in parent-rated EF functioning, as described in the study's aims.

Participants

The clinical sample comprised 79 young individuals aged 7–17 years (M_{age} = 12.1, SD_{age} = 3.0; 50.6% girls) who were assessed for various psychiatric conditions at CAP Clinics in Southern Sweden. The youths and their parents were invited to participate in the study following a comprehensive psychiatric evaluation. This evaluation included the use of standardized rating scales, a developmental history assessment, and the Mini-International Neuropsychiatric Interview for Children and Adolescents (MINI-Kid). The MINI-Kid, a clinician-administered diagnostic interview, assesses psychiatric conditions based on the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) (American Psychiatric Association [APA], 2013). Some of them were awaiting a comprehensive neuropsychological and/or psychiatric evaluation, while others were in the process of receiving treatment, which could be pharmaceutical or cognitive-behavioral therapy (CBT). The clinical group comprised a transdiagnostic sample, which included children with a range of disorders such as ADHD, ASD, anxiety, depression, obsessive-compulsive disorder (OCD), stress and trauma-related disorders, Oppositional Defiant Disorder (ODD), and Conduct Disorder (CD). However, children diagnosed with intellectual disability (ID) were excluded from the clinical sample. The participants in the NDD group had either ADHD, ASD or both. All participants in the non-NDD comorbid psychiatric group met the DSM-5 criteria for any anxiety syndrome with or without concurrent comorbidity involving one or more of the following disorders: depression, OCD, stress and trauma related disorder, ODD or CD, as outlined in Table 1. Henceforward we will refer to this group as non-NDD comorbid psychiatric group.

The participants in the community control sample (N = 151, M_{age} = 12.4, SD_{age} = 2.8, 51.7% girls) were recruited from schools located in the same region as the CAP

Table 1. Characteristics of the clinical and community control samples.

Characteristic	Control sample (n = 151)	Clinical sample (n = 79)	Test statistic
Age, mean (SD)**	12.4 (2.8)	12.1 (3.0)	t = −0.91, p = .37
Gender, girls (%)/boys (%)	78 (51.7%)/ 73 (48.3%)	40 (50.6%)/ 39 (49.4%)	χ^2 = 0.02, p = .88
Parents' highest educational level			χ^2 = 1.46, p = .69
Primary education*	1 (0.7%)	2 (2.5%)	
Upper secondary education	37 (24.5%)	20 (25.3%)	
Single subject university courses	44 (29.1%)	22 (27.8%)	
University degree	69 (45.7%)	35 (44.3%)	
Economic status, mean (SD)	3.9 (0.8)	3.8 (0.9)	t = −0.65, p = .52
Psychiatric diagnoses**			
ADHD		49 (62.0%)	
ASD		21 (26.6%)	
Non-NDD/Comorbid psychiatry group		55 (69.6%)	
Number of psychiatric diagnoses			
1		25 (31.6%)	
2		25 (31.6%)	
3		22 (27.8%)	
≥4		7 (8.9%)	

*Primary education in Sweden refers to the mandatory 9-year schooling, spanning grades 1 to 9, typically for students aged 7 to 15. Upper secondary education (gymnasium) is a three-year program that follows this mandatory schooling, usually attended by students aged 16 to 19.

**Due to comorbidity, sum exceeds 100%.

Clinics. This control sample was carefully selected to match the clinical sample in terms of gender, age, parents' educational level, and perceived economic status, aiming to minimize potential confounding factors. Participants who reported a suspected or confirmed NDD diagnosis were excluded from the community control sample.

Measures

MINI Kid

The Mini-International Neuropsychiatric Interview for Children and Adolescents (MINI Kid) is a widely used structured diagnostic interview for DSM-IV and ICD-10 psychiatric disorders in children and adolescents. It was used to assess the most common and clinically relevant disorders or disorder subtypes in pediatrics mental health and has been shown to have high diagnostic accuracy (Duncan et al., 2018; Högberg et al., 2019). The interview was conducted either with the child and parent together, or with the child alone, depending on the child's age and maturity.

Behavior rating inventory of executive function-2, parent-report form (BRIEF-2-P)

The BRIEF-2 (Gioia et al., 2015) parent version was utilized to evaluate behavioral manifestations of everyday EF in children aged 5 to 18 years old. This instrument was selected due to its widespread use in Sweden for measuring behavioral EF and its utility as a supplementary diagnostic tool in the assessment of NDDs, such as ADHD and ASD. Parent ratings provided through the BRIEF-2 offer valuable insights into everyday EF, supporting the diagnostic process for these conditions. The parent-report form consists of 63 items assessing the frequency of specific behaviors or situations related to EF. Parents indicate the frequency of EF-related behaviors on a Likert-type scale, ranging from "never" (1) to "often" (3). Higher scores reflect more difficulties and poorer everyday executive functioning. Scores are aggregated across items within each of the nine subscales: Inhibit (the ability to resist impulses and stop behavior at the appropriate time), Self-Monitor (awareness of the impact of one's behavior on others and outcomes), Shift (the ability to transition freely between situations or aspects of a problem as needed), Emotional Control (the ability to regulate emotional responses), Initiate (the ability to begin tasks and generate ideas or problem-solving strategies independently), Working Memory (the capacity to hold information in mind to complete tasks), Plan/Organize (the ability to manage current and future task demands), Task-Monitor (the ability to assess and monitor one's own work), and Organization of Materials (orderliness of work, play, and storage spaces). These subscales are further grouped into three broader indexes: Behavior Regulation (BRI, reflecting the ability to regulate and monitor behavior), Emotional Regulation (ERI, reflecting the ability to regulate emotional responses and adapt to environmental changes), and Cognitive Regulation (CRI, reflecting the ability to problem-solve and control cognitive processes). These indexes collectively contribute to a summary index: Global Executive Composition (GEC). The parent-report form was administered to all parents in the sample. Cronbach's alpha values ranged from .80 to .92, indicating excellent internal consistency across all scales in both the clinical and community control samples.

Procedure

Participants in the clinical sample were recruited from a CAP-clinic through various methods. They were identified and invited to participate through (1) inclusion from a list of new patients, (2) selection from participation in group treatment, (3) inclusion from a waiting list for group treatment at the psychiatric center, or (4) identification from a list after undergoing psychiatric assessment at an external psychiatric assessment unit. During the psychiatric assessment and examination at the CAP-clinic, the majority of patients underwent interviews using the MINI Kid, which served as the basis for psychiatric diagnosis. If patients were suspected to meet the criteria for one or more disorders within the neurodevelopmental domain, they were placed on a waiting list for a comprehensive neuropsychological and child psychiatric assessment. This assessment could be conducted either at the CAP-clinic or at an external neurodevelopmental assessment unit. For patients diagnosed with any psychiatric disorder such as anxiety, OCD, or depression, appropriate treatments, including psychological therapy or medical interventions, were provided.

Parents in the clinical sample completed the BRIEF-2 either digitally at home, filled out a paper-pencil version at the end of a group session at the center, or as part of the neuropsychiatric assessment at the external unit. The children in the NDD group were all medication-free. The survey typically took around 15 minutes to complete. Parents in the community control sample completed the BRIEF-2 digitally at home.

Neurodevelopmental diagnoses were conducted by licensed clinical psychologists and psychiatrists. These diagnoses were based on several factors, including (1) clinical interviews with the patients, (2) behavioral ratings provided by parents, patients, and teachers, and (3) clinical psychological testing to assess intelligence, executive functioning, and if applicable autism interviews (for example the Autism Diagnostic Interview – Revised) and observational schedules (Autism Diagnostic Observation Schedule – 2nd version). Symptoms, their chronicity, situational consistency, and functional impairment were considered in the overall evaluation of psychiatric considerations. The assessment of the total child psychopathology was established by diagnostic criteria met from the MINI Kid interview and the comprehensive psychiatric/neuropsychological assessment.

All participants and their parents provided informed consent, voluntarily agreeing to participate in the study, and were informed of their right to withdraw at any time. It was explicitly stated that their psychological, neuropsychological assessment, or treatment would not be affected if they chose not to participate in the study or if they withdrew. The study received approval from the Swedish Ethical Review Board (No 2020–05885, 2021–01666).

Statistical analyses

Differences between the community control and clinical groups, as well as among various diagnostic groups, were evaluated using one-way ANOVAs with planned contrast and post hoc analyses. Before conducting ANOVAs, we assessed the assumptions of normality and homogeneity of variance. Skewness values were within acceptable limits of ± 2 (Gravetter & Wallnau, 2014), and Levene's F tests for homogeneity of variance were non-significant except for inhibition. However, examination of standard deviations between

the groups on inhibition showed that none exceeded four times the size of the smallest, indicating robustness for ANOVA in these cases (Howell, 2009). Effect sizes were quantified using partial η^2 for one-way ANOVAs and Cohen's d for the post hoc and planned contrast analyses. Effect sizes of 0.01/0.20 indicate a small effect, 0.06/0.50 denote a medium effect, and ≥ 0.14/0.80 signify a large effect for partial η^2/Cohen's d. Bonferroni corrections were applied where necessary when specific hypotheses were not provided and the p level exceeded .001, with a corrected significance threshold of $p < .004$ ($p < .05/13$), as indicated under the relevant table.

Results

Given that the majority of children in the clinical sample had comorbidities, we have divided them into three groups: (1) Only NDD ($n = 20$, 25.3%), (2) NDD and non-NDD comorbid psychiatric group ($n = 32$, 40.5%), (3) Only non-NDD comorbid psychiatric group ($n = 27$, 34.2%).

Comparing EF community controls to diverse clinical subgroups

Planned contrast analyses revealed that children in the clinical sample had significantly elevated levels of EF difficulties across all domains and indices ($p < .001$, one tailed) when contrasted with the community control group. These disparities exhibited substantial effect sizes, spanning from Cohen's $d = -0.85$ for Organization of Materials to −1.67 for Shift and −1.74 for the ERI. A succinct summary of the results is outlined in Table 2.

Table 3 presents the means and standard deviations for all BRIEF-2 domains and indices, both in the three clinical groups and community control group. Notably significant differences (all < .001) and substantial effect sizes (partial η^2), ranging from .20 for Task-Monitor to .45 for Shift, were observed when the four groups were compared using one-way ANOVAs. These results underscore the substantial differences in

Table 2. Descriptive statistics, Independent t-tests, and effect sizes comparing the community control sample and clinical sample on the Parent-Rated BRIEF-2 Domains.

BRIEF-2 domain	Control sample ($n = 151$)	Clinical sample ($n = 79$)	t	*Cohen's d*
Inhibit	10.92 (2.68)	14.89 (4.44)	−10.35	−1.22
Self-Monitor	5.78 (1.83)	8.23 (2.76)	−9.70	−1.23
Shift	11.32 (2.85)	16.77 (4.20)	−12.68	−1.67
Emotional Control	11.25 (3.31)	16.35 (4.49)	−11.09	−1.44
Initiate	7.62 (2.03)	10.55 (2.34)	−10.18	−1.36
Working Memory	11.25 (3.31)	16.80 (4.46)	−11.70	−1.61
Plan/Organize	12.62 (3.43)	17.35 (4.22)	−9.77	−1.50
Task-Monitor	8.33 (2.39)	10.51 (2.33)	−6.71	−0.91
Organization of Materials	9.11 (2.47)	11.41 (3.17)	−6.45	−0.85
BRI	16.70 (4.13)	23.12 (6.26)	−11.16	−1.34
ERI	22.57 (5.39)	33.12 (7.87)	−13.53	−1.74
CRI	48.93 (11.74)	66.61 (14.42)	−10.80	−1.40
GEC	88.21 (19.29)	122.86 (25.26)	−13.14	−1.64

All differences are significant at $p < .001$ *(one tailed)*.
BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

Table 3. Descriptive statistics of BRIEF-2 domains and indices, and one-way ANOVA results for comparisons between community controls and three clinical groups.

		Clinical sample			ANOVA	
BRIEF-2 domain	Control sample ($N = 151$)	Only NDD ($n = 20$)	NDD + comorbid Non-NDD psychiatry ($n = 32$)	Only Non-NDD comorbid psychiatry ($n = 27$)	*F (3, 225)*	partial η^2
Inhibit	10.92 (2.68)^{a,b}	18.35 (3.25)^{a,d}	16.16 (3.75)^{b,e}	11.41 (3.58)^{d,e}	55.41	.43
Self-Monitor	5.78 (1.83)^{a,b,c}	9.55 (1.93)^{a,d}	8.69 (1.73)^{b,e}	6.89 (2.44)^{c,d,e}	38.34	.34
Shift	11.32 (2.85)^{a,b,c}	18.35 (3.63)^{a,d}	18.44 (3.80)^{b,e}	14.11 (3.65)^{c,d,e}	65.31	.46
Emotional Control	11.25 (3.31)^{a,b,c}	18.60 (4.15)^{a,d}	17.90 (3.55)^{b,e}	13.59 (3.87)^{c,d,e}	50.57	.40
Initiate	7.62 (2.03)^{a,b,c}	11.40 (1.88)^{a,d}	11.25 (2.00)^{b,e}	9.11 (2.49)^{c,d,e}	41.41	.36
Working Memory	11.25 (3.31)^{a,b,c}	19.15 (4.18)^{a,d}	18.31 (3.39)^{b,e}	13.48 (3.98)^{c,d,e}	58.21	.44
Plan/Organize	12.62 (3.43)^{a,b,c}	18.75 (3.85)^{a,d}	19.06 (3.62)^{b,e}	14.67 (3.83)^{c,d,e}	41.14	.35
Task-Monitor	8.33 (2.39)^{a,b}	11.25 (2.49)^{a,d}	11.09 (2.08)^{b,e}	9.22 (2.04)^{d,e}	19.11	.20
Organization of Materials	9.11 (2.47)^{a,b}	12.40 (2.93)^{a,d}	12.78 (2.99)^{b,e}	9.19 (2.42)^{d,e}	24.86	.25
BRI	16.70 (4.13)^{a,b}	27.90 (4.91)^{a,d}	24.94 (4.71)^{b,e}	18.30 (5.48)^{d,e}	58.55	.44
ERI	22.57 (5.39)^{a,b,c}	36.95 (6.79)^{a,d}	36.29 (6.14)^{b,e}	27.70 (6.83)^{c,d,e}	74.34	.50
CRI	48.93 (11.74)^{a,b,c}	72.95 (13.10)^{a,d}	72.50 (11.53)^{b,e}	55.67 (12.51)^{c,d,e}	51.13	.40
GEC	88.21 (19.29)^{a,b,c}	137.80 (19.59)^{a,d}	133.61 (18.26)^{b,e}	101. 67 (22.05)^{c,d,e}	74.07	.50

All differences regarding the main effects of group on the various domains of the BRIEF-2 are significant at $p < .001$. Means sharing the same superscripts are significantly different from each other. For details on the level of significance and effect sizes in the pairwise comparisons, please refer to the relevant tables in the supplementary material. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

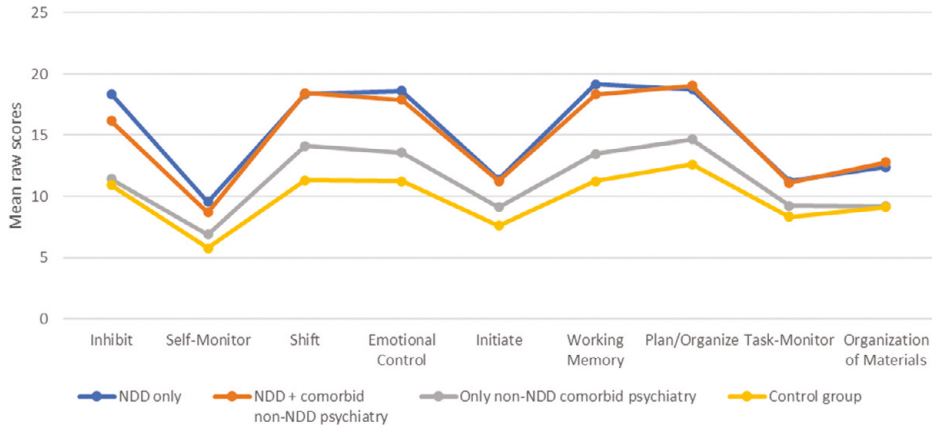


Figure 1. Group comparisons of BRIEF-2 domain scores across clinical and community control groups.

behavioral EF across the groups, and the findings are further illustrated in Figure 1 for visual clarity.

Post hoc analyses comparing the community control group with the three clinical groups pairwise revealed that the most notable differences were observed in the contrasts between the community control group and individuals exclusively diagnosed with NDD, as well as those diagnosed with NDD along with non-NDD psychiatric comorbidity. All differences involving the community control group and the two clinical groups exhibited high levels of significance ($p < .001$, one-tailed), accompanied by substantial effect sizes (all Cohen's $d > 0.80$). These effect sizes ranged from −1.22 for Task-Monitor to −2.70 for Inhibition in the case of individuals exclusively diagnosed with NDD, and from −1.18 for Task-Monitor to −2.35 for Shift in those diagnosed with NDD along with non-NDD psychiatric comorbidity. For a more comprehensive breakdown of the results, please refer to the supplementary material (Tables S1 and S2).

Moreover, post hoc analyses comparing the community control group with individuals with non-NDD psychiatric conditions showed some significant results as presented in Table 3. The most pronounced differences were identified in Shift ($p < .001$), Initiate ($p = .004$), Emotional Control ($p = .008$) as well as the ERI ($p < .001$). These differences, tested with two-tailed analyses due to the absence of specific hypotheses, were also substantial in magnitude, with effect sizes of Cohen's $d \geq .70$. A concise overview of the findings is presented in Table S3 (please refer to the supplementary material).

When comparing children diagnosed with NDD only to those with both NDD along with non-NDD psychiatric comorbidity, post hoc analyses did not reveal any statistically significant differences. However, certain tendencies ($p < .10$, two-tailed) suggested contrasting outcomes in specific functions. For instance, individuals with NDD only reported notably more difficulties in Inhibition ($p = .057$, two-tailed, Cohen's $d = 0.61$) and on the BRI ($p = .097$, two-tailed, Cohen's $d = 0.62$) compared to those with NDD along with non-NDD psychiatric comorbidity. A succinct summary of the outcomes can be found in Table S4 (please refer to the supplementary material).

Table 4. Descriptive statistics, Independent t-tests, and effect sizes comparing the youth with dual neurodevelopmental disorders and those with single neurodevelopmental disorder.

BRIEF-2 domain	ADHD ($n = 31$)	ADHD +ASD ($n = 18$)	t	p (one tailed)	Cohen's d
Inhibit	16.93 (2.90)	18.06 (4.36)	−0.97	.170	−0.32
Self-Monitor	8.68 (1.51)	9.89 (2.11)	−2.14	.021	−0.69
Shift	17.19 (3.65)	20.39 (3.26)	−3.07	.002	−0.91
Emotional Control	17.80 (3.79)	19.28 (3.71)	−1.32	.097	−0.39
Initiate	10.90 (1.81)	11.94 (2.13)	−1.82	.038	−0.54
Working Memory	17.84 (3.33)	20.28 (3.85)	−2.34	.012	−0.69
Plan/Organize	18.32 (3.57)	19.94 (3.64)	−1.52	.067	−0.45
Task-Monitor	11.19 (2.37)	10.94 (1.92)	0.38	.353	0.11
Organization of Materials	12.45 (2.86)	13.11 (2.91)	−0.77	.222	−0.23
BRI	25.70 (3.78)	27.94 (5.87)	−1.45	.079	−0.48
ERI	34.90 (6.19)	39.67 (6.07)	−2.60	.006	−0.78
CRI	70.71 (11.43)	76.22 (12.21)	−1.59	.060	−0.47
GEC	131.13 (15.57)	143.83 (21.21)	−2.39	.011	−0.71

Bonferroni corrections were applied with a corrected significance threshold of $p < .004$ ($p < .05/13$).
BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

Comparing EF in youth with single vs. Dual neurodevelopmental disorders

To investigate whether individuals with dual NDDs exhibit more pronounced EF difficulties compared to individuals with a single NDD, even in the presence of coexisting non-NDD psychiatric comorbidity, we conducted a detailed analysis within our clinical sample. Among those diagnosed with NDD, individuals were categorized into having either one or two NDDs. Among individuals with a single NDD diagnosis, the majority (31 out of 34, 90%) were diagnosed with ADHD, while the remaining three were diagnosed with ASD, either with or without coexisting non-NDD psychiatric comorbidity. In cases of individuals with two NDD diagnoses, all 18 individuals had both ADHD and ASD, with or without coexisting non-NDD psychiatric comorbidity. In both the single and dual NDD groups, there was a roughly similar distribution of individuals with coexisting non-NDD psychiatric comorbidity (single NDD: 19 [61.3%] individuals, dual NDDs: 10 [55.6%] individuals reported coexisting non-NDD psychiatric comorbidity; $\chi^2_{(1)} = 0.16$, $p = .694$).

When comparing individuals diagnosed solely with ADHD to those with both ADHD and ASD, the latter group generally reported more pronounced difficulties in EF (see Table 4). Notably, significant differences were observed only in four out of the nine distinct EF domains, with the most prominent distinction seen in the domain related to shifting abilities (Cohen's $d = -0.91$).

Only marginal alterations in results emerge when the three individuals with ASD only are included in the ADHD group and compared to the ADHD and ASD group.

Discussion

This study aimed to compare behavioral manifestations of EF profiles among children with NDDs, both with and without co-occurring psychiatric comorbidity, as well as those with only non-NDD psychiatric comorbidity or community controls, using the Swedish translation of the BRIEF-2 parent version. Additionally, we investigated differences in the

severity of EF deficits by comparing children with a single NDD diagnosis to those with dual NDDs, with or without other psychiatric disorders.

As expected and consistent with previous findings of the original BRIEF (e.g., Tallberg et al., 2023; Bodnar et al., 2007; Gilotty et al., 2002; Hovik et al., 2017; Hummer et al., 2011; Mahone et al., 2002; McAuley et al., 2010; McCandless & O'Laughlin, 2007; Skogli et al., 2013; Toplak et al., 2008) and the updated BRIEF-2 (e.g., Gentil-Gutiérrez et al., 2022; Huizinga et al., 2023; Jacobson et al., 2020; Lace et al., 2022; Parhoon et al., 2022), youths in our clinical sample showed significantly more behavioral EF difficulties across all domains and indices compared to youths in our community control sample. This result provides promising initial support for the Swedish translation of the BRIEF-2 in detecting everyday EF deficits among youth with NDDs and other psychiatric diagnoses compared to the community control group. This finding is particularly significant because research on rating-based EF in clinical samples is understudied, and other methods of assessing EF, such as EF performance tests, have limitations in capturing daily functionality from an ecological perspective in real-life situations (Pino Muñoz & Arán Filippetti, 2021; Toplak et al., 2013). More specifically, substantial differences, characterized by notable effect sizes, were observed between the community control group and individuals exclusively diagnosed with NDDs, as well as those diagnosed with NDDs alongside non-NDD psychiatric comorbidity. Comparatively, for individuals exclusively diagnosed with NDDs, the most significant effect size was observed in the Inhibition domain, whereas the largest effect size was identified in the Shift domain for children diagnosed with both NDDs and non-NDD psychiatric comorbidities. In accordance with previous research, difficulties related to inhibition and flexibility are frequently correlated with an individual's ability to adapt to situational demands – a skill often compromised in individuals diagnosed with NDDs (Antshel & Russo, 2019; Benallie et al., 2021; Gentil-Gutiérrez et al., 2022; Lawson et al., 2015). Anxiety appears to serve as a protective factor, alleviating inhibition problems in children with ADHD and comorbid anxiety/mood disorders (Craig et al., 2016; Lawson et al., 2015; Maric et al., 2018). However, despite this alleviating effect, inhibition problems, along with deficits in shift and other behavioral EF domains, remained significant when compared to controls.

Moreover, the analyses comparing the community control group with individuals with non-NDD psychiatric comorbidity revealed significant differences on six out of nine BRIEF-2 subscales, albeit with lower effect sizes compared to those observed when comparing community controls to groups with NDDs. Consistent with prior research (e.g., Rydqvist et al., 2023; Pollastri et al., 2022), youth with non-NDDs exhibited more EF difficulties, particularly in the Shift, Initiate, and Emotional Control domains. Notably, the Shift domain, reflecting flexibility, showed the most substantial deficiency and largest effect size, consistent with findings from previous studies (Rydqvist et al., 2023; Lawson et al., 2015; Pollastri et al., 2022). This underscores the significance of flexibility in managing anxiety, OCD, and other psychiatric disorders.

Somewhat unexpectedly, our analyses revealed no significant differences and generally low effect sizes when comparing the diagnostic group NDD only and the group exhibiting NDD along with non-NDD psychiatric comorbidity. However, a clear trend ($p = .057$) with a moderate effect size was observed for the Inhibition domain, where youths

with only NDDs exhibited a 0.6 SD higher mean compared to those with both NDDs and psychiatric comorbidity. This aligns with previously mentioned research (Craig et al., 2016; Lawson et al., 2015; Maric et al., 2018), which suggests that anxiety may attenuate inhibition difficulties in children with ADHD and comorbid anxiety disorders. Nevertheless, the lack of significant differences between the two diagnostic groups implies that everyday EF deficits, as measured by BRIEF-2, do not appear to worsen with coexisting non-NDD psychiatric comorbidity, particularly when considering clinical relevance. Instead, behavioral executive dysfunction seems to be primarily associated with NDDs.

Finally, consistent with expectations and prior research (Antshel & Russo, 2019; Benallie et al., 2021; Rosello et al., 2022), children with dual NDDs exhibited elevated scores across all BRIEF-2 domains compared to those with a single NDD, with significant differences observed in four out of the nine domains. The most notable differences were in the Shift, Working Memory, and Self-Monitor domains. These findings align with previous research on the etiology of EF and its association with clinical symptoms (Chang et al., 2020; Corbett et al., 2009; Shanmugan et al., 2016). Given that ASD is often associated with deficits in cognitive flexibility and working memory, and ADHD with deficits in working memory and other EF domains like planning, our results were expected (Demetriou et al., 2018; Frazier et al., 2004; Lai et al., 2019; Ramos et al., 2020; Schachar, 2023; Willcutt et al., 2005).

Recent research has also examined the neurobiological basis of NDDs, particularly focusing on the role of white matter and myelin development in brain dysfunctions related to NDDs and EF (Goddings et al., 2021; Zhao et al., 2022). Zhao et al. (2022) conducted a meta-analysis identifying white matter anomalies, especially in the posterior corpus callosum, in both ADHD and ASD, which may impair the brain's ability to integrate visual and spatial information across hemispheres. Moreover, ASD has been linked to additional abnormalities, particularly in the anterior corpus callosum and the connections between the thalamus and occipital lobe, potentially affecting brain connectivity more broadly.

While white matter development and its link to EF has been less extensively studied, Goddings et al. (2021) found that better inhibition is associated with higher fractional anisotropy (a marker of healthy white matter) in frontal regions, while better working memory is linked to higher fractional anisotropy across various brain regions.

For optimal brain development, factors such as nutrition and physical activity are also critical (Cernigliaro et al., 2024; Sung et al., 2022). Further research in these areas is warranted to deepen understanding of the relationships between EF, neurobiology, and NDDs.

Strengths and limitations of the study and suggestions for future research

This study is significant as one of the few Nordic investigations examining behavioral manifestations of EF using the BRIEF-2 parent version in a clinical sample of Swedish youths. It provides important insights into behavioral EF profiles among diagnostic groups compared to a community control group, shedding light on potential differences in daily functionality. Additionally, the study benefits from a rigorous diagnostic process conducted by licensed clinical psychologists and child psychiatrists, incorporating

validated diagnostic interviews, parental behavioral ratings, and psychological testing assessing intelligence and other abilities. Notably, youths in the NDD group were not receiving any pharmaceutical treatment, reducing potential bias. The wide age range of the sample (7–17 years) and the exclusion criterion of an IQ below 70 enhance the generalizability of the results.

However, certain limitations should be acknowledged. The small sample sizes within the different diagnostic groups limit the statistical power of the analyses and increase the risk for type 2 errors, although most differences that reached a moderate effect size, were found to be significant. Additionally, due to the small sample sizes within specific categories, certain comparisons were not feasible. For example, the majority of the children in the NDD group with a single NDD had ADHD, with only three of them having solely ASD. In the non-NDD comorbid psychiatry group, most children had anxiety followed by depression and OCD, with a minority having other conditions such as stress and trauma related disorders, ODD or CD. Thus, future studies could benefit from larger sample sizes within each diagnostic group to provide more robust conclusions. Furthermore, longitudinal studies could offer valuable insights into the developmental trajectories of everyday EF behavior in children with NDD and psychiatric comorbidity and those with non-NDD psychiatric syndromes as well as elucidate the nature and direction of the association between EF and psychopathology. Recent studies by Halse et al. (2022) and Romer and Pizzagalli (2021) suggest that EF may play an important role in the development and manifestation of various psychiatric conditions. Halse et al. (2022) demonstrated that teacher-rated EF predicted increased symptoms of diverse psychopathology, while Romer and Pizzagalli (2021) found that impaired EF may act as both a risk factor and an outcome of youth transdiagnostic psychopathology. Thus, longitudinal investigations could provide valuable insights into the dynamic interplay between EF and psychopathology over time.

Another limitation is that the findings were constrained to parental perspectives on observable behaviors, which may not capture the full extent of EF difficulties experienced by the children. Future research should aim to corroborate these results by employing teacher-rated or self-rated EF behavior scales, along with performance-based tests and computerized cognitive tasks such as the Cambridge Neuropsychological Test Automated Battery (CANTAB, 2020). This approach would provide a more multimodal and comprehensive understanding, favoring a contrasting comparison of daily EF in children with or without NDD and/or other psychiatric comorbidity.

Clinical and practical implications

This study recognizes the utility of the Swedish translation of the BRIEF-2's in assessing day-to-day behavioral manifestations of EF, while exploring differences between youth with NDDs (specifically ADHD and ASD) and those with non-NDD psychiatric comorbidities as well as community controls in terms of parent-rated EF. Although the BRIEF-2 is not specifically designed to directly assess NDDs (i.e., ADHD and Autism) or other non-NDD psychiatric diagnoses (i.e., anxiety, depression, OCD, stress and trauma related disorders, ODD or CD), our results suggest that the BRIEF-2 significantly identifies patterns of self-regulatory behavioral EF deficits among clinical groups in everyday settings, particularly those diagnosed with NDDs. This information

could be valuable as complementary clinical data when assessing the daily functionality of children diagnosed with psychiatric disorders and/or NDDs. It could also be important when considering how to implement function-enhancing support for these groups both at school and in the home environment. Importantly, the findings suggest that the severity of behavioral executive difficulties, as measured by the BRIEF-2, does not escalate when children are diagnosed with NDD along with other non-NDD psychiatric comorbidities. Consequently, the current study suggests that indications of impaired EF behaviors (as measured by the BRIEF-2) can be used to specify daily functionality and could be interpreted as an incentive to continue clinical assessments for potential NDDs and other psychiatric conditions. Furthermore, it emphasizes the importance of comprehensive assessment and diagnostic evaluation to ensure accurate identification and appropriate intervention for children presenting with behavioral EF difficulties.

Additionally, individuals with dual NDDs revealed a more intricate nature of behavioral executive deficits, underscoring the importance of considering the interaction between different neurodevelopmental conditions in understanding EF deficits and developing targeted learning measures and interventions. These efforts are crucial not only for supporting affected youths but also for equipping educators, parents, and other stakeholders with the tools and knowledge necessary to provide effective assistance. Broadly speaking, there are two approaches to addressing EF deficits: employing scaffolding strategies to compensate for the deficits (St John et al., 2018) and implementing training to improve the functions (Takacs & Kassai, 2019). Scaffolding techniques require that the parents, and/or teachers have acquired, and also have access to their own executive, and cognitive abilities (St John et al., 2018). Different EF interventions aiming at improving EF in children have shown diverse results depending on the capability of the children. This study, along with others, indicates that youths with NDDs are most in need of support for improving everyday EF, yet they seem to benefit less from explicit EF training compared to typically developing youths (Takacs & Kassai, 2019). Instead, approaches that implicitly foster EF – such as biofeedback relaxation, reinforcement of improved behavior by teachers, and supportive feedback in everyday activities – appear to be more effective for them (Takacs & Kassai, 2019).

Conclusions

Our findings revealed highly significant differences with very large effect sizes in parent-rated scores of various behavioral EF domains, as measured by the BRIEF-2, among Swedish youth with NDDs – whether accompanied by non-NDD psychiatric comorbidities or not – compared to youths solely diagnosed with non-NDD and contrasted to community controls. Youth with non-NDDs showed more behavioral EF deficits than community controls in six out of eight domains, with the Shift domain displaying the largest effect size. Unexpectedly, no significant differences were found between the NDD-only group and the NDD group with coexisting non-NDD psychiatric comorbidities. This suggests that the presence of non-NDD comorbidities alongside NDDs does not significantly exacerbate the behavioral manifestations of EF deficits. Additionally, youth with dual NDDs (both ADHD and ASD) displayed more behavioral EF deficits across

four out of nine domains compared to youth diagnosed with a single NDD, with the Shift domain again showing the largest effect size.

Overall, this study suggests that the presence of an NDD emerged as a crucial factor in differentiating clinically significant behavioral EF deficits in children, irrespective of the presence of other comorbid psychiatric diagnoses. Additionally, the study provides initial support for the use of the Swedish translation of the BRIEF-2 in a Swedish clinical context, indicating its potential utility as a reliable tool for assessing behavioral EF deficits in children with NDDs and other psychiatric conditions.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the Crafoordska Stiftelsen [20180643] and also received partial funding from Hogrefe Publishing for data collection. Importantly, the funding sources had no influence on the data analysis, interpretation, or conclusions drawn from the study, ensuring the integrity and independence of the research findings.

ORCID

Daiva Daukantaitė http://orcid.org/0000-0002-1994-041X

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Antshel, K. M., & Russo, N. (2019). Autism spectrum disorders and ADHD: Overlapping phenomenology, diagnostic issues, and treatment considerations. *Current Psychiatry Reports*, *21*(5), 34. https://doi.org/10.1007/s11920-019-1020-5

Baggetta, A., & Alexander, P. A. (2016). Conceptualization and operationalization of Executive function. *Mind Brain & Education*, *10*(1), 10–33.

Barican, J. L., Yung, D., Schwartz, C., Zheng, Y., Georgiades, K., & Waddell, C. (2022). Prevalence of childhood mental disorders in high-income countries: A systematic review and meta-analysis to inform policymaking. *Evidence-Based Mental Health*, *25*(1), 36–44. https://doi.org/10.1136/ebmental-2021-300277

Barkley, R. A. (2012). *Executive functions: What they are, how they work, and why they evolved*. Guilford Press.

Benallie, K. J., McClain, M. B., Bakner, K. E., Roanhorse, T., & Ha, J. (2021). Executive functioning in children with ASD+ ADHD and ASD+ ID: A systematic review. *Research in Autism Spectrum Disorders*, *86*, 101807. https://doi.org/10.1016/j.rasd.2021.101807

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., Morgan, C. L., & Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting & Clinical Psychology*, *72*(5), 757–766. https://doi.org/10.1037/0022-006X.72.5.757

Bodnar, L. E., Prahme, M. C., Cutting, L. E., Denckla, M. B., & Mahone, E. M. (2007). Construct validity of parent ratings of inhibitory control. *Child Neuropsychology*, *13*(4), 345–362. https://doi.org/10.1080/09297040600899867

CANTAB. (2020, July 13). *The most sensitive and validated cognitive research software available*. Cambridge Cognition. https://www.cambridgecognition.com/cantab

Cernigliaro, F., Santangelo, A., Nardello, R., Lo Cascio, S., D'Agostino, S., Correnti, E., Marchese, F., Pitino, R., Valdese, S., Rizzo, C., Raieli, V., & Santangelo, G. (2024). Prenatal nutritional factors and neurodevelopmental disorders: A narrative review. *Life (Basel, Switzerland)*, *14*(9), 1084. https://doi.org/10.3390/life14091084

Chang, S., Yang, L., Wang, Y., & Faraone, S. V. (2020). Shared polygenic risk for ADHD, executive dysfunction and other psychiatric disorders. *Translational Psychiatry*, *10*(1), 182. https://doi.org/10.1038/s41398-020-00872-9

Corbett, B. A., Constantine, L. J., Hendren, R., Rocke, D., & Ozonoff, S. (2009). Examining executive functioning in children with autism spectrum disorder, attention deficit hyperactivity disorder and typical development. *Psychiatry Research*, *166*(2–3), 210–222. https://doi.org/10.1016/j.psychres.2008.02.005

Craig, F., Margari, F., Legrottaglie, A. R., Palumbi, R., de Giambattista, C., & Margari, L. (2016). A review of executive function deficits in autism spectrum disorder and attention-deficit/hyperactivity disorder. *Neuropsychiatric Disease and Treatment*, *12*, 1191–1202. https://doi.org/10.2147/NDT.S104620

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., Hickie, I., & Guastella, A. J. (2018, May). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry*, *23*(5), 1198–1204. https://doi.org/10.1038/mp.2017.75. Epub 2017 Apr 25. PMID: 28439105; PMCID: PMC5984099.

Duncan, L., Georgiades, K., Wang, L., Van Lieshout, R. J., MacMillan, H. L., Ferro, M. A., Lipman, E. L., Szatmari, P., Bennett, K., Kata, A., Janus, M., & Boyle, M. H. (2018). Psychometric evaluation of the mini international neuropsychiatric interview for children and adolescents (MINI-KID). *Psychological Assessment*, *30*(7), 916–928. https://doi.org/10.1037/pas0000541

Esch, P., Bocquet, V., Pull, C., Couffignal, S., Lehnert, T., Graas, M., Fond-Harmant, L., & Ansseau, M. (2014). The downward spiral of mental disorders and educational attainment: A systematic review on early school leaving. *BMC Psychiatry*, *14*, 237. https://doi.org/10.1186/s12888-014-0237-4

Francés, L., Quintero, J., Fernández, A., Ruiz, A., Caules, J., Fillon, G., Hervás, A., & Soler, C. V. (2022). Current state of knowledge on the prevalence of neurodevelopmental disorders in childhood according to the DSM-5: A systematic review in accordance with the PRISMA criteria. *Child and Adolescent Psychiatry and Mental Health*, *16*(1), 27. https://doi.org/10.1186/s13034-022-00462-1

Frazier, T. W., Demaree, H. A., & Youngstrom, E. A. (2004). Meta-analysis of intellectual and neuropsychological test performance in attention-deficit/hyperactivity disorder. *Neuropsychology*, *18*(3), 543–555. https://doi.org/10.1037/0894-4105.18.3.543

Gentil-Gutiérrez, A., Santamaría-Peláez, M., Mínguez-Mínguez, L. A., González-Santos, J., Fernández-Solana, J., & González-Bernal, J. J. (2022). Executive functions in children and adolescents with autism spectrum disorder, grade 1 and 2, vs. Neurotypical development: A school view. *International Journal of Environmental Research and Public Health*, *19*(13), 7987. https://doi.org/10.3390/ijerph19137987

Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology: A Journal on Normal & Abnormal Development in Childhood & Adolescence*, *8*(4), 241–248. https://doi.org/10.1076/chin.8.4.241.13504

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *The behavior rating inventory of Executive function professional manual*. Psychological Assessment Resources.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2015). *Behavior rating inventory of Executive functions-2*. Psychological Assessment Resources.

Goddings, A. L., Roalf, D., Lebel, C., & Tamnes, C. K. (2021). Development of white matter microstructure and executive functions during childhood and adolescence: A review of

diffusion MRI studies. *Developmental Cognitive Neuroscience*, *51*, 101008. https://doi.org/10.1016/j.dcn.2021.101008

Gravetter, F., & Wallnau, L. (2014). *Essentials of statistics for the behavioral sciences* (8th ed.). Wadsworth.

Halse, M., Steinsbekk, S., Hammar, Å., & Wichstrøm, L. (2022). Longitudinal relations between impaired executive function and symptoms of psychiatric disorders in childhood. *Journal of Child Psychology and Psychiatry*, *63*(12), 1574–1582. https://doi.org/10.1111/jcpp.13622

Högberg, C., Billstedt, E., Björck, C., Björck, P.-O., Ehlers, S., Gustle, L.-H., Hellner, C., Höök, H., Serlachius, E., Svensson, M. A., & Larsson, J.-O. (2019). Diagnostic validity of the MINI-KID disorder classifications in specialized child and adolescent psychiatric outpatient clinics in Sweden. *BMC Psychiatry*, *19*(142). https://doi.org/10.1186/s12888-019-2121-8

Hovik, K. T., Egeland, J., Isquith, P. K., Gioia, G., Skogli, E. W., Andersen, P. N., & Øie, M. (2017). Distinct patterns of everyday Executive function problems distinguish children with Tourette syndrome from children with ADHD or autism spectrum disorders. *Journal of Attention Disorders*, *21*(10), 811–823. https://doi.org/10.1177/1087054714550336

Howell, D. C. (2009). *Statistical methods for psychology* (7th ed.). Wadsworth Cengage Learning.

Huizinga, M., Smidts, D. P., & Baeyens, D. (2023). The Dutch version of the behavior rating inventory of Executive function-2 (BRIEF-2). *Psychological Test Adaptation and Development*, *4*(1), 97–115. https://doi.org/10.1027/2698-1866/a000038

Hummer, T. A., Kronenberger, W. G., Wang, Y., Dunn, D. W., Mosier, K. M., Kalnin, A. J., & Mathews, V. P. (2011). Executive functioning characteristics associated with ADHD comorbidity in adolescents with disruptive behavior disorders. *Journal of Abnormal Child Psychology*, *39*(1), 11–19. https://doi.org/10.1007/s10802-010-9449-3

Jacobson, L. A., Pritchard, A. E., Koriakin, T. A., Jones, K. E., & Mahone, E. M. (2020). Initial examination of the BRIEF2 in clinically referred children with and without ADHD symptoms. *Journal of Attention Disorders*, *24*(12), 1775–1784. https://doi.org/10.1177/1087054716663632

Jangmo, A., Stålhandske, A., Chang, Z., Chen, Q., Almqvist. C., Feldman. I., Bulik, C. M., Lichtenstein. P., D'Onofrio, B., Kuja-Halkola, R., & Larsson, H. (2019). Attention-Deficit/Hyperactivity disorder, school performance, and effect of medication. *Journal of the American Academy of Child and Adolescent Psychiatry*, *58*(4), 423–432. https://doi.org/10.1016/j.jaac.2018.11.014

Jarrett, M. A. (2016). Attention-deficit/hyperactivity disorder (ADHD) symptoms, anxiety symptoms, and executive functioning in emerging adults. *Psychological Assessment*, *28*(2), 245–250. https://doi.org/10.1037/pas0000190

Jensen, C. M., & Steinhausen, H. C. (2015). Comorbid mental disorders in children and adolescents with attention-deficit/hyperactivity disorder in a large nationwide study. *Attention Deficit and Hyperactivity Disorders*, *7*(1), 27–38. https://doi.org/10.1007/s12402-014-0142-1

Kern, L., Evans, S. W., Lewis, T. J., State, T. M., Weist, M. D., & Wills, H. P. (2015). CARS comprehensive intervention for secondary students with emotional and behavioral problems: Conceptualization and development. *Journal of Emotional and Behavioral Disorders*, *23*(4), 195–205. https://doi.org/10.1177/1063426615578173

Lace, J. W., Seitz, D. J., Austin, T. A., Kennedy, E. E., Ferguson, B. J., & Mohrland, M. D. (2022). The dimensionality of the behavior rating inventory of Executive function, second edition in a clinical sample. *Applied Neuropsychology: Child*, *11*(4), 579–590. https://doi.org/10.1080/21622965.2021.1910950

Lai, M. C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *Lancet Psychiatry*, *6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Lawson, R. A., Papadakis, A. A., Higginson, C. I., Barnett, J. E., Wills, M. C., Strang, J. F., Wallace, G. L., & Kenworthy, L. (2015). Everyday executive function impairments predict comorbid psychopathology in autism spectrum and attention deficit hyperactivity disorders. *Neuropsychology*, *29*(3), 445–453. https://doi.org/10.1037/neu0000145

Mahone, E. M., Cirino, P. T., Cutting, L. E., Cerrone, P. M., Hagelthorn, K. M., Hiemenz, J. R., Singer, H. S., & Denckla, M. B. (2002). Validity of the behavior rating inventory of executive function in children with ADHD and/or Tourette syndrome. *Archives of Clinical Neuropsychology: The Official Journal of the National Academy of Neuropsychologists*, *17*(7), 643–662. https://doi.org/10.1093/arclin/17.7.643

Maric, M., Bexkens, A., & Bögels, S. M. (2018). Is clinical anxiety a risk or a protective factor for Executive functioning in youth with ADHD? A meta-regression analysis. *Clinical Child & Family Psychology Review*, *21*(3), 340–353. https://doi.org/10.1007/s10567-018-0255-8

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function? *Journal of the International Neuropsychological Society: JINS*, *16*(3), 495–505. https://doi.org/10.1017/S1355617710000093

McCandless, S., & O'Laughlin, L. (2007). The clinical utility of the behavior rating inventory of Executive function (BRIEF) in the diagnosis of ADHD. *Journal of Attention Disorders*, *10*(4), 381–389. https://doi.org/10.1177/1087054706292115

Parhoon, K., Moradi, A., Alizadeh, H., Parhoon, H., Sadaphal, D. P., & Coolidge, F. L. (2022). Psychometric properties of the behavior rating inventory of executive function, second edition (BRIEF2) in a sample of children with ADHD in Iran. *Child Neuropsychology*, *28*(4), 427–436. https://doi.org/10.1080/09297049.2021.1975669

Pino Muñoz, M., & Arán Filippetti, V. (2021). Confirmatory factor analysis of the BRIEF-2 parent and Teacher form: Relationship to performance-based measures of Executive functions and academic achievement. *Applied Neuropsychology: Child*, *10*(3), 219–233. https://doi.org/10.1080/21622965.2019.1660984

Pollastri, A. R., Forchelli, G., Vuijk, P. J., Stoll, S. J., Capawana, M. R., Bellitti, J., Braaten, E. B., & Doyle, A. E. (2022). Behavior ratings of executive functions index multiple domains of psychopathology and school functioning in child psychiatric outpatients. *Applied Neuropsychology: Child*, *12*(4), 304–317. https://doi.org/10.1080/21622965.2022.2099743

Ramos, A. A., Hamdan, A. C., & Machado, L. (2020). A meta-analysis on verbal working memory in children and adolescents with ADHD. *The Clinical Neuropsychologist*, *34*(5), 873–898. https://doi.org/10.1080/13854046.2019.1604998

Romer, A. L., & Pizzagalli, D. A. (2021). Is executive dysfunction a risk marker or consequence of psychopathology? A test of executive function as a prospective predictor and outcome of general psychopathology in the adolescent brain cognitive development study®. *Developmental Cognitive Neuroscience*, *51*, Article 100994. https://doi.org/10.1016/j.dcn.2021.100994

Rosello, R., Martinez-Raga, J., Tomas, J. M., Mira, A., & Cortese, S. (2023). Cognitive and behavioral profiles in children with autism spectrum disorder with and without attention-deficit /hyperactivity disorder. *Child and Adolescent Mental Health*, *28*(2), 269–276. https://doi.org/10.1111/camh.12562

Rosello, R., Martinez-Raga, J., Mira, A., Pastor, J. C., Solmi, M., & Cortese, S. (2022). Cognitive, social, and behavioral manifestations of the co-occurrence of autism spectrum disorder and attention-deficit/hyperactivity disorder: A systematic review. *Autism: The International Journal of Research and Practice*, *26*(4), 743–760. https://doi.org/10.1177/13623613211065545

Rydqvist, F., Hoff, E., Daukantaitė, D., & Cervin, M. (2023). Everyday executive functioning in pediatric obsessive-compulsive disorder: Diagnostic specificity, clinical correlations, and outcome. *BMC Psychiatry*, *23*(1), 622. https://doi.org/10.1186/s12888-023-05111-1

Schachar, R. J. (2023). Fifty years of executive control research in attention-deficit/hyperactivity disorder: What we have learned and still need to know. *Neuroscience & Biobehavioral Reviews*, *155*, 105461. https://doi.org/10.1016/j.neubiorev.2023.105461

Shanmugan, S., Wolf, D. H., Calkins, M. E., Moore, T. M., Ruparel, K., Hopson, R. D., Vandekar, S. N., Roalf, D. R., Elliott, M. A., Jackson, C., Gennatas, E. D., Leibenluft, E., Pine, D. S., Shinohara, R. T., Hakonarson, H., Gur, R. C., Gur, R. E., & Satterthwaite, T. D. (2016). Common and dissociable mechanisms of executive system dysfunction across psychiatric disorders in youth. *The American Journal of Psychiatry*, *173*(5), 517–526. https://doi.org/10.1176/appi.ajp.2015.15060725

Skogli, E. W., Teicher, M. H., Andersen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys–gender differences in co-existing symptoms and executive function measures. *BMC Psychiatry*, *13*, 298. https://doi.org/10.1186/1471-244X-13-298

Sørensen, L., Plessen, K. J., Nicholas, J., & Lundervold, A. J. (2011). Is behavioral regulation in children with ADHD aggravated by comorbid anxiety disorder? *Journal of Attention Disorders*, *15*(1), 56–66. https://doi.org/10.1177/1087054709356931

Stark, I., Liao, P., Magnusson, C., Lundberg, M., Rai, D., Lager, A., & Idring Nordström, S. (2021). Qualification for upper secondary education in individuals with autism without intellectual disability: Total population study, Stockholm, Sweden. *Autism: The International Journal of Research & Practice*, *25*(4), 1036–1046. https://doi.org/10.1177/1362361320975929

Stevanovic, D., Jafari, P., Knez, R., Franic, T., Atilola, O., Davidovic, N., Bagheri, Z., & Lakic, A. (2017). Can we really use available scales for child and adolescent psychopathology across cultures? A systematic review of cross-cultural measurement invariance data. *Transcultural Psychiatry*, *54*(1), 125–152. https://doi.org/10.1177/1363461516689215

St. John, A. M., Oztahtaci, B., & Tarullo, A. R. (2018). Parental executive function and verbal ability matter for scaffolding. *Journal of Family Psychology*, *32*(3), 406–411. https://doi.org/10.1037/fam0000374

Sung, M. C., Ku, B., Leung, W., & MacDonald, M. (2022). The effect of physical activity interventions on Executive function among people with neurodevelopmental disorders: A meta-analysis. *Journal of Autism & Developmental Disorders*, *52*(3), 1030–1050. https://doi.org/10.1007/s10803-021-05009-5

Takacs, Z. K., & Kassai, R. (2019). The efficacy of different interventions to foster children's executive function skills: A series of meta-analyses. *Psychological Bulletin*, *145*(7), 653–697. https://doi.org/10.1037/bul0000195

Tallberg, P., Rastam, M., Hallin, A. L., Perrin, S., & Gustafsson, P. (2023). A longitudinal investigation of parental ratings and performance metrics for executive functioning and symptom severity in clinically referred youth with ADHD. *Applied Neuropsychology: Child*, *12*(4), 259–271. https://doi.org/10.1080/21622965.2022.2093113

Tallberg, P., Svanberg, K., Hallin, A. L., Rastam, M., Gustafsson, P., & Perrin, S. (2022). The three-year outcome of emotional symptoms in clinically referred youth with ADHD and their relationship to Neuropsychological Functions. *Scandinavian Journal of Child and Adolescent Psychiatry and Psychology*, *10*(1), 72–86. https://doi.org/10.2478/sjcapp-2022-0008

Toplak, M. E., Bucciarelli, S., Jain, U., & Tannock, R. (2008). Executive functions: Performance-based measures and the behavior rating inventory of Executive function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology*, *15*(1), 53–72. https://doi.org/10.1080/09297040802070929

Toplak, M. E., West, R. F., & Stanovich, K. E. (2013). Practitioner review: Do performance- based measures and ratings of executive function assess the same construct? *Journal of Child Psychology and Psychiatry*, *54*(2), 131–143. https://doi.org/10.1111/jcpp.12001

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: A meta-analytic review. *Biological Psychiatry*, *57*(11), 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006

Zablotsky, B., Bramlett, M. D., & Blumberg, S. J. (2020). The Co-occurrence of autism spectrum disorder in children with ADHD. *Journal of Attention Disorders*, *24*(1), 94–103. https://doi.org/10.1177/1087054717713638

Zhao, Y., Yang, L., Gong, G., Cao, Q., & Liu, J. (2022). Identify aberrant white matter microstructure in ASD, ADHD and other neurodevelopmental disorders: A meta-analysis of diffusion tensor imaging studies. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, *113*, 110477. https://doi.org/10.1016/j.pnpbp.2021.110477

Study IV

The Overlooked Role of Internalizing Symptoms in Adolescent Executive Function: Insights from Self- and Teacher Ratings

Daiva Daukantaitė, Johan Klarin, Frida Ilahi, Eva Hoff & Pia Tallberg

Abstract

Executive functioning (EF), encompassing cognitive processes that support goal-directed behavior (e.g., planning, organization, self-regulation), is consistently found to be impaired in adolescents with neurodevelopmental disorders (NDDs; e.g., autism). Most research has examined EF in diagnostic contexts, with less attention to community-based samples. The relationship between EF difficulties and internalizing symptoms (e.g., anxiety, depression) also remains underexplored, despite their prevalence and significance in adolescence. In addition, few studies have incorporated both adolescent and teacher perspectives, limiting insight into how EF difficulties manifest across contexts. This study examined associations among EF, self-reported NDDs, internalizing symptoms, academic achievement, and gender across two developmental cohorts. EF was assessed with the Behavior Rating Inventory of Executive Function–Second Edition (BRIEF2), completed by adolescents and teachers in a community sample of younger (N = 393; M_{age} = 14; 45.8% female) and older adolescents (N = 359; M_{age} = 17; 66.6% female). Adolescents with self-reported NDDs showed greater EF difficulties across domains, particularly in the younger cohort, according to both self- and teacher reports. Self-reported EF difficulties were strongly associated with internalizing symptoms, whereas teacher ratings showed minimal overlap, suggesting such difficulties may be less visible in classroom settings. Gender differences were informant-specific: girls reported greater EF difficulties, while teachers—especially for younger students—rated boys as having more challenges. Teacher-rated EF was the strongest predictor of academic achievement, exceeding self-reports, internalizing symptoms, and NDD status. Among girls, a suppression effect was observed: controlling for internalizing symptoms strengthened the association between self-reported EF difficulties and academic performance, consistent with compensatory mechanisms such as increased effort or perfectionism. Findings highlight the overlooked role of internalizing symptoms in adolescent EF and underscore the value of multi-informant assessments for identifying context-dependent difficulties.

Introduction

Executive function (EF) refers to a core set of interrelated cognitive processes that enable individuals to regulate, direct, and manage their thoughts, emotions, and behaviors in pursuit of purposeful, goal-directed problem-solving (Gioia et al., 2015). These processes include essential skills such as planning, working memory, cognitive flexibility, inhibitory control, and self-regulation. Collectively, these abilities are fundamental to success across a wide range of life domains, with particularly strong implications for school achievement, where executive functions support core learning activities such as reading comprehension, mathematics problem-solving, and effective study behaviors (Best et al., 2011; Diamond, 2013; Spiegel et al., 2021).

Teachers, who interact with students daily in structured educational environments, are uniquely positioned to observe EF-related behaviors and provide important insights into how these abilities—or deficits—affect classroom learning and behavior. Because of their direct and ongoing contact with students, teachers are frequently asked to complete rating scales such as the Behavior Rating Inventory of Executive Function (BRIEF) or its successor, the BRIEF2 (Gioia et al., 2015), as part of broader neurodevelopmental assessments. Although not diagnostic instruments, the BRIEF and BRIEF2 are most commonly used in clinical contexts and have consistently demonstrated strong sensitivity in distinguishing children with neurodevelopmental disorders (NDDs)—including Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD)—from typically developing peers (e.g., Rydqvist et al., 2023; Hamilton et al., 2024; Gentil-Gutiérrez et al., 2022; Jacobson et al., 2020; Hovik et al., 2017; Skogli et al., 2013). Consequently, most BRIEF/BRIEF2 studies have been conducted in clinical or referred samples in which teachers rate a specific child due to suspected EF difficulties. This problem-focused context may not fully capture the broader spectrum of EF strengths and weaknesses that exist in everyday classroom settings. Much less is known about how the BRIEF2 performs in community-based samples, where it is administered outside the diagnostic process and may reflect a wider and more heterogeneous range of functioning — including youth with NDDs whose symptoms may be less pronounced or partially mitigated through previous or ongoing support.

Another important knowledge gap concerns the relationship between EF and internalizing symptoms. While teachers are most often asked to rate EF deficits during evaluations of students with suspected NDDs, and substantial differences between the students diagnosed with NDD and their peers without NDDs are well documented, it remains unclear whether such ratings are equally sensitive and accurate for identifying EF difficulties in students with internalizing problems. Growing evidence indicates that individuals with internalizing disorders, such as anxiety and depression, frequently experience EF challenges (e.g., Hamilton et al.,

2024; Holler et al., 2014; Snyder, 2013). Given the steadily increasing prevalence of mental health concerns among youth (e.g., WHO, 2020), and the fact that these students often remain less noticeable in classroom settings due to the more hidden nature of their difficulties, it is important to examine them alongside students with NDDs in order to obtain a more complete understanding of EF functioning across different mental health profiles. This is particularly relevant as EF difficulties associated with internalizing symptoms may be more subtle and less overt—manifesting as challenges with task initiation, sustained attention, emotional regulation, or social interactions (Holmes et al., 2014; McCloskey et al., 2009)—and may therefore go undetected in everyday school environments.

An additional gap in the literature is that children's own perceptions of their EF are rarely examined alongside ratings from external informants (e.g., teachers or parents). As a result, it remains unclear whether EF profiles differ across informants when an NDD or other mental health condition is present — particularly when the focus is on EF and mental health, rather than solely on establishing an NDD diagnosis.

Building on these identified gaps, the present study investigates how teacher- and self-rated EF, as measured by the BRIEF2, relate to self-reported NDD diagnoses, subclinical and clinical levels of internalizing symptoms, academic achievement, and gender in community-based samples of middle and high school adolescents.

EF Deficits in Youth with NDDs and Internalizing Problems

EF deficits are a hallmark of NDDs. In ADHD, affecting approximately 5–11% of children and adolescents for instance, impairments in working memory, inhibitory control, and planning contribute to characteristic symptoms such as hyperactivity, impulsivity, and inattention (Ramos et al., 2020; Willcutt et al., 2005). Similarly, in ASD, affecting 0.7–3% of children, difficulties in cognitive flexibility and working memory often exacerbate challenges in social communication, behavioral regulation, and adapting to changes (Demetriou et al., 2018; Lai et al., 2019). These EF deficits profoundly impact academic achievement, social relationships, and emotional well-being (e.g., Biederman et al., 2004; Jangmo et al., 2019; Sibley et al., 2019), making their early identification and intervention critical.

Given the critical role of EF deficits in ADHD and ASD, research has largely focused on these groups to better understand EF-related challenges and develop targeted interventions that enhance academic, social, and emotional outcomes. However, a growing body of evidence indicates that adolescents with internalizing problems—such as anxiety and depression—also experience significant EF difficulties (Hamilton et al., 2024; Holler et al., 2014; Snyder, 2013), yet this population has received considerably less research attention. Internalizing conditions, characterized by withdrawal, excessive worry, and mood dysregulation,

often go unnoticed in school settings due to their subtle, inward-facing nature (Merikangas et al., 2010). Nevertheless, EF difficulties in these adolescents—such as deficits in planning, self-monitoring, and emotional regulation—can severely undermine both academic achievement and social functioning, especially when combined with the distress associated with internalizing symptoms (McTeague et al., 2016).

While teachers play a key role in identifying EF difficulties among students with NDDs, their role in recognizing such difficulties in adolescents with internalizing conditions—like anxiety or depression—is often more limited. Symptoms of internalizing disorders tend to emerge gradually, may fluctuate over time, and can be mistaken for stable personality traits—such as shyness or perfectionism—making them less visible in routine classroom interactions (Costello et al., 2003; Merikangas et al., 2010). The subtlety of these symptoms raises pressing questions: Are teachers sufficiently equipped to spot EF deficits among adolescents with internalizing problems? And if so, are they equally adept at doing so for both boys and girls? Answering these questions is crucial for ensuring comprehensive evaluations, timely interventions, and equitable support.

The interplay between EF deficits and internalizing symptoms creates a complex picture. While EF difficulties may exacerbate anxiety or depression by amplifying daily functional challenges, the inward-facing nature of these symptoms can distort adolescents' self-perceptions of EF, leading to under- or overreporting of their challenges (McNeilly & Wang, 2021). These discrepancies underscore the importance of multi-informant approaches to EF assessment, which integrate self-reports with external observations to provide a more nuanced understanding of adolescents' functioning (Achenbach et al., 1987; De Los Reyes et al., 2015).

Gender Differences in EF Ratings and Recognition

Gender differences further complicate EF assessment and diagnosis. Boys with ADHD typically exhibit hyperactivity and impulsivity, making their EF deficits more visible, while girls often struggle with inattention and working memory deficits, which are subtler and more prone to underdiagnosis (Gershon, 2002; Rucklidge, 2010;). Similarly, boys with ASD tend to display cognitive inflexibility and rigid thinking, whereas girls frequently mask EF difficulties by mimicking social behaviors, delaying identification but increasing emotional strain (Lai et al., 2015; Mandy et al., 2012). These gendered differences affect how EF deficits are perceived in everyday settings. Boys' externalized behaviors are more likely to be flagged by teachers, while girls' internalized EF challenges—manifesting as organizational struggles, perfectionism, or self-criticism—are often misinterpreted as disengagement or lack of effort (Mandy et al., 2012; Rucklidge, 2010; van Tetering et al., 2020). Consequently, girls are more frequently referred for emotional concerns like anxiety or depression, while boys are more commonly assessed for

neurodevelopmental disorders (Klefsjö et al., 2021). This imbalance may lead to delayed or overlooked EF deficits in girls, especially when masked by compensatory strategies.

Self-report patterns further reflect these gender disparities. Girls tend to report more EF difficulties than boys, possibly due to greater self-awareness or internalization (Gioia et al., 2015; Huizinga et al., 2023), whereas boys are consistently rated by teachers and parents as having more observable EF challenges (Gioia et al., 2015; Huizinga et al., 2023).

Multi-Informant Approaches and Contextual Variability

Given that EF difficulties may be overlooked by external raters in individuals with internalizing symptoms, and that they can both manifest and be rated differently across genders, a multi-informant approach is essential to capture the full spectrum of challenges. Boys' EF deficits, often externalized, are more easily identified by teachers or parents, whereas girls' more internalized struggles may be overlooked without self-reports. Thus, multi-informant methods help address these discrepancies by incorporating diverse perspectives on EF-related behaviors, which often vary across contexts and observers (Achenbach et al., 1987; De Los Reyes et al., 2015). Teacher-reported EF ratings, for example, more reliably predict academic performance than parent (Nunez et al., 2024) or self-ratings (Samuels, 2016), likely because teachers observe students in structured, goal-directed environments and are responsible for assigning grades themselves. However, self-reports are essential for identifying internalized EF challenges, such as self-monitoring difficulties or perfectionism, which may not be evident to external observers. Adolescents with internalizing symptoms are particularly prone to discrepancies between self-perceptions and external ratings (McNeilly & Wang, 2021), highlighting the need for complementary perspectives.

Integrating both teacher and adolescent perspectives may provide a more comprehensive understanding of EF challenges, ensuring that internalised as well as externalised difficulties are captured. While self-reports reveal personal struggles that may not be visible in the classroom, teacher ratings offer valuable information about behaviour in academic settings. Combining these perspectives helps resolve informant discrepancies (Achenbach et al., 1987; De Los Reyes et al., 2015) and enables more precise assessment and targeted intervention. In parallel, school-based EF interventions have expanded considerably over the last decade and show modest but promising effects on children's executive functioning and related outcomes (Diamond & Ling, 2016; Zelazo et al., 2017). A recent meta-analysis of 57 intervention studies (Birtwistle et al., 2025) further demonstrates that EF training has a positive overall effect in children (g = .23), although outcomes remain mixed due to variation in timing, implementation and measurement (Jacob et al., 2022). In response to these mixed results, attention has increasingly shifted away from

isolated skill training toward interventions that target the broader classroom environment, with studies showing that improving teacher–student interactions can lead to consistent gains in both self-regulation and EF (Sankalaite et al., 2021). Given the shortage of questionnaire-based EF research (Heidary et al., 2024) and calls for studies that consider age and gender in contextual EF interventions (Sankalaite et al., 2021), examining multi-informant approaches to EF and internalising symptoms in adolescents could help address current gaps and inform the development of more effective school-based programmes.

The Present Study

Using a multi-informant approach that combines self- and teacher reports on the Behavior Rating Inventory of Executive Function, Second Edition (BRIEF2; Gioia et al., 2015), this study examines behavioral EF in adolescents in relation to self-reported NDD, subclinical and clinical levels of internalizing symptoms, and academic achievement. Spanning two developmental groups—younger (M = 14 years) and older adolescents (M = 17 years)—it also explores gender differences to provide a clearer understanding of how EF challenges manifest and impact adolescents across different contexts.

Specifically, this study has three main objectives: (1) to compare EF differences between adolescents with and without self-reported NDDs; (2) to analyze EF variations across different levels of internalizing symptoms, categorized as low, subclinical, and clinical, based on the Revised Child Anxiety and Depression Scale (RCADS; Chorpita et al., 2000); and (3) to determine how EF difficulties, self-reported NDDs, and internalizing symptoms individually and collectively relate to academic achievement. Recognizing the potential impact of gender differences on the presentation of EF challenges, all analyses will either include gender as a factor or be conducted separately for boys and girls.

Building on prior research, the study is guided by the following hypotheses:

1. Adolescents with self-reported NDDs are expected to demonstrate significantly greater EF difficulties compared to those without NDDs. This pattern is anticipated to emerge consistently in both self-reports and teacher ratings, reflecting the pervasive nature of EF impairments in this population, even when assessed outside a clinical context.
2. Adolescents with clinical levels of internalizing symptoms are expected to report more pronounced EF difficulties compared to those with subclinical or low levels of symptoms. However, given the subtle and internalized nature of these challenges, we anticipate clear differences in self-reported EF difficulties, while their detectability in teacher ratings remains uncertain.

3. Girls are hypothesized to report greater EF difficulties in self-assessments, whereas teachers are expected to rate boys as exhibiting higher EF difficulties.
4. Adolescents' self- and teacher-rated EF difficulties are expected to be negatively associated with academic achievement. This relationship is anticipated to remain significant even after controlling for self-reported NDDs and internalizing symptoms.
5. Teacher-rated EF difficulties are hypothesized to show stronger associations with academic achievement compared to self-reported EF difficulties.

Methods

Sample

Data were collected from four middle schools and one high school in the Scania region of southern Sweden, an area with a population of over 1.34 million that is comparable to the national Swedish average in terms of socioeconomic conditions, according to Statistics Sweden.

The middle school sample included 393 Swedish adolescents (180 girls, 210 boys, 3 others; 25.4% with a foreign background) from grades 7–9. Participants ranged in age from 12 to 16 years, with a mean age of 14 years (SD = 0.87).

The high school sample consisted of 359 students (239 girls, 111 boys, 9 others; 14.8% with a foreign background) enrolled in the first through third year of a large *gymnasium* offering five main programs and serving approximately 1,200 students. Participant ages ranged from 15 to 19 years, with a mean age of 17 years (SD = 0.89). The response rate for both school samples was approximately 80%.

Each student completed a self-rating of EF and was subsequently rated by their teacher using the BRIEF2 Teacher Form. A total of 38 teachers participated, assessing the same students who provided self-ratings, with an average of 15 students per teacher (range: 2–38). Teachers were selected based on their familiarity with the students, ensuring that evaluations reflected accurate observations.

Measures

BRIEF2

The Behavior Rating Inventory of Executive Function, Second Edition (BRIEF2; Gioia et al., 2015), is a widely used tool designed to assess everyday EF in children and adolescents in both school and home environments. The instrument includes three forms: parent/caregiver, teacher, and self-report. Respondents rate the presence of specific behavioral challenges on a three-point scale: 1 (never), 2 (sometimes), and 3 (often), with higher scores indicating greater EF deficits (Gioia et al., 2015). In the study, we used both the self-report and teacher-report forms of the BRIEF2.

The BRIEF2 self-report form

The self-report form is designed for individuals aged 11–18, consists of 55 items assessing seven EF scales: Inhibit (ability to resist impulses and delay actions), Self-Monitor (awareness of one's behavior and its impact on others and outcomes), Shift (flexibility in transitioning between tasks or adapting to new situations), Emotional Control (regulation of emotional responses), Task Completion (ability to efficiently and effectively finish tasks), Working Memory (retaining and manipulating information for task completion), and Plan/Organize (capacity to plan and manage current and future tasks). These seven scales are grouped into three indices. The Behavioral Regulation Index (BRI) reflects the ability to monitor and regulate behavior. The Emotion Regulation Index (ERI) assesses the capacity to control emotional responses in various contexts. The Cognitive Regulation Index (CRI) measures the management of cognitive processes and problem-solving abilities. Together, these indices form the Global Executive Composite (GEC), providing an overall score for EF (Gioia et al., 2015). As outlined in the BRIEF2 manual (Gioia et al., 2015), the self-report form demonstrates strong psychometric properties. Test-retest reliability is reported at .80, while Cronbach's alpha values for scales and indices within the relevant age group (14–18 years) range from .81 to .97, indicating excellent internal consistency. In this study, Cronbach's alpha values demonstrated similarly robust reliability, ranging from good to excellent, as shown in Table S1 of the Supplementary Material.

The BRIEF2 Teacher-report Form

The teacher-form assess EF in children and adolescents aged 5–18 years. It consists of 63 items that evaluate nine EF scales. Six of these scales—Inhibit, Self-Monitor, Shift, Emotional Control, Working Memory, and Plan/Organize—align with those in the self-report version. The teacher form introduces three additional scales: Task-Monitor (evaluating difficulties in recognizing minor errors in work output), Organization of Materials (assessing orderliness in workspaces, play areas, and storage spaces), and Initiation (ability to begin tasks independently) (Gioia et al.,

2015). These nine scales collectively contribute to three indices: the BRI, ERI, and CRI, along with the overall score, GEC (Gioia et al., 2015). According to the BRIEF2 manual (Gioia et al., 2015), the test-retest reliability for the teacher form is reported at .87, with Cronbach's alpha values for the scales and indices ranging from .81 to .97, indicating excellent reliability. Internal consistency for teacher ratings in this study is presented in Table S1 of the Supplementary Material.

Self-reported NDD

Self-reported NDDs were assessed with the question: "Have you undergone an evaluation and received a confirmed neuropsychiatric diagnosis (e.g., autism, ADHD, ADD)?" The response options were: "Yes," "No," "No, but we are waiting for an evaluation," and "No, but there is a suspicion." For participants who answered "Yes," a follow-up question asked them to specify the diagnosis or diagnoses received. Analyses of NDD effects were restricted to adolescents with confirmed NDD diagnoses and those without any reported NDD, while individuals with suspected or pending evaluations were excluded to reduce potential confounding. Given the ethical and practical constraints of conducting research in school settings, self-report was the most feasible method for collecting NDD data. While this approach may involve risks of underreporting or misreporting, it is important to note that, in the Swedish educational context, NDDs are relatively openly discussed, and students with such diagnoses often receive visible classroom support, which may mitigate some of these concerns.

Anxiety and Depression

The Revised Children's Anxiety and Depression Scale-25 (RCADS-25; Ebesutani et al., 2012) was used to assess anxiety and depression levels in adolescents. This scale comprises two subscales: a 10-item depression scale (e.g., "I feel sad and empty"), structured according to DSM-IV criteria, and a 15-item broad anxiety scale (e.g., "I worry when I think I have done poorly at something"), which is not specific to any single DSM diagnosis. The RCADS-25 also provides an overall internalizing symptoms score. The measure uses a 4-point Likert scale ranging from 0 (never) to 3 (always), indicating the frequency of symptoms, and is validated for use in individuals aged 8 to 18. Reliability data across two samples indicate strong internal consistency. Among younger adolescents, Cronbach's alpha values were high for all scales: Anxiety (α = .88), Depression (α = .88), and Overall Internalizing Symptoms (α = .93). Among older adolescents, alpha values were also robust: Anxiety (α = .82), Depression (α = .84), and Overall Internalizing Symptoms (α = .89).

In our study, overall internalizing symptoms, as well as anxiety and depression symptoms in the follow-up analyses, were transformed into T-scores using normative data from Carlander et al. (2024), who validated the RCADS-25 in a Swedish national sample. T-score severity levels were defined as follows: scores of

0–64 indicated low severity of internalizing symptoms, 65–69 indicated medium severity (subclinical level), and 70 or above indicated high severity, meeting the clinical threshold. Because self-reported NDD status in our study reflected confirmed clinical diagnoses, we applied a parallel approach for internalizing symptoms by categorizing participants into low-symptom, subclinical, and clinical groups. This categorization allowed us to focus on levels of emotional difficulties most likely to warrant clinical attention, thereby creating a more consistent basis for comparison across the NDD and internalizing symptom groups.

Academic Achievement

To assess academic achievement, participants' grades in Swedish, Mathematics, and English from the current academic year were obtained directly from their schools and combined into a composite score. These data were only available for younger adolescents, as comparable measures were not obtainable for older participants due to the structure of the Swedish upper secondary (high school) system. In contrast to middle school, high school students do not receive ongoing grades for each subject; instead, they are awarded final grades upon completion of a specific course or level within subjects such as Swedish, Mathematics, or English. These final grades were not yet available for the high school sample at the time of data collection. In Swedish schools, grades range from F to A, with A being the highest. The grades were standardized on a 0 to 5 scale for each subject, with higher values indicating better performance. Strong intercorrelations were observed among the subjects: Math correlated with Swedish at $r = .70$, Math with English at $r = .63$, and Swedish with English at $r = .67$, all statistically significant at $p < .001$. These correlations suggest that the grades represent a unidimensional construct, further supported by a high Cronbach's alpha of .85. Given this strong internal consistency, the standardized scores for Swedish, Math, and English were averaged to create a single composite measure of overall academic achievement for use in the analyses.

Procedure

This study was conducted as an exploratory correlational study within the larger research project titled *Well-being in School Environment (WiSE)*, led by Daiva Daukantaitė at the Department of Psychology, Lund University, Sweden.

Selected school principals were approached to determine their interest in participating in the research project, and the schools for which the principal gave a positive answer, participated. Prior to data collection, students provided informed consent, and for those younger than age of 15, additional parental consent was collected. The students were informed about their right to withdraw at any time without penalty, and the confidentiality of their responses. To protect participants' identities, pseudonymization was implemented by assigning unique study numbers. The list of study numbers was securely stored in a locked file.

Data was collected during school hours, with both a teacher and a research assistant, facilitating the process. The survey required approximately 45 minutes to be completed. The response rate was approximately 80% in both samples.

Following student data collection, a group of teachers were invited to participate in the project by rating their students. To ensure accurate evaluations, only teachers who were highly familiar with the participating students were selected, in consultation with school principals. Teachers gave their informed consent after being informed of their rights to withdraw. The teachers were clearly instructed on how to complete the BRIEF2 Teacher Form. For their time and effort, teachers were compensated with 50 SEK (approximately 4 euros) for each completed student evaluation. This research project received ethical approval from the Swedish Ethics Committee under reference numbers 2021-01666 and 2023-01013-02.

Statistical Analyses

All analyses were conducted separately for middle and high school students, primarily due to important contextual and developmental differences between these educational levels. In Sweden, middle school (≈13–16 years) is compulsory and therefore includes a broad spectrum of students, including those with NDDs, except for the most severe cases who attend specialized schools. In contrast, high school (≈16–19 years) is voluntary, which means that students with NDDs or other difficulties who continue to this level may represent a more selective group. They are likely to include those with milder forms of NDDs, those who have received effective educational or clinical support, or those who have developed compensatory strategies that facilitate continued academic success. Since students around the age of 16 can belong to either educational level, separating analyses by middle and high school allowed us to more accurately account for both developmental stage and contextual differences between the two groups.

To evaluate differences in self-rated EF, two-way ANOVAs were conducted separately for two age groups: younger adolescents (mean age = 14) and older adolescents (mean age = 17). Analyses examined (1) the effects of self-reported NDD status (yes/no) and gender (girl/boy), and (2) the effects of internalizing symptom level (low, subclinical, clinical) and gender (girl/boy). Assumptions of normality and equal variances were examined and confirmed for all analyses.

Because each teacher evaluated an average of 15 students, a linear mixed model (LMM) approach was used for teacher-rated EF to account for the nesting of students within teachers. Separate LMM analyses examined (1) the effects of self-reported NDD status (yes/no) and gender (girl/boy), and (2) the effects of internalizing symptom level (low, subclinical, clinical) and gender (girl/boy) on EF domains, controlling for the clustering of students by teacher. Assumptions for the LMMs were evaluated prior to analysis. Residuals were examined to verify

linearity, normality, and homoscedasticity, and no substantial deviations were observed. Independence of observations between clusters (teachers) was assumed, with within-cluster dependency accounted for by including teacher as a random effect.

To enhance the specificity of the non-NDD group in the first analysis, adolescents with subclinical or clinical levels of internalizing symptoms were excluded to minimize confounding effects, as internalizing symptoms (e.g., anxiety and depression) can influence EF (Snyder et al., 2013). This exclusion was particularly important to ensure that internalizing symptoms did not obscure genuine EF differences in the non-NDD group (Hamilton et al., 2024). Similarly, adolescents with NDD were excluded from analyses examining the relationship between internalizing problems and EF to further reduce confounding.

Pearson correlations were used to explore relationships between academic achievement and EF, NDD diagnosis (yes/no), and raw scores of internalizing symptoms. Separate hierarchical regression analyses were further conducted to predict academic achievement based on self-reported and teacher-rated EF while controlling for NDD diagnosis and internalizing symptoms. Preliminary analyses confirmed that the assumptions of normality, linearity, multicollinearity, and homoscedasticity were not violated, ensuring the validity of the statistical models used in this study.

To control for Type I error, significance thresholds were adjusted using Bonferroni correction, with corrected p-values reported in the table notes.

Results

Executive Functioning Differences between Adolescents with and without Self-Reported NDDs

Among younger adolescents, 47 students (12.0%) reported a confirmed neurodevelopmental disorder (NDD), with ADHD being the most common (27 students, 57.4%), while 300 students (76.3%) reported no NDD. Among older adolescents, 21 students (7.9%) reported a confirmed NDD, with ADHD again being the most frequent (6 students, 28.6%), while 206 students (77.7%) reported no NDD. For comparative analyses, only students with either a confirmed NDD or no NDD were included, excluding those who were under investigation or suspected of having an NDD. Furthermore, adolescents without NDD but exhibiting subclinical or clinical internalizing symptoms were excluded to reduce confounding effects. This resulted in final groups of 256 younger adolescents and 188 older adolescents classified as having no NDD. Additional details on the NDD status groups are provided in Table S2 in the Supplementary Material.

Results from the two-way ANOVAs for self-rated EF (Table 1) and the LMMs for teacher-rated EF (Table 2) are presented separately for younger adolescents (M ≈ 14 years) and older adolescents (M ≈ 17 years).

Self-Rated EF by NDD Status

Significant effects of NDD status and gender were observed across both age groups. Adolescents with self-reported NDDs consistently reported greater EF difficulties than their peers without NDDs, although effect sizes varied. Among younger adolescents, effect sizes were primarily moderate to large, with the largest differences found for Task Completion (partial η^2 = .14) and Working Memory (partial η^2 = .14). In contrast, among older adolescents, effect sizes were generally more modest, though still mostly moderate, with non-significant differences for Emotional Control (p = .293, partial η^2 = .01); Working Memory again showed the largest group difference (partial η^2 = .13).

Gender differences in self-reported EF were also significant, though they varied across age groups. Among younger adolescents, girls generally reported greater EF difficulties across all domains (*partial* η^2 = .02–.09). For older adolescents, gender differences were less pronounced and associated with small effect sizes, except for Emotional Control, where girls reported substantially greater difficulties (p < .001, *partial* η^2 = .06).

Teacher-Rated EF by NDD Status

Teacher EF ratings for younger adolescents with and without self-reported NDDs closely mirrored the self-reported data, whereas group differences were less pronounced among older students (see Table 2). Among younger adolescents, those with an NDD were rated as having significantly greater EF difficulties across all BRIEF2 domains (all $p < .001$), with the largest differences observed for Plan/Organize, Shift, and Working Memory. In contrast, among older adolescents, fewer domains showed significant differences; however, the most pronounced differences were observed for Shift and Self-Monitor (both $p < .001$).

Gender differences in teacher-rated EF were more evident among younger adolescents than among older ones. In the younger group, the largest difference was observed for Task-Monitor ($p = .001$), where boys were rated as having greater difficulties. In contrast, gender differences among older adolescents were less pronounced. Only Emotional Control showed a significant effect, with girls rated as experiencing greater difficulties ($p = .008$). Beyond statistical significance, mean-level patterns also diverged across age groups: whereas boys were clearly rated as having more EF difficulties in the younger cohort, the older cohort showed more mixed results, with several domains indicating slightly higher mean levels of EF difficulties for girls, although only one of these differences, as noted above, reached significance.

Table 1.

Means (SD) and Two-Way ANOVA Results for the Main Effects of NDD Status and Gender on Self-Rated BRIEF2 Domains and Indices

	NDD diagnos				Main effect of NDD			Main effect of gender		
	Yes		No							
BRIEF2 domain	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*F*	*p*	*partial* η^2
Younger adolescents (mean age 14)										
Inhibit	17.22 (4.27)	14.82 (3.87)	13.61 (3.16)	11.76 (2.95)	36.83	<.001	.12	14.96	<.001	.05
Self-Monitor	10.00 (2.00)	9.09 (2.27)	8.34 (2.12)	7.35 (2.19)	21.10	<.001	.07	6.60	.010	.02
Shift	17.28 (3.41)	14.50 (3.08)	13.86 (2.87)	11.58 (2.93)	39.43	<.001	.12	25.11	<.001	.08
Emotional Control	11.83 (2.96)	9.59 (2.67)	10.57 (2.81)	8.20 (2.40)	8.74	.003	.03	26.27	<.001	.09
Task Completion	16.78 (3.67)	14.00 (2.83)	12.73 (3.48)	10.53 (2.96)	46.47	<.001	.14	20.42	<.001	.07
Working Memory	18.50 (3.20)	15.59 (3.46)	14.39 (3.58)	11.93 (3.06)	46.78	<.001	.14	22.27	<.001	.07
Plan/Organize	22.11 (4.75)	19.41 (3.95)	17.83 (3.94)	15.31 (3.61)	40.31	<.001	.13	15.66	<.001	.05
BRI	27.22 (5.52)	23.91 (5.64)	21.92 (4.74)	19.11 (4.64)	37.36	<.001	.12	13.79	<.001	.05
ERI	29.11 (5.12)	24.09 (4.84)	24.41 (4.79)	19.78 (4.82)	29.57	<.001	.10	33.86	<.001	.11
CRI	57.38 (10.63)	49.00 (9.62)	44.89 (10.14)	37.78 (8.88)	52.29	<.001	.16	22.35	<.001	.07
GEC	113.72 (19.17)	97.00 (18.38)	91.27 (17.57)	76.56 (17.15)	50.85	<.001	.15	27.32	<.001	.09

	NDD diagnos				Main effect of NDD			Main effect of gender		
	Yes		No							
BRIEF2 domain	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*F*	*p*	*partial* η^2
Older adolescents (mean age 17)										
Inhibit	15.38 (3.57)	14.50 (3.39)	12.31 (2.66)	12.33 (2.50)	13.88	<.001	.06	0.37	.542	.00
Self-Monitor	7.92 (2.39)	9.50 (2.43)	7.03 (1.84)	7.37 (1.71)	9.87	.002	.05	3.99	.047	.02
Shift	17.15 (4.28)	14.17 (4.26)	13.40 (3.00)	12.90 (2.60)	10.09	.002	.05	4.87	.028	.02
Emotional Control	11.54 (2.79)	9.17 (2.79)	10.73 (2.61)	8.63 (1.84)	1.11	.293	.01	12.26	<.001	.06
Task Completion	17.23 (2.52)	14.33 (4.27)	12.18 (3.26)	12.25 (3.30)	17.69	<.001	.08	2.76	.098	.01
Working Memory	18.69 (3.59)	17.50 (3.08)	13.58 (3.09)	13.92 (2.97)	29.14	<.001	.13	0.28	.596	.00
Plan/Organize	21.00 (2.35)	21.67 (6.15)	16.50 (3.74)	17.55 (3.53)	20.03	<.001	.09	0.80	.373	.00
BRI	23.31 (5.04)	24.00 (5.73)	19.34 (3.94)	19.71 (3.80)	15.54	<.001	.07	0.26	.614	.05
ERI	28.69 (6.61)	23.33 (6.53)	24.13 (4.80)	21.53 (3.88)	6.58	.011	.03	10.30	.002	.05
CRI	56.92 (5.47)	53.50 (11.54)	42.26 (9.05)	43.73 (8.80)	27.98	<.001	.12	0.18	.673	.00
GEC	108.92 (12.86)	100.83 (21.69)	85.96 (14.16)	84.96 (14.16)	24.31	<.001	.11	1.22	.270	.01

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

After Bonferroni correction: $p < .05/11 = .005$ (applied separately for each age group).

Table 2.

Means (SD) and Linear Mixed Model Results for Main Effects of Self-Reported NDD Status and Gender on Teacher-Rated BRIEF2 Domains and Indices

BRIEF2 domain	NDD				Main effect of NDD		Main effect of gender	
	Yes		No					
	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Younger adolescents (mean age 14)								
Inhibit	13.19 (6.13)	13.86 (5.49)	9.47 (2.97)	11.09 (3.79)	18.53	<.001	2.31	.130
Self-Monitor	9.19 (3.60)	8.36 (2.95)	6.19 (2.26)	7.30 (2.67)	15.51	<.001	0.73	.778
Shift	14.31 (5.22)	14.29 (4.83)	9.41 (2.80)	9.92 (2.79)	55.02	<.001	0.15	.697
Emotional Control	12.19 (5.26)	11.86 (5.27)	9.08 (2.69)	9.20 (2.90)	20.50	<.001	0.03	.872
Initiate	7.19 (2.66)	8.79 (2.42)	5.00 (1.77)	6.01 (2.24)	35.39	<.001	9.88	.002
Working Memory	14.06 (5.32)	17.00 (4.57)	9.53 (3.12)	11.15 (3.80)	50.01	<.001	9.60	.002
Plan/Organize	15.63 (3.88)	15.64 (3.88)	9.42 (2.48)	10.41 (3.05)	96.36	<.001	0.74	.389
Task-Monitor	10.38 (3.46)	13.29 (3.87)	7.27 (2.22)	9.48 (3.04)	38.23	<.001	20.92	<.001
Organization of Material	7.38 (2.55)	8.79 (2.72)	5.61 (1.58)	6.24 (1.73)	36.23	<.001	8.14	.005
BRI	22.38 (9.24)	22.21 (8.21)	15.66 (5.02)	18.39 (6.05)	19.22	<.001	1.14	.287
ERI	26.50 (9.14)	26.14 (9.77)	18.49 (5.22)	19.13 (5.20)	41.47	<.001	0.01	.904
CRI	54.63 (15.53)	63.50 (15.39)	36.84 (10.30)	43.29 (12.39)	63.97	<.001	10.41	<.001
GEC	103.50 (32.11	111.86 (29.20)	70.99 (19.55)	80.81 (21.44)	53.01	<.001	4.33	.039

BRIEF2 domain	NDD				Main effect of NDD		Main effect of gender	
	Yes		No					
	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Older adolescents (mean age 17)								
Inhibit	10.23 (2.86)	10.00 (2.45)	8.60 (1.43)	9.00 (1.69)	9.50	.002	0.04	.842
Self-Monitor	6.85 (3.16)	6.33 (2.16)	5.37 (0.95)	5.53 (1.19)	11.61	<.001	0.27	.604
Shift	11.08 (3.50)	10.00 (2.76)	8.82 (1.70)	8.43 (1.06)	17.25	<.001	2.55	.112
Emotional Control	9.62 (2.81)	8.17 (0.41)	8.49 (1.33)	8.10 (0.50)	3.06	.082	7.24	.008
Initiate	5.85 (1.99)	5.00 (1.55)	4.68 (1.45)	4.61 (1.20)	4.37	.038	1.51	.220
Working Memory	10.54 (2.79)	9.83 (2.23)	8.91 (2.15)	8.84 (1.88)	5.60	.019	0.48	.490
Plan/Organize	10.77 (3.39)	9.33 (2.07)	9.10 (2.22)	9.16 (2.02)	2.46	.118	1.38	.241
Task-Monitor	7.85 (1.14)	8.33 (2.34)	6.86 (1.58)	7.31 (1.71)	5.71	.018	1.25	.264
Organization of Material	5.54 (0.78)	5.50 (0.84)	5.26 (0.77)	5.14 (0.45)	3.02	.084	0.20	.656
BRI	17.08 (5.88)	16.33 (4.59)	13.96 (1.95)	14.53 (2.59)	13.25	<.001	0.02	.895
ERI	20.69 (6.09)	18.17 (6.53)	17.31 (2.70)	16.53 (1.14)	12.23	<.001	5.33	.022
CRI	40.54 (8.56)	38.00 (7.38)	34.81 (7.60)	35.06 (6.52)	5.07	.025	0.35	.553
GEC	78.31 (18.83)	72.50 (11.20)	66.09 (11.06)	66.12 (9.00)	10.12	.002	0.98	.324

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite. Effect sizes (partial η^2) are not reported for fixed effects in mixed linear models, as SPSS does not provide this statistic for nested data structures. After Bonferroni correction: $p < .05/13 = .004$ (applied separately for each age group).

Executive Functioning Differences among Low-Symptom, Subclinical, and Clinical Groups of Internalizing Symptoms in Adolescents

Results from the two-way ANOVAs for internalizing symptom severity and self-rated EF (Table 3) and from the LMMs for teacher-rated EF (Table 4) are presented separately for younger (M = 14) and older adolescents (M = 17). Internalizing symptom groups were based on RCADS-25 T-scores: low-symptom (T-score < 65; n = 319/226), subclinical (T-score 65–69; n = 25/12), and clinical (T-score ≥ 70; n = 44/26) for younger/older adolescents, respectively. To further nuance the results, complementary analyses were conducted for anxiety and depression symptoms separately, using the same T-score–based severity groupings (Tables S3–S6, supplementary material). Adolescents with NDD were excluded to minimize confounding, as outlined in the Statistical Analyses section.

Self-Rated EF by Internalizing Symptom Status

For self-reported EF, statistically significant differences among symptom groups were observed across all domains in both age categories (see Table 3). Effect sizes were predominantly large among younger adolescents ($p < .001$, *partial* $\eta^2 = .11$–$.25$) and somewhat smaller among older adolescents ($p \leq .005$, *partial* $\eta^2 = .04$–$.18$). When examining specific internalizing problems (see Tables S3–S4), significant group differences were found for both anxiety and depression, particularly among younger adolescents (all $p < .001$, *partial* $\eta^2 = .14$–$.20$). Across both age groups, depression showed the strongest effects, with larger effect sizes than those observed for anxiety (younger: all $p < .001$, *partial* $\eta^2 = .14$–$.20$; older: $p \leq .002$, *partial* $\eta^2 = .05$–$.17$), resembling the pattern found for overall internalizing problems. Our hypothesis—that adolescents with clinical levels of internalizing symptoms would report significantly greater EF difficulties than those with subclinical or low symptoms—was largely supported among younger adolescents and only partially supported among older adolescents. In the younger group, the clinical subgroup reported significantly greater EF difficulties than both the subclinical and low-symptom groups across four of the seven EF domains as well as all BRIEF2 indices. In the older group, however, differences between the clinical and subclinical subgroups were not significant for either the EF domains or the BRIEF2 indices, although both groups reported significantly greater EF difficulties than the low-symptom group across most domains and all BRIEF2 indices.

Gender differences (see Table 3) were again more pronounced among younger adolescents, with girls reporting greater EF difficulties, particularly in Emotional Control (*partial* $\eta^2 = .09$) and Inhibit (*partial* $\eta^2 = .04$). Among older adolescents, gender differences were limited, with the largest effect observed for Emotional Control (*partial* $\eta^2 = .03$), where girls reported slightly greater difficulties.

Teacher-Rated EF by Internalizing Symptom Status

Teacher-rated EF showed minimal differences between internalizing symptom groups across BRIEF2 domains in both age cohorts (Table 4; Tables S5–S6, supplementary), as expected. Among younger adolescents, a minor difference was observed in Plan/Organize, where the clinical group reported greater difficulties than the low-symptom group for overall internalizing symptoms. This effect was stronger when comparing the clinical depression group to the low-symptom group ($p = .004$; Table S6). For older adolescents, no significant differences were found between internalizing severity groups. Although small trends appeared when comparing depression severity groups, none reached the adjusted significance threshold of $p < .005$ after Bonferroni correction.

Gender differences in teacher-rated EF were more evident among younger adolescents, with boys showing greater difficulties in Inhibit, Self-Monitor, and Task-Monitor (all $p < .001$). Among older adolescents, the only significant difference was observed in Emotional Control ($p = .002$), where girls were rated as experiencing slightly greater difficulties.

Table 3.

Means (SD) and Two-Way ANOVA Results for Main Effects of Internalizing Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Self-Rated BRIEF2 Domains and Indices

BRIEF2 domain	Groups based on RCADS-25 T-scores						Main effect of $RCADS_{total}$				Main effect of gender		
	Low-symptom group (T-Scores <65)		Subclinical group (T-Scores 65-69)		Clinical group (T-Scores ≥ 70)								
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*Tukey post-hoc*	*F*	*p*	*partial* η^2
Younger adolescents (mean age 14)													
Inhibit	13.89 (3.23)	12.14 (3.21)	16.08 (3.45)	12.70 (2.63)	17.67 (2.81)	16.06 (2.90)	24.22	<.001	.13	3>2&1	14.58	<.001	.04
Self-Monitor	8.48 (2.17)	7.53 (2.26)	9.83 (1.99)	8.70 (1.83)	10.72 (1.87)	10.06 (2.08)	20.77	<.001	.11	3>1, 2>1	5.13	.024	.02
Shift	14.02 (2.88)	11.86 (3.01)	17.08 (3.32)	14.80 (2.25)	19.00 (2.32)	17.11 (2.87)	56.21	<.001	.25	3>2>1	15.32	<.001	.04
Emotional Control	10.79 (2.93)	8.32 (2.48)	13.42 (2.27)	10.10 (2.08)	14.56 (2.55)	11.89 (2.68)	35.01	<.001	.17	3>1, 2>1	32.81	<.001	.09
Task Completion	13.08 (3.66)	10.86 (3.13)	16.17 (2.82)	12.60 (2.46)	16.39 (3.50)	16.94 (2.96)	35.01	<.001	.17	3>1, 2>1	7.99	.005	.02
Working Memory	14.67 (3.60)	12.22 (3.17)	17.75 (2.86)	14.60 (2.84)	18.61 (3.71)	18.33 (3.01)	40.13	<.001	.19	3>2>1	10.04	.002	.03
Plan/Organize	18.21 (4.03)	15.79 (3.83)	20.92 (3.37)	18.70 (2.21)	22.47 (4.05)	22.56 (4.29)	34.44	<.001	.17	3>2>1	4.39	.037	.01
BRI	22.36 (4.88)	19.67 (4.94)	25.92 (5.12)	21.40 (4.17)	28.39 (4.07)	25.65 (3.82)	25.90	<.001	.13	3>2>1	13.69	<.001	.04
ERI	24.80 (4.92)	20.20 (4.90)	30-50 (4.89)	24.90 (3.87)	33.56 (3.90)	29.00 (5.00)	60.25	<.001	.27	3>2>1	30.15	<.001	.08
CRI	45.92(10.41)	38.86 (9.42)	54.83 (8.40)	45.90 (5.57)	57.35(10.69)	57.83 (8.83)	42.18	<.001	.20	3>2>1	8.14	.005	.02
GEC	93.12 (18.23)	78.64 (18.10)	111.25 (16.46)	92.20 (12.75)	119.06 (15.66)	111.59 (15.65)	46.88	<.001	.22	3>2>1	16.93	<.001	.05

BRIEF2 domain	Groups based on RCADS-25 T-scores						Main effect of $RCADS_{total}$				Main effect of gender		
	Low-symptom group (T-Scores <65)		Subclinical group (T-Scores 65-69)		Clinical group (T-Scores ≥ 70)								
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*Tukey post-hoc*	*F*	*p*	*partial* η^2
Older adolescents (mean age 17)													
Inhibit	12.89 (3.13)	12.79 (2.93)	17.40 (4.83)	14.00 (2.16)	15.47 (2.80)	17.00 (4.47)	13.48	<.001	.10	3>1, 2>1	0.59	.443	.00
Self-Monitor	7.22 (1.96)	7.63 (1.84)	9.20 (2.17)	8.75 (1.89)	7.93 (2.71)	9.25 (2.76)	5.26	.006	.04	3>1, 2>1	0.61	.435	.00
Shift	13.69 (3.18)	13.14 (2.73)	15.60 (1.82)	15.75 (2.63)	14.73 (3.49)	16.38 (3.20)	6.31	.002	.05	3>1	0.24	.622	.00
Emotional Control	10.89 (2.63)	8.67 (1.87)	14.40 (4.51)	10.25 (2.22)	13.20 (2.37)	14.25 (2.82)	26.20	<.001	.18	3>1, 2>1	6.81	.010	.03
Task Completion	12.67 (3.57)	12.58 (3.34)	13.60 (3.51)	16.00 (0.82)	14.47 (4.17)	16.25 (2.66)	6.83	.001	.05	3>1	2.04	.154	.01
Working Memory	14.19 (3.46)	14.16 (2.98)	16.40 (3.91)	16.50 (1.73)	15.27 (4.33)	17.75 (3.28)	5.90	.003	.05	3>1	0.85	.357	.00
Plan/Organize	17.15 (4.07)	18.11 (3.78)	20.40 (5.59)	20.75 (1.89)	19.20 (4.14)	23.88 (4.02)	10.47	<.001	.08	3>1, 2>1	3.34	.069	.01
BRI	20.11 (4.52)	20.42 (4.42)	26.60 (6.99)	22.75 (3.50)	23.40 (5.04)	26.25 (6.92)	11.86	<.001	.09	3>1, 2>1	0.03	.857	.00
ERI	24.58 (5.04)	21.81 (3.79)	30.00 (6.04)	26.00 (1.41)	27.93 (5.12)	30.63 (4.03)	18.49	<.001	.13	3>1, 2>1	1.11	.293	.01
CRI	44.00 (10.12)	44.84 (9.18)	50.40 (12.22)	53.25 (2.22)	48.93 (10.89)	57.88 (8.32)	9.48	<.001	.07	3>1	2.46	.118	.01
GEC	88.65 (17.58)	87.07 (14.99)	107.0 (22.61)	102.00 (4.97)	100.27 (18.29)	114.75 (13.68)	15.57	<.001	.12	3>1, 2>1	0.33	.568	.00

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite. After Bonferroni correction: $p < .05/11 = .005$ (applied separately for each age group).

Table 4.

Means (SD) and Linear Mixed Model Results for Main Effects of Internalizing Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Teacher-Rated BRIEF2 Domains and Indices

BRIEF2 domain	Groups based on RCADS-25 T-scores						Main effect of $RCADS_{total}$		Main effect of gender	
	Low-symptom group (T-Scores <65)		Subclinical group (T-Scores 65-69)		Clinical group (T-Scores ≥ 70)					
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Younger adolescents (mean age 14)										
Inhibit	9.90 (3.55)	11.59 (4.31)	9.09 (1.87)	11.78 (5.26)	10.50 (4.81)	12.77 (5.05)	0.65	.523	13.30	<.001
Self-Monitor	6.45 (2.61)	7.58 (2.90)	5.55 (1.04)	7.33 (3.43)	7.10 (3.41)	8.08 (3.57)	0.93	.398	11.37	<.001
Shift	9.84 (3.36)	10.36 (3.21)	9.91 (1.51)	9.67 (1.66)	10.90 (4.96)	11.46 (4.82)	1.22	.298	1.26	.263
Emotional Control	9.35 (3.03)	9.58 (3.50)	9.27 (1.95)	9.22 (3.67)	10.20 (3.94)	9.46 (3.31)	0.14	.869	0.09	.762
Initiate	5.29 (2.13)	6.18 (2.33)	5.45 (2.66)	5.89 (2.57)	6.00 (3.02)	6.84 (2.76)	0.93	.396	8.97	.003
Working Memory	10.07 (3.83)	11.61 (4.11)	9.55 (3.30)	11.00 (4.15)	11.50 (4.81)	12.54 (4.79)	1.11	.332	9.07	.003
Plan/Organize	9.93 (3.22)	10.98 (3.60)	9.55 (2.91)	10.67 (3.00)	12.80 (4.59)	12.54 (4.14)	4.16	.017	4.89	.028
Task-Monitor	7.67 (2.67)	9.98 (3.36)	7.55 (3.47)	9.44 (4.64)	9.20 (3.43)	10.38 (3.73)	0.98	.375	31.03	<.001
Organization of Materials	5.86 (1.93)	6.61 (2.25)	5.73 (1.85)	7.11 (2.32)	6.70 (2.21)	7.54 (3.10)	1.77	.172	9.07	.003
BRI	16.35 (6,01)	19.17 (6.82)	14.64 (2.77)	19.11 (8.48)	17.60 (7.95)	20.85 (8.41)	0.79	.455	13.57	<.001
ERI	19.19 (6.16)	19.93 (6.29)	19.18 (2.82)	18.89 (4.46)	19.35 (6.13)	20.92 (7.87)	0.61	.544	0.58	.448
CRI	38.83 (12.93)	45.36 (14.24)	37.82 (13.59)	44.11 (15.02)	46.20 (17.25)	49.85 (17.18)	1.90	.152	13.30	<.001
GEC	74.37 (24.06)	84.46 (25.29)	71.64 (17.37)	82.11 (24.56)	84.90 (32.03)	91.62 (31.44)	1.41	.247	10.18	.002

BRIEF2 domain	Groups based on RCADS-25 T-scores						Main effect of $RCADS_{total}$		Main effect of gender	
	Low-symptom group (T-Scores <65)		Subclinical group (T-Scores 65-69)		Clinical group (T-Scores ≥ 70)					
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Older adolescents (mean age 17)										
Inhibit	8.87 (1.91)	9.28 (2.37)	11.00 (5.66)	9.00 (1.15)	8.13 (0.34)	9.30 (2.28)	1.47	.231	1.96	.163
Self-Monitor	5.50 (1.19)	5.70 (1.57)	6.60 (3.58)	5.00 (0.00)	5.13 (0.34)	6.25 (1.67)	0.23	.797	1.24	.267
Shift	8.94 (1.79)	8.49 (1.14)	9.60 (3.58)	8.00 (0.00)	8.20 (0.56)	8.13 (0.35)	1.55	.214	4.05	.045
Emotional Control	8.58 (1.43)	8.09 (0.48)	9.60 (3.05)	8.00 (0.48)	9.00 (2.14)	8.00 (0.00)	1.01	.367	9.62	.002
Initiate	4.84 (1.56)	4.63 (1.29)	5.40 (3.13)	4.50 (1.00)	4.53 (0.92)	4.25 (0.46)	0.68	.506	1.38	.241
Working Memory	9.19 (2.42)	8.96 (1.96)	11.20 (7.16)	9.50 (1.91)	9.07 (1.58)	9.13 (2.10)	1.37	.256	0.58	.447
Plan/Organize	9.38 (2.45)	9.28 (2.16)	11.00 (5.61)	9.75 (2.36)	9.20 (2.11)	9.00 (2.14)	1.02	.362	0.22	.638
Task-Monitor	7.11 (1.75)	7.63 (2.14)	8.00 (3.94)	7.25 (1.89)	6.53 (1.13)	7.75 (2.25)	0.48	.620	4.00	.047
Organization of Materials	5.32 (0.81)	5.21 (0.68)	5.80 (1.79)	5.25 (0.50)	5.00 (0.00)	5.38 (0.74)	1.03	.360	0.55	.460
BRI	14.37 (2.73)	14.98 (3.72)	17.60 (9.21)	14.00 (1.15)	13.27(0.59)	15.88 (3.72)	1.01	.367	1.96	.163
ERI	17.52 (2.90)	16.58 (1.19)	19.20 (6.61)	16.00 (0.00)	17.20 (2.37)	16.13 (0.35)	0.53	.588	8.07	.005
CRI	35.85 (8.34)	35.72 (7.35)	41.40 (21.59)	36.25 (7.09)	34.33 (4.93)	35.50 (7.33)	0.91	.404	0.03	.854
GEC	67.74 (12.58)	67.28 (11.10)	78.20 (37.36)	66.25 (8.10)	64.80 (5.95)	67.50 (11.05)	1.04	.354	0.13	.723

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

Effect sizes (partial η^2) are not reported for fixed effects in mixed linear models, as SPSS does not provide this statistic for nested data structures. After Bonferroni correction: $p < .05/13 = .004$ (applied separately for each age group).

Correlations between Academic Achievement, EF and Internalizing Symptoms

To reduce the number of analyses, and given that the results showed similar patterns for the BRIEF2 Global Executive Composite (GEC) and the separate BRIEF2 domains, as well as for total internalizing symptom severity and the anxiety and especially depression severity groups, we focused on BRIEF2 GEC scores and RCADS internalizing symptom total scores in the analyses examining how EF difficulties, self-reported NDDs, and internalizing symptoms individually and collectively relate to academic achievement among younger adolescents. Table 5 presents the correlations between academic achievement, self- and teacher-rated EF difficulties, NDD diagnoses, and internalizing symptoms for girls and boys.

Academic achievement demonstrated significant negative correlations with both self-reported EF difficulties (girls: r = -.23, boys: r = -.26, both p < .01) and teacher-reported EF difficulties (girls: r = -.51, boys: r = -.51, both p < .001). It also showed a moderate negative correlation with NDD diagnosis (girls: r = -.30, boys: r = -.26, both p < .01). In contrast, internalizing symptoms were weakly and nonsignificantly associated with academic achievement in both genders (girls: r = .06, boys: r = -.11).

Table 5.

Correlations Between Academic Achievement and Study Variables in Younger Adolescents (Girls: Below Diagonal, Boys: Above Diagonal)

Variable	1	2	3	4	5
Academic achievement	– –	-.26***	-.11	-.26***	-.51***
Self-reported NDD	-.30***	– –	.32***	.42***	.41***
Internalizing symptoms	.06	.43***	– –	.65***	.13
BRIEF2 GEC-SR	-.23**	.40***	.62***	– –	.23**
BRIEF2 GEC-TR	-.51***	.46***	.20*	.45***	– –

Note. ***p<.001, **p<.01, *p<.05.

BRIEF2 GEC-SR = Global Executive Composite, Self-Reported; BRIEF2 GEC-TR = Global Executive Composite, Teacher-Reported; Self-Reported NDD = Self-Reported Neurodevelopmental Diagnosis (1 = Yes, 0 = No).

Predicting Academic Achievement from EF controlling for NDD

Hierarchical regression analyses were conducted to examine the predictive value of self-reported and teacher-reported EF difficulties on academic achievement while controlling for self-reported NDD diagnosis (Table 6) and internalizing symptoms (Table 7).

The results indicate that adding NDD diagnosis to the models revealed notable gender differences in the relationship between EF and academic achievement. For girls, NDD diagnosis significantly predicted lower academic achievement (β = -.27, p < .01) and reduced the predictive power of self-reported EF from β = -.20, p = .05 to nonsignificance β = -.09, p = .15. For boys, NDD diagnosis had a marginally significant effect (β = -.14, p = .05) and slightly decreased the predictive strength of self-reported EF, which remained significant, reducing from β = -.30 to β = -.22, p < .05.

For teacher-reported EF, NDD diagnosis did not significantly predict academic achievement for either girls (β = -.14, p = n.s.) or boys (β = -.02, p = n.s.). However, teacher-reported EF difficulties emerged as the strongest predictor of academic achievement, explaining 24.3% of the variance for girls and 21.2% for boys (R^2 = .243 and .212, respectively). In contrast, self-reported EF difficulties explained 10% and 11.4% of the variance for girls and boys, respectively (R^2 = .100 and .114). These findings align with expectations and highlight the critical role of teacher-observed EF difficulties in predicting academic performance, outweighing the influence of both NDD diagnosis and self-reported EF difficulties.

Table 6.

Predicting Academic Achievement from Self-Reported and Teacher-Reported Executive Functioning, Controlling for Self-Reported NDD in Younger Adolescents

	Girls			Boys		
Predictor	B (SE)	β	R^2	B (SE)	β	R^2
Self-rated executive functioning						
Model 1			.040			.088
BRIEF2 GEC-SR	-0.04 (0.02)	-0.20*		-0.06 (0.02)	-0.30***	
Model 2			.100			.114
BRIEF2 GEC-SR	-0.02 (0.02)	-0.09		-0.04 (0.02)	-0.22*	
Self-Reported NDD	-2.79 (0.94)	-0.27**		-1.78 (0.84)	-0.18*	
Teacher-rated executive functioning						
Model 1			.243			.212
BRIEF2 GEC-TR	-0.07 (0.01)	-0.49***		-0.06 (0.01)	-0.46***	
Model 2			.259			.215
BRIEF2 GEC-TR	-0.06 (0.01)	-0.43***		-0.06 (0.01)	-0.43***	
Self-Reported NDD	-1.41 (0.94)	-0.14		-0.61 (0.93)	-0.06	

Note. ***p<.001, **p<.01, *p<.05, #p≤.10

BRIEF2 GEC-SR = Global Executive Composite, Self-Reported; BRIEF2 GEC-TR = Global Executive Composite, Teacher-Reported; Self-Reported NDD = Self-Reported Neurodevelopmental Diagnosis (1 = Yes, 0 = No).

Predicting Academic Achievement from EF controlling for Internalizing Symptoms

When controlling for internalizing symptoms, the results revealed an unexpected pattern for self-reported EF difficulties. Although internalizing symptoms were not significantly correlated with academic achievement for either girls or boys (Table 5), their inclusion in the regression models altered the predictive dynamics, particularly for girls, as detailed in Table 7.

For girls, self-reported EF difficulties had a significant negative association with academic achievement in Model 1 ($\beta = -.23$, $p < .001$). However, when internalizing symptoms were included in Model 2, the predictive strength of EF difficulties increased substantially ($\beta = -.43$, $p < .001$), while internalizing symptoms also became a significant positive predictor ($\beta = .32$, $p < .001$). The results suggest a compensatory effect, indicating that internalizing symptoms may amplify EF difficulties and, in turn, their impact on academic performance.

For boys, self-reported EF difficulties remained a strong predictor across both models, with a slight increase in predictive strength in Model 2 (Model 1: $\beta = -.26$; Model 2: $\beta = -.32$, both $p < .001$). The increase in predictive value for EF difficulties, coupled with a change of sign for internalizing symptoms, suggests a weak compensatory effect for boys. However, internalizing symptoms did not emerge as a significant predictor, indicating a lower compensatory effect compared to girls.

For teacher-reported EF difficulties, consistent and significant negative associations with academic achievement were observed for both genders across all models. For girls, teacher-reported EF difficulties remained the strongest predictor ($\beta = -.52$, $p < .001$), while for boys, the results were similarly robust ($\beta = -.51$, $p < .001$). Unlike self-reported EF, the inclusion of internalizing problems did not significantly alter the predictive power of teacher-reported EF for either gender. Internalizing symptoms failed to contribute significantly to the models for both girls and boys, underscoring the dominant role of teacher-observed EF difficulties in predicting academic outcomes.

Table 7.
Predicting Academic Achievement from Self-Reported and Teacher-Reported Executive Functioning, Controlling for Internalizing Problems in Younger Adolescents

	Girls			Boys		
Predictor	B (SE)	β	R^2	B (SE)	β	R^2
Self-rated executive functioning						
Model 1			.052			.068
BRIEF2 GEC-SR	-0.04 (0.01)	-0.23**		-0.05 (0.01)	-0.26***	
Model 2			.116			.072
BRIEF2 GEC-SR	-0.08 (0.02)	-0.43***		-0.06 (0.02)	-0.32***	
Internalizing problems	0.10 (0.03)	0.32***		0.03 (0.04)	0.09	
Teacher-rated executive functioning						
Model 1			.256			.264
BRIEF2 GEC-TR	-0.07 (0.01)	-0.51***		-0.07 (0.01)	-0.51***	
Model 2			.263			.268
BRIEF2 GEC-TR	-0.08 (0.01)	-0.52***		-0.07 (0.01)	-0.51***	
Internalizing problems	0.03 (0.02)	0.09		-0.02 (0.03)	-0.06	

Note. ***p<.001, **p<.01, *p<.05;

BRIEF2 GEC-SR = Global Executive Composite, Self-Reported; BRIEF2 GEC-TR = Global Executive

Discussion

The present study explored behavioral EF among adolescents, focusing on its relationship with self-reported NDDs, internalizing symptoms, and academic achievement. Using a multi-informant approach that included self-reports and teacher ratings via the BRIEF2 (Gioia et al., 2015), the study examined two distinct age groups: younger adolescents (mean age 14) and older adolescents (mean age 17). Due to the structure of the Swedish educational system, these groups represent not only different developmental stages but also different educational contexts, as middle school is compulsory while high school attendance is voluntary. The study aimed to clarify three key areas: (1) differences in self- and teacher-reported behavioral EF ratings between adolescents with and without self-reported NDDs, (2) differences in self- and teacher-reported behavioral EF ratings across levels of internalizing symptoms (low, subclinical, and clinical) as measured by the RCADS (Chorpita et al., 2000), and (3) the predictive value of self- and teacher-rated EF for academic achievement among younger adolescents, while controlling for NDD diagnosis and internalizing symptoms. Additionally, gender was considered as a factor across all analyses to provide a more nuanced understanding of these relationships.

EF Difficulties in Adolescents with Self-Reported NDDs

In line with expectations and prior research on the BRIEF (e.g., Skogli et al., 2013;; Huizinga et al., 2023; Jacobson et al., 2020; Lace et al., 2022; Parhoon et al., 2022; Hamilton et al., 2024), adolescents with self-reported NDDs exhibited significantly greater EF difficulties compared to peers without NDDs. This pattern was evident in both self-reported and teacher-rated EF measures, although adolescents generally rated their EF difficulties as milder than teachers did. This child–teacher rating discrepancy, consistent with prior studies (Kenworthy et al., 2022; Krieger et al., 2019; De Los Reyes & Kazdin, 2005), likely reflects differences in perspective: teachers observe EF-related difficulties in structured academic settings, where organizational demands and task management are directly observable, whereas adolescents may underreport or interpret their difficulties differently. Self-reported EF may also be influenced by adolescents' self-awareness, emotional state, or a tendency to minimize difficulties due to social desirability or limited insight. For example, a teacher might note consistent problems with task initiation and completion in the classroom, while the adolescent perceives these challenges as occasional or attributes them to external factors such as boredom rather than underlying EF impairments. Furthermore, the differences observed in teacher ratings were less pronounced than those typically found in clinical samples, where teacher or parent ratings are often collected as part of the diagnostic process for NDD. This may reflect a shift in focus or a reduced level of EF difficulties due to

received support, particularly among those with milder EF difficulties within the NDD group.

The most significant EF difficulties among younger adolescents were observed in domains such as shift, working memory, and plan/organize, aligning with parent-rated EF studies comparing adolescents with NDD to community controls (Hamilton et al., 2024). These domains may be particularly vulnerable to the impacts of NDDs during early adolescence, a critical developmental stage characterized by rapid cognitive and emotional growth (Hunter et al., 2012). Interestingly, as expected, girls reported more EF difficulties compared to boys in the younger age group. However, unexpectedly, fewer significant gender differences with lower effect sizes were observed in teacher-rated EF. This is surprising especially for younger adolescents, as teachers typically have more frequent and closer interactions with younger students during regular instruction, providing ample opportunities to observe EF difficulties. The discrepancy between self-reports and teacher ratings may highlight differences in how EF challenges are expressed in school environments versus personal experiences, or it could reflect varying perceptions of EF behaviors based on context.

In contrast, among older adolescents, EF differences—particularly in teacher ratings—were less pronounced. This may reflect greater homogeneity in EF abilities at the high school level. By this stage, students who are higher functioning, experience only mild EF difficulties, or have received early support or training are more likely to remain enrolled, resulting in a more uniform sample in terms of EF capabilities, regardless of gender. The structure of Swedish high schools—being non-compulsory and often requiring high entrance grades—likely contributes to this pattern. Adolescents with more severe EF deficits may be less likely to meet these requirements, particularly in selective admission schools such as the one included in this study. This may introduce a sampling bias, potentially underrepresenting students with significant EF challenges.

This sampling bias may also help explain the minimal gender differences observed among older adolescents. Additionally, the reduction in gender differences at this stage may reflect developmental maturation, leading to a narrowing of gender-related EF disparities as adolescents age. Research indicates that while some studies find no significant gender differences in EF development, others suggest that distinct components of EF are influenced by maturational status differently in boys and girls (Laureys et al., 2021).

EF Difficulties in Adolescents with Internalizing Symptoms

Distinct patterns emerged when examining the relationship between EF ratings and internalizing symptom severity levels (low, subclinical, clinical) among adolescents without NDD. Adolescents with clinical levels of internalizing symptoms reported

significantly greater EF difficulties in their self-ratings compared to both subclinical and low-symptom groups, whereas teachers reported minimal differences between groups. These findings are consistent with research suggesting that EF challenges associated with internalizing symptoms are often subjectively experienced and less observable in structured settings (Hankin et al., 2016).

Internalizing symptoms, such as anxiety and depression, are often characterized by cognitive patterns such as worry, rumination, and attentional biases toward negative information. These symptoms may disproportionately affect adolescents' perceptions of their EF abilities, leading to heightened self-reported difficulties (Eysenck & Derakshan, 2011). Self-reported EF problems in non-clinical samples have also been associated with traits like neuroticism and low conscientiousness, while showing limited correlation with performance-based EF measures (Buchanan, 2016). Teachers, in contrast, may find it harder to detect EF difficulties in adolescents with internalizing symptoms, as these do not always manifest as overt behaviors, particularly in structured environments that prioritize task compliance and routine adherence (Muris et al., 2007).

Gender differences in EF ratings among adolescents with varying levels of internalizing symptoms were more pronounced in younger adolescents, even when those with NDD were excluded. Younger girls consistently reported greater EF difficulties than boys. However, among older adolescents, gender differences narrowed, though girls continued to report higher scores in emotional control problems on both self-reports and teacher ratings. In other EF domains, differences between genders among older adolescents were minimal. This reduction in gender disparities among older adolescents, similar to the findings when NDD was included, may reflect developmental shifts, such as improvements in self-regulation with age (Best & Miller, 2010) or the adoption of more effective coping strategies (Zimmermann & Iwanski, 2014). Environmental changes, such as increased autonomy and flexibility in older adolescents' educational settings, may also mitigate observable EF differences. Furthermore, older students may adapt more effectively to their environments over time, employing strategies to mask or compensate for EF difficulties, thereby making these challenges less apparent to teachers (Gioia et al., 2015).

EF Difficulties and Academic Achievement

As expected, both self-reported and teacher-reported EF difficulties were significantly associated with academic achievement, with teacher-reported ratings emerging as the strongest predictor. This finding aligns with previous research highlighting the critical role of teacher observations in identifying EF deficits that influence academic performance (Samuels et al., 2016; Nunez et al., 2024). Teachers may provide more accurate assessments of EF difficulties due to their observation of students in structured, goal-oriented settings, where issues like

attention, organization, and task completion are more evident. As they also assign grades, their evaluations naturally align closely with academic outcomes, reinforcing the predictive value of teacher-reported EF ratings.

However, when accounting for NDD diagnoses and internalizing problems, distinct gender-specific patterns emerged in the relationship between self-reported EF difficulties and academic achievement. While students' self-reported NDD provided minimal additional explanatory power for academic outcomes beyond teacher-assessed EF, a different dynamic was observed with self-reported EF difficulties. Among girls, self-reported EF difficulties were initially associated with lower academic achievement (Model 1), but this association became non-significant once NDD was added to the model. Instead, self-reported NDD significantly predicted lower academic achievement and accounted for additional explained variance. This may reflect the subtler and more internalised nature of EF challenges often experienced by girls with NDDs, such as difficulties with inattention and working memory (Rucklidge, 2010; Gershon, 2002). Because such difficulties are less observable in classroom settings, they may be underrecognised by external informants and therefore better captured by self-reports. The finding that NDD contributes unique explanatory value among girls underscores the importance of identifying internalised EF difficulties, which may negatively affect academic outcomes while remaining largely invisible in traditional observational assessments. Moreover, girls often develop compensatory strategies (e.g., increased effort and organisation) to mask these challenges (Lai et al., 2015; Mandy et al., 2012). Although such strategies may reduce the observable impact of NDDs in teacher-reported evaluations, the academic consequences are still evident in self-reports and actual outcomes.

For boys, self-reported EF difficulties remained significant predictors of academic performance, even when accounting for an NDD diagnosis. This difference may be explained by the more externalized and disruptive nature of EF difficulties in boys, such as hyperactivity and impulsivity (Gaub & Carlson, 1997; Martel, 2013), which are more readily observable and have a direct impact on structured academic tasks. Boys with NDDs may also face distinct struggles in behavioral regulation and adaptability within classroom environments (Hill, 2004; Van Eylen et al., 2011), further amplifying the effect of their diagnosis on academic outcomes. Additionally, differences in how NDDs are identified and perceived between genders may play a role in these variations, with boys' overt symptoms more likely to be recognized and addressed compared to the subtler presentations often seen in girls (Skogli et al., 2013; Dai, 2019).

An unexpected gender pattern emerged in predicting school achievement from self-reported EF when internalizing symptoms were taken into account. Although internalizing symptoms showed minimal and nonsignificant correlations with school achievement for both genders—contrasting with some prior studies that have linked internalizing symptoms to diminished academic performance, particularly in

tasks requiring sustained cognitive effort (e.g., Owens et al., 2012; McLeod & Fettes, 2007)—their inclusion in the regression analysis revealed nuanced, gender-specific patterns. Among girls, the inclusion of internalizing symptoms in the regression model significantly enhanced the predictive strength of EF difficulties, while internalizing symptoms themselves emerged as significant positive predictors. This unexpected suppression effect suggests that internalizing symptoms, rather than simply impairing academic performance, may paradoxically contribute to better outcomes by amplifying the predictive power of EF difficulties. Specifically, girls with elevated internalizing symptoms may engage in compensatory strategies, such as increased effort and heightened academic focus, to meet school demands. This dual contribution highlights the complex interplay between internalizing symptoms and EF in shaping academic outcomes, where internalizing symptoms may either mitigate or exacerbate the impact of EF difficulties. Furthermore, the self-critical nature of internalizing symptoms may enhance academic performance through perfectionistic tendencies, heightened concern about failure, and increased effort. These findings align with prior research suggesting that, while internalizing symptoms can present challenges, they may also drive greater academic engagement, particularly in girls (Roeser et al., 1998; Plamondon et al., 2019). However, such compensatory strategies may come at a long-term emotional cost, potentially leading to burnout, increased stress, or reduced well-being without appropriate support mechanisms (Owens et al., 2012).

In contrast, for boys, self-reported EF difficulties were strong predictors of academic achievement, with only a slight increase in predictive strength when internalizing symptoms were included. Unlike in girls, internalizing symptoms did not emerge as significant predictors, suggesting that boys may rely less on compensatory strategies linked to internalizing symptoms. Instead, boys' EF difficulties, particularly externalized behaviors like impulsivity and hyperactivity, may have a more direct and observable impact on academic performance (Gaub & Carlson, 1997; Martel, 2013). These findings underscore gendered differences in the interaction between EF difficulties and internalizing symptoms, with boys' challenges often being more overt and directly disruptive in structured academic settings.

Unlike self-reported EF, teacher-reported EF difficulties remained unaffected by the inclusion of internalizing symptoms, emphasizing the dominant role of observable EF impairments. This finding highlights the ecological validity of teacher observations in structured settings, where behaviors such as disorganization, inattention, and poor task management are directly linked to academic outcomes (Toplak et al., 2013; Barkley, 2012).

Our results, in conjunction with evidence of gender differences in referral processes for NDD assessments (Klefsjö et al., 2021), underscore the importance of incorporating multiple perspectives when evaluating EF in adolescents with varying levels of internalizing symptoms (De Los Reyes, 2016). Research further supports

the need for multi-informant assessments, as internalizing symptoms can subtly impact EF domains such as working memory, planning, and inhibitory control, which may not always manifest in observable deficits but significantly influence adolescents' self-perception and daily functioning (Snyder et al., 2015).

Strengths and Limitations

This study has several notable strengths. By including both self- and teacher-reported EF ratings, it provides a comprehensive perspective that captures both adolescents' internalized experiences and teachers' observations of behavior in structured settings. The high response rate and relatively large sample size—spanning both younger and older adolescents—enhance the generalizability of the findings and enable meaningful age-specific analyses, which can inform more targeted interventions and support strategies. Together, these strengths underscore the study's contributions to research on adolescent EF and to educational practice.

Nevertheless, several limitations should be acknowledged. One limitation concerns the reliance on self-reported NDD diagnoses, rather than medically verified records, which may have introduced some degree of misclassification. Although many participants specified their diagnosis type, thereby strengthening plausibility, the risk of inaccurate or incomplete reporting cannot be ruled out. This was largely unavoidable given the school-based design and the lack of access or ethical approval to use medical records. Furthermore, the absence of a dimensional measure of externalizing symptoms represents a missed opportunity for validation. Including a standardized instrument such as the Conners-3 Self-Report Form could have provided complementary information on attention, hyperactivity, and behavioral regulation, thereby strengthening the assessment of NDD-related difficulties and improving the validity of self-reported diagnoses.

Another limitation relates to sample size. The relatively small number of adolescents reporting an NDD, as well as those in the subclinical and clinical internalizing symptom groups, likely reduced statistical power and may have limited the detection of more subtle effects. This also precluded examination of potential interaction effects between EF and NDD or internalizing problems in relation to academic achievement. Furthermore, the use of subclinical and clinical internalizing symptom groups, rather than a continuous approach, may have obscured meaningful variation within groups. We chose this categorical approach to parallel clinically defined groups for NDD diagnoses, with a focus on the most severe internalizing profiles. However, future studies would benefit from combining categorical and continuous methods to provide a more nuanced understanding of the associations between internalizing symptoms and EF difficulties.

A further limitation is that data for older adolescents were collected from a single large school, raising the possibility of selection bias. While the high response rate

and the inclusion of students from diverse educational programs mitigate this concern to some extent, the findings may not fully represent the broader population of older adolescents. Moreover, the absence of academic achievement data for this age group constrained conclusions regarding the suppression effect. Future research should include more diverse educational contexts and adopt longitudinal designs to examine how EF difficulties evolve across adolescence and how suppression effects may vary by age. Another sampling-related limitation concerns the small number of teachers who provided ratings. This restricted the variability in teacher perspectives and may have introduced bias related to individual rating styles. Larger and more diverse teacher samples are needed in future studies to increase the robustness of teacher-report findings and to allow for more reliable generalization across educational contexts.

Finally, the stronger associations observed between self-reported EF and internalizing symptoms, compared with teacher-reported EF, may partly reflect shared method variance, which future studies should address through multi-method approaches.

Implications

This study underscores the overlooked role of internalizing symptoms in adolescent EF and the importance of using both self- and teacher-reported EF assessments in schools. While teacher ratings effectively capture observable EF difficulties typically associated with NDDs, they may not fully reflect challenges related to internalizing symptoms, such as anxiety and depression. This raises concerns about whether teachers are sufficiently equipped to identify EF deficits in adolescents struggling with internalized issues. Given that teacher-rated EF was the strongest predictor of academic achievement, schools should integrate EF assessments into routine evaluations and provide targeted training for educators to better recognize both externalized and internalized EF difficulties.

The findings suggest that teachers may be more adept at identifying EF deficits in boys, whose challenges tend to manifest outwardly, whereas girls, who often compensate for EF difficulties through increased effort, may be overlooked. This highlights the need for gender-sensitive interventions that address both emotional and behavioral EF struggles. Schools should adopt a multi-informant approach that combines teacher observations with self-reports to ensure that internalized EF difficulties do not go unnoticed.

Further research is warranted to determine whether internalizing symptoms influence self-reported EF difficulties and academic outcomes in older adolescents, as our findings were limited to younger adolescents. Schools should incorporate EF assessments into academic evaluations to enhance early intervention efforts and

develop more inclusive support strategies that address both academic performance and emotional well-being.

Conclusions

This study explored the relationship between self- and teacher-reported EF ratings, self-reported NDDs, internalizing symptoms, and academic achievement in adolescents, emphasizing the often-overlooked role of internalizing symptoms in behavioral EF.

The findings revealed that while teacher- and self-rated EF were rather similarly linked to self-reported NDDs, different patterns emerged for internalizing symptoms. Unlike the minimal association observed in teacher ratings, self-reports strongly linked EF struggles to internalizing symptoms, suggesting that students with these challenges may not always display behaviors that teachers can easily recognize. This discrepancy highlights a gap in teacher awareness and training, emphasizing the need for improved strategies to identify EF difficulties beyond those associated with externalized behaviors.

A notable suppression effect in girls further illustrated how internalizing symptoms might drive compensatory efforts, temporarily masking EF difficulties in academic performance. This raises important questions about the long-term emotional cost of such compensatory strategies and the need for gender-sensitive interventions.

By integrating teacher and self-reports, schools can gain a more comprehensive understanding of EF challenges in adolescents. The findings highlight the importance of equipping teachers with better tools to identify EF difficulties linked to internalizing symptoms and ensuring that intervention strategies address both the academic and emotional needs of students.

References

Achenbach, T. M., McConaughy, S. H., & Howell, C. T. (1987). Child/adolescent behavioral and emotional problems: implications of cross-informant correlations for situational specificity. *Psychological Bulletin, 101*(2), 213–232.

Anderson, V., Jacobs, R., & Anderson, P.J. (Eds.). (2008). *Executive functions and the frontal lobes: A lifespan perspective (1st ed.). Psychology Press.*

Barkley, R. A., & Murphy, K. R. (2011). The nature of executive function (EF) deficits in daily life activities in adults with ADHD and their relationship to performance on EF tests. *Journal of Psychopathology and Behavioral Assessment, 33*(2), 137–158. https://doi.org/10.1007/s10862-011-9217-x

Ciuhan, G. C., & Iliescu, D. (2021). Depression and learning problems in children: Executive function impairments and inattention as mediators. *Acta Psychologica*, *220*, 103420. https://doi.org/10.1016/j.actpsy.2021.103420

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development, 81*(6), 1641–1660. https://doi.org/10.1111/j.1467-8624.2010.01499.x

Best, J. R., Miller, P. H., & Naglieri, J. A. (2011). Relations between executive function and academic achievement from ages 5 to 17 in a large, representative national sample. *Learning and Individual Differences, 21*(4), 327–336. https://doi.org/10.1016/j.lindif.2011.01.007

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., Morgan, C. L., & Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Cconsulting and Clinical Psychology, 72*(5), 757–766. https://doi.org/10.1037/0022-006X.72.5.757

Birtwistle, E., Chernikova, O., Wünsch, M., & Niklas, F. (2025). Training of Executive Functions in Children: A meta-analysis of cognitive training interventions. *SAGE Open*, *15*(1). https://doi.org/10.1177/21582440241311060

Blair, C., & Raver, C. C. (2015). School readiness and self-regulation: a developmental psychobiological approach. *Annual Review of Psychology, 66*, 711–731. https://doi.org/10.1146/annurev-psych-010814-015221

Bodnar, L. E., Prahme, M. C., Cutting, L. E., Denckla, M. B., & Mahone, E. M. (2007). Construct validity of parent ratings of inhibitory control. *Child Neuropsychology, 13*(4), 345-362. https://doi.org/10.1080/09297040600899867

Buchanan, T. (2016). Self-report measures of executive function problems correlate with personality, not performance-based executive function measures, in nonclinical samples. *Psychological Assessment, 28*(4), 372–385. https://doi.org/10.1037/pas0000192

Carlander, A., Cassel, S., J-Son Höök, M., Lundgren, O., & Löf, M. (2024). Validation and normative data on the Revised Child Anxiety and Depression Scale RCADS-25 in a Swedish national probability sample of children and adolescents aged 4–17 years. *International Journal of Methods in Psychiatric Research, 33*(1), e2007. https://doi.org/10.1002/mpr.2007

Ceruti, C., Mingozzi, A., Scionti, N., & Marzocchi, G. M. (2024). Comparing Executive Functions in Children and Adolescents with Autism and ADHD—A Systematic Review and Meta-Analysis. *Children, 11*(4), 473. https://doi.org/10.3390/children11040473

Ciuhan, G. C., & Iliescu, D. (2021). Depression and learning problems in children: Executive function impairments and inattention as mediators. *Acta Psychologica, 220*, 103420. https://doi.org/10.1016/j.actpsy.2021.103420.

Chorpita, B. F., Yim, L., Moffitt, C., Umemoto, L. A., & Francis, S. E. (2000). Assessment of symptoms of DSM-IV anxiety and depression in children: a revised child anxiety and depression scale. *Behaviour Research and Therapy, 38*(8), 835–855. https://doi.org/10.1016/s0005-7967(99)0 0130-8

Colomer, J., Pallisera, M., Fullana, J., Burriel, M.P., & Fernández, R. (2013). Reflective learning in higher education: A comparative analysis. *Procedia – Social and Behavioral Sciences*, 93, 364–370.

Cornblath, E. J., Tang, E., Baum, G. L., Moore, T. M., Adebimpe, A., Roalf, D. R., Gur, R. C., Gur, R. E., Pasqualetti, F., Satterthwaite, T. D., & Bassett, D. S. (2019). Sex differences in network controllability as a predictor of executive function in youth. *NeuroImage, 188,* 122–134. https://doi.org/10.1016/j.neuroimage.2018.11.048.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., & Angold, A. (2003). Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60*(8), 837–844. https://doi.org/10.1001/archpsyc.60.8.837

Dai, M., Lin, L., Liang, J., Wang, Z., & Jing, J. (2019). Gender difference in the association between executive function and autistic traits in typically developing children. *Journal of Autism and Developmental Disorders, 49*(3), 1182–1192. https://doi.org/10.1007/s10803-018-3813-5.

De Los Reyes, A., Augenstein, T. M., Wang, M., Thomas, S. A., Drabick, D. A. G., Burgers, D. E., & Rabinowitz, J. (2015). The validity of the multi-informant approach to assessing child and adolescent mental health. *Psychological Bulletin, 141*(4), 858–900. https://doi.org/10.1037/a0038498

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., Hickie, I., & Guastella, A. J. (2018). Autism spectrum disorders: a meta-analysis of executive function. *Molecular psychiatry, 23*(5), 1198–1204. https://doi.org/10.1038/mp.2017.75

Diamond A., (2013). Executive functions. *Annual Review of Psychology, 64*, 135–168. https://doi.org/10.1146/annurev-psych-113011-143750

Diamond, A., & Ling, D. S. (2016). Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental Cognitive Neuroscience, 18*, 34–48. https://doi.org/10.1016/j.dcn.2015.11.005

Ebesutani, C., Reise, S. P., Chorpita, B. F., Ale, C., Regan, J., Young, J., Higa-McMillan, C., & Weisz, J. R. (2012). The Revised Child Anxiety and Depression Scale-Short Version: scale reduction via exploratory bifactor modeling of the broad anxiety factor. *Psychological Assessment, 24*(4), 833–845. https://doi.org/10.1037/a0027283

Egan, K. N., Cohen, L. A., & Limbers, C. (2019). Parent-child agreement on the Behavior Rating Inventory of Executive Functioning (BRIEF) in a community sample of adolescents. *Applied Neuropsychology. Child, 8*(3), 264–271. https://doi.org/10.1080/21622965.2018.1438896

Eysenck, M. W., & Derakshan, N. (2011). New perspectives in attentional control theory. *Personality and Individual Differences, 50*(7), 955–960. https://doi.org/10.1016/j.paid.2010.08.019

Francés, L., Quintero, J., Fernández, A., Ruiz, A., Caules, J., Fillon, G., Hervás, A., & Soler, C. V. (2022). Current state of knowledge on the prevalence of neurodevelopmental disorders in childhood according to the DSM-5: a systematic review in accordance with the PRISMA criteria. *Child and Adolescent Psychiatry and Mental Health, 16*(1), 27. https://doi.org/10.1186/s13034-022-00462-1.

Frazier, T. W., Demaree, H. A., & Youngstrom, E. A. (2004). Meta-analysis of intellectual and neuropsychological test performance in attention-deficit/hyperactivity disorder. *Neuropsychology, 18*(3), 543–555. https://doi.org/10.1037/0894-4105.18.3.543.

Gentil-Gutiérrez, A., Santamaría-Peláez, M., Mínguez-Mínguez, L. A., Fernández-Solana, J., González-Bernal, J. J., González-Santos, J., & Obregón-Cuesta, A. I. (2022). Executive Functions in Children and Adolescents with Autism Spectrum Disorder in Family and School Environment. International journal of environmental research and public health, 19(13), 7834. https://doi.org/10.3390/ijerph19137834.

Geurts, H. M., Verté, S., Oosterlaan, J., Roeyers, H., & Sergeant, J. A. (2004). How specific are executive functioning deficits in attention deficit hyperactivity disorder and autism? *Journal of Child Psychology and Psychiatry,* 45(4), 836–854. https://doi.org/10.1111/j.1469-7610.2004.00276.x

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2015). BRIEF2: Behavior Rating Inventory of Executive Function (2nd ed.). Psychological Assessment Resources.

Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology*, 8(4), 241–248. https://doi.org/10.1076/chin.8.4.241.13504

Hamilton, A., Tallberg, P., Ilahi, F., Hoff, E., Ahmadi, B., & Daukantaitė, D. (2025). Behavioral manifestations of executive functioning in Swedish youth with ADHD, autism, and psychiatric comorbidity: a comparative analysis with community controls. Child Neuropsychology, 31(5), 771-790. https://doi.org/10.1080/09297049.2024.2434736

Hankin, B. L., Snyder, H. R., Gulley, L. D., Schweizer, T. H., Bijttebier, P., Nelis, S., Toh, G., & Vasey, M. W. (2016). Understanding comorbidity among internalizing problems: Integrating latent structural models of psychopathology and risk mechanisms. Development and psychopathology, 28(4pt1), 987–1012. https://doi.org/10.1017/S0954579416000663

Holler, K., Kavanaugh, B., & Cook, N. E. (2014). Executive functioning in adolescent depressive disorders. Journal of Child and Family *Studies, 23*(8), 1315–1324. https://doi.org/10.1007/s10826-013-9789-z

Holmes, J., Hilton, K. A., Place, M., Alloway, T. P., Elliott, J. G., & Gathercole, S. E. (2014). Children with low working memory and children with ADHD: same or different? Frontiers in human neuroscience, 8, 976. https://doi.org/10.3389/fnhum.2014.00976.

Hovik, K. T., Egeland, J., Isquith, P. K., Gioia, G., Skogli, E. W., Andersen, P. N., & Øie, M. (2017). Distinct Patterns of Everyday Executive Function Problems Distinguish Children With Tourette Syndrome From Children With ADHD or Autism Spectrum Disorders. Journal of attention disorders, 21(10), 811–823.

Huizinga, M., Smidts, D. P., & Baeyens, D. (2023). The Dutch version of the behavior rating inventory of Executive function-2 (BRIEF2). *Psychological Test Adaptation and Development, 4* (1), 97–115. https://doi.org/10.1027/2698-1866/a000038

Hummer, T. A., Kronenberger, W. G., Wang, Y., Dunn, D. W., Mosier, K. M., Kalnin, A. J., & Mathews, V. P. (2011). Executive functioning characteristics associated with ADHD comorbidity in adolescents with disruptive behavior disorders. Journal of abnormal child psychology, 39(1), 11–19. https://doi.org/10.1007/s10802-010-9449-3.

Hunter, S. J., Edidin, J. P., & Hinkle, C. D. (2012). The developmental neuropsychology of executive functions. In S. J. Hunter & E. P. Sparrow (Eds.), *Executive function and dysfunction: Identification, assessment and treatment* (pp. 17–36). Cambridge University Press.

Jacob, R., Watts, T. W., & von Suchodoletz, A. (2022). Editorial: The Potential of School-Based Interventions That Target Executive Function. Frontiers in psychology, 13, 831745. https://doi.org/10.3389/fpsyg.2022.831745

Jacobson, L. A., Pritchard, A. E., Koriakin, T. A., Jones, K. E., & Mahone, E. M. (2020). Initial Examination of the BRIEF2 in Clinically Referred Children With and Without ADHD Symptoms. Journal of attention disorders, 24(12), 1775–1784. https://doi.org/10.1177/1087054716663632.

Jangmo, A., Stålhandske, A., Chang, Z., Chen, Q., Almqvist, C., Feldman, I., Bulik, C. M., Lichtenstein, P., D'Onofrio, B., Kuja-Halkola, R., & Larsson, H. (2019). Attention-Deficit/Hyperactivity Disorder, School Performance, and Effect of Medication. Journal of the American Academy of Child and Adolescent Psychiatry, 58(4), 423–432.

Kenworthy, L., Verbalis, A., Bascom, J., daVanport, S., Strang, J. F., Pugliese, C., Freeman, A., Jeppsen, C., Armour, A. C., Jost, G., Hardy, K., & Wallace, G. L. (2022). Adding the missing voice: How self-report of autistic youth self-report on an executive functioning rating scale compares to parent report and that of youth with attention deficit hyperactivity disorder or neurotypical development. Autism : the international journal of research and practice, 26(2), 422–433. https://doi.org/10.1177/13623613211029117

Krieger, V., Amador-Campos, J. A., & Peró-Cebollero, M. (2019). Interrater agreement on behavioral executive function measures in adolescents with Attention Deficit Hyperactivity Disorder. International journal of clinical and health psychology : IJCHP, 19(2), 141–149. https://doi.org/10.1016/j.ijchp.2019.02.007

Lace, J. W., Seitz, D. J., Austin, T. A., Kennedy, E. E., Ferguson, B. J., & Mohrland, M. D. (2021). The dimensionality of the Behavior Rating Inventory of Executive Function, Second Edition in a clinical sample. Applied Neuropsychology: Child, 11(4), 579–590. https://doi.org/10.1080/21622965.2021.1910950

Lai, M. C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: a systematic review and meta-analysis. *The Lancet. Psychiatry*, *6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Laureys, F., Middelbos, L., Rommers, N., De Waelle, S., Coppens, E., Mostaert, M., Deconinck, F. J. A., & Lenoir, M. (2021). The effects of age, biological maturation and sex on the development of executive functions in adolescents. *Frontiers in Physiology*, 12, Article 703312. https://doi.org/10.3389/fphys.2021.703312

Lyall, K., Croen, L., Daniels, J., Fallin, M. D., Ladd-Acosta, C., Lee, B. K., Park, B. Y., Snyder, N. W., Schendel, D., Volk, H., & Windham, G. C. (2017). The changing epidemiology of autism spectrum disorders. *Annual Review of Public Health, 38*, 81–102. https://doi.org/10.1146/annurev-publhealth-031816-044318

Mahone, E. M., Cirino, P. T., Cutting, L. E., Cerrone, P. M., Hagelthorn, K. M., Hiemenz, J. R., Singer, H. S., & Denckla, M. B. (2002). Validity of the behavior rating inventory of executive function in children with ADHD and/or Tourette syndrome. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists, 17*(7), 643–662. https://doi.org/10.1016/S0887-6177(01)00168-8

Mandy, W., Chilvers, R., Chowdhury, U., Salter, G., Seigal, A., & Skuse, D. (2012). Sex differences in autism spectrum disorder: evidence from a large sample of children and adolescents. Journal of autism and developmental disorders, 42(7), 1304–1313. https://doi.org/10.1007/s10803-011-1356-0

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function?. *Journal of the International Neuropsychological Society, 16*(3), 495–505 .https://doi.org/10.1017/S1355617710000093

McCandless, S., & O'Laughlin, L. (2007). The Clinical Utility of the Behavior Rating Inventory of Executive Function (BRIEF) in the diagnosis of ADHD. *Journal of Attention Disorders, 10(*4), 381–389. https://doi.org/10.1177/1087054706292115

McCloskey, G., Perkins, L.A., & Van Diviner, B. (2008). *Assessment and Intervention for Executive Function Difficulties (1st ed.). Routledge.* https://doi.org/10.4324/9780203893753.

McLeod, J. D., & Fettes, D. L. (2007). Trajectories of Failure: The Educational Careers of Children with Mental Health Problems. *American journal of Sociology, 113*(3), 653–701. https://doi.org/10.1086/521849

McNeilly, E. A., & Wang, M. T. (2021). Executive function as a mechanism linking socioeconomic status to internalizing and externalizing psychopathology in children and adolescents. Developmental Science, 24(1), e13011.

McTeague, L. M., Goodkind, M. S., & Etkin, A. (2016). Transdiagnostic impairment of cognitive control in mental illness. Journal of psychiatric research, 83, 37–46. https://doi.org/10.1016/j.jpsychires.2016.08.001

Merikangas, K. R., He, J. P., Burstein, M., Swanson, S. A., Avenevoli, S., Cui, L., Benjet, C., Georgiades, K., & Swendsen, J. (2010). Lifetime prevalence of mental disorders in U.S. adolescents: results from the National Comorbidity Survey Replication--Adolescent Supplement (NCS-A). Journal of the American Academy of Child and Adolescent Psychiatry, 49(10), 980–989. https://doi.org/10.1016/j.jaac.2010.05.017.

Mowlem, F., Agnew-Blais, J., Taylor, E., & Asherson, P. (2019). Do different factors influence whether girls versus boys meet ADHD diagnostic criteria? Sex differences among children with high ADHD symptoms. Psychiatry research, 272, 765-773.

Muris, P., Meesters, C., & Blijlevens, P. (2007). Self-reported reactive and regulative temperament in early adolescence: Relations to internalizing and externalizing problem behavior and "Big Three" personality factors. Journal of Adolescence, 30(6), 1035–1049. https://doi.org/10.1016/j.adolescence.2007.03.003

Núnez, J.M.; Soto-Rubio, A.; Pérez-Marín, M. Executive Functions and Special Educational Needs and Their Relationship with School-Age Learning Difficulties. Children 2024, 11, 1398. https://doi.org/10.3390/ children11111398

Orbach, L., Herzog, M., & Fritz, A. (2020). Relation of attention deficit hyperactivity disorder (ADHD) to basic number skills and arithmetic fact retrieval in children. Research in Developmental Disabilities, 103, Article 103697. https://doi.org/10.1016/j.ridd.2020.103697

Owens, M., Stevenson, J., Hadwin, J. A., & Norgate, R. (2012). Anxiety and depression in academic performance: An exploration of the mediating factors of worry and working memory. *School Psychology International, 33*(4), 433-449. https://doi.org/10.1177/0143034311427433

Parhoon, K., Moradi, A., Alizadeh, H., Parhoon, H., Sadaphal, D. P., & Coolidge, F. L. (2022). Psychometric properties of the behavior rating inventory of executive function, second edition (BRIEF2) in a sample of children with ADHD in Iran. *Child Neuropsychology, 28*(4), 427–436. https://doi.org/10.1080/09297049.2021.1975669

Quinn, P. O., & Madhoo, M. (2014). A review of attention-deficit/hyperactivity disorder in women and girls: uncovering this hidden diagnosis. *Prim Care Companion CNS Disord*, *16*(3), PCC-13r01596.

Ramos, A. A., Hamdan, A. C., & Machado, L. (2020). A meta-analysis on verbal working memory in children and adolescents with ADHD. *The Clinical Neuropsychologist, 34(*5), 873–898. https://doi.org/10.1080/13854046.2019.1604998.

Rucklidge J. J. (2010). Gender differences in attention-deficit/hyperactivity disorder. *The Psychiatric clinics of North America, 33*(2), 357–373. https://doi.org/10.1016/j.psc.2010.01.006

Rydqvist, F., Hoff, E., Daukantaitė, D., & Cervin, M. (2023). Everyday executive functioning in pediatric obsessive-compulsive disorder: Diagnostic specificity, clinical correlations, and outcome. *BMC Psychiatry*, *23*(1), 622. https://doi.org/10.1186/s12888-023-05111-1

Samuels, P. (2017). Advice on exploratory factor analysis. Birmingham City University. https://www.open-access.bcu.ac.uk/6076/

Samuels, W. E., Tournaki, N., Blackman, S., & Zilinski, C. (2016). Executive Functioning Predicts Academic Achievement in Middle School: A Four-Year Longitudinal Study. *Journal of Educational Research*, *109*(5), 478–490. https://doi.org/10.1080/00220671.2014.979913

Sankalaite, S., Huizinga, M., Dewandeleer, J., Xu, C., de Vries, N., Hens, E., & Baeyens, D. (2021). Strengthening Executive Function and Self-Regulation Through Teacher-Student Interaction in Preschool and Primary School Children: A Systematic Review. *Frontiers in Psychology, 12*, 718262. https://doi.org/10.3389/fpsyg.2021.718262

Schachar R. J. (2023). Fifty years of executive control research in attention-deficit/hyperactivity disorder: What we have learned and still need to know. *Neuroscience and Biobehavioral Reviews*, 155, 105461. https://doi.org/10.1016/j.neubiorev.2023.105461.

Sibley, M. H., Graziano, P. A., Ortiz, M., Rodriguez, L., & Coxe, S. (2019). Academic impairment among high school students with ADHD: The role of motivation and goal-directed executive functions. *Journal of School Psychology*, *77*, 67–76. https://doi.org/10.1016/j.jsp.2019.10.005

Skogli, E. W., Teicher, M. H., Andersen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys--gender differences in co-existing symptoms and executive function measures. *BMC Psychiatry*, 13, 298. https://doi.org/10.1186/1471-244X-13-298.

Snyder, H. R. (2013). Major depressive disorder is associated with broad impairments on neuropsychological measures of executive function: A meta-analysis and review. *Psychological Bulletin, 139*(1), 81–132.

Snyder, H. R., Miyake, A., & Hankin, B. L. (2015). Advancing understanding of executive function impairments and psychopathology: bridging the gap between clinical and cognitive approaches. *Frontiers in Psychology, 6*, 328. https://doi.org/10.3389/fpsyg.2015.00328

Spiegel, J. A., Goodrich, J. M., Morris, B. M., Osborne, C. M., & Lonigan, C. J. (2021). Relations between executive functions and academic outcomes in elementary school children: A meta-analysis. *Psychological Bulletin, 147*(4), 329–351. https://doi.org/10.1037/bul0000322

Tervo-Clemmens, B., Calabro, F. J., Parr, A. C., Fedor, J., Foran, W., & Luna, B. (2023). A canonical trajectory of executive function maturation from adolescence to adulthood. *Nature Communications, 14,* 6922. https://doi.org/10.1038/s41467-023-42540-8

Toplak, M. E., Bucciarelli, S. M., Jain, U., & Tannock, R. (2009). Executive functions: performance-based measures and the behavior rating inventory of executive function (BRIEF) in adolescents with attention deficit/hyperactivity disorder (ADHD). *Child Neuropsychology 15*(1), 53–72. https://doi.org/10.1080/09297040802070929

Van der Ende, J., Verhulst, F. C., & Tiemeier, H. (2016). The bidirectional pathways between internalizing and externalizing problems and academic performance from 6 to 18 years. *Development and psychopathology*, *28*(3), 855–867. https://doi.org/10.1017/S0954579416000353

Van Tetering, M. A. J. V., Laan, A. M. V., Kogel, C. H., Groot, R. H. M., & Jolles, J. (2020). Sex differences in self-regulation in early, middle and late adolescence: A large-scale cross-sectional study. *PloS one*,*15*(1), e0227607. https://doi.org/10.1371/journal.pone.0227607

Vergunst F, Commisso M, Geoffroy M, et al. Association of Childhood Externalizing, Internalizing, and Comorbid Symptoms With Long-term Economic and Social Outcomes. JAMA Netw Open. 2023;6(1):e2249568. doi:10.1001/jamanetworkopen.2022.49568

White, E. I., Wallace, G. L., Bascom, J., Armour, A. C., Register-Brown, K., Popal, H. S., Ratto, A. B., Martin, A., & Kenworthy, L. (2017). Sex differences in parent-reported executive functioning and adaptive behavior in children and young adults with autism spectrum disorder. *Autism Research 10*(10), 1653–1662. https://doi.org/10.1002/aur.1811

World Health Organization (2020). Adolescent mental health – fact sheet. Accessed from: https:// www. who. int/ news- room/ factsheets/detail/ adole scent- mental- health

Willcutt, E. G., Doyle, A. E., Nigg, J. T., Faraone, S. V., & Pennington, B. F. (2005). Validity of the executive function theory of attention-deficit/hyperactivity disorder: a meta-analytic review. *Biological psychiatry, 57*(11), 1336–1346. https://doi.org/10.1016/j.biopsych.2005.02.006

Zablotsky, B., Black, L. I., Maenner, M. J., Schieve, L. A., Danielson, M. L., Bitsko, R. H., Blumberg, S. J., Kogan, M. D., & Boyle, C. A. (2019). Prevalence and trends of developmental disabilities among children in the United States: 2009–2017. *Pediatrics, 144*(4), e20190811.

Supplementary Materials

Table S1.

Cronbach Alpha Values for BRIEF2 Self-Report and Teacher-Report Forms

		Self-report form		Teacher form	
BRIEF2 domain	Index	Younger adolescents (mean age = 14 years)	Older adolescents (mean age = 17 years)	Younger adolescents (mean age = 14 years)	Older adolescents (mean age = 17 years)
Inhibit	BRI	.77	.77	.94	.88
Self-Monitor	BRI	.69	.68	.92	.88
Shift	ERI	.80	.76	.91	.85
Emotional Control	ERI	.83	.78	.95	.86
Initiate	CRI	(-)	(-)	.88	.85
Task Completion	CRI	.88	.88	(-)	(-)
Working Memory	CRI	.84	.81	.93	.90
Plan/Organize	CRI	.82	.80	.90	.88
Task-Monitor	CRI	(-)	(-)	.90	.78
Organisation of Materials	CRI	(-)	(-)	.86	.67
BRI		.86	.83	.96	.88
ERI		.89	.83	.95	.90
CRI		.94	.92	.97	.96
GEC		.96	.95	.98	.97

Note. BRI =Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite.

Table S2.

Self-Reported Diagnostic Characteristics

Category	Younger Adolescents N (%)	Older Adolescents N (%)
Reported level of NDD		
Confirmed NDD	47 (12.0%)	21 (7.9%)
No NDD*	300 (76.3%)	206 (77.7%)
Under Evaluation	10 (2.6%)	7 (2.6%)
Suspected NDD	34 (8.7%)	31 (11.7%)
Reported diagnosis*		
ADHD	27 (57.4%)	6 (28.6%)
ASD	11 (23.4%)	4 (19.0%)
ADD	4 (8.5%)	4 (19.0%)
Dyslexia/Dyscalculia	9 (19.1%)	4 (19.0%)

Note. *In the ANOVA analyses, 44 students from the younger adolescent group and 18 from the older adolescent group were excluded from the No NDD group, as these students reported either clinical or subclinical levels of internalized problems. This exclusion was made to minimize confounding effects, resulting in sample sizes of 256 and 188 for the younger and older adolescent groups, respectively.

**Due to comorbidity, sum exceeds 100%.

Table S3.

Means (SD) and Two-Way ANOVA Results for Main Effects of Anxiety Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Self-Rated BRIEF2 Domains and Indices

BRIEF2 domain	Groups based on RCADS-25 T-scores						*Main effect of $RCADS_{anxiety}$*				*Main effect of gender*		
	Low-symptom anxiety group (T-Scores <65)		Subclinical anxiety group (T-Scores 65-69)		Clinical anxiety group (T-Scores ≥ 70)								
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*Tukey post hoc*	*F*	*p*	*partial* η^2
Younger adolescents (mean age 14)													
Inhibit	14.00 (3.36)	12.25 (3.37)	15.33 (2.69)	13.20 (2.57)	16.95 (3.06)	14.60 (2.82)	12.40	<.001	.07	3>1	11.23	<.001	.03
Self-Monitor	8.53 (2.22)	7.53 (2.29)	9.67 (2.00)	8.80 (1.32)	10.32 (1.91)	9.60 (2.28)	15.55	<.001	.09	3>1	4.25	.040	.01
Shift	14.16 (3.01)	11.87 (3.08)	15.56 (3.43)	15.10 (1.45)	18.32 (2.71)	16.35 (3.22)	40.31	<.001	.19	3>2>1	7.61	.006	.02
Emotional Control	10.86 (2.98)	8.36 (2.53)	12.56 (2.74)	10.20 (2.20)	14.18 (2.48)	11.25 (2.73)	26.11	<.001	.14	3>1, 2>1	25.64	<.001	.07
Task Completion	13.23 (3.72)	10.95 (3.28)	14.00 (3.84)	13.10 (3.14)	16.18 (3.26)	15.35 (3.53)	21.02	<.001	.11	3>1	4.15	.042	.01
Working Memory	14.83 (3.74)	12.35 (3.26)	16.00 (2.65)	14.80 (4.49)	18.18 (3.50)	16.65 (3.65)	22.93	<.001	.12	3>1	6.88	.009	.02
Plan/Organize	18.37 (4.08)	15.91 (3.99)	18.78 (4.35)	19.10 (3.31)	22.00 (3.82)	20.75 (4.62)	20.47	<.001	.11	3>1	2.17	.142	.01
BRI	22.51 (5.06)	19.70 (5.01)	25.00 (4.39)	22.00 (3.46)	27.27 (4.47)	24.20 (4.73)	17.21	<.001	.09	3>1	10.10	.002	.03
ERI	25.01 (5.16)	20.24 (5.04)	28.11 (5.11)	25.30 (3.13)	32.50 (4.36)	27.60 (5.42)	43.17	<.001	.21	3>2>1	19.21	<.001	.05
CRI	46.38 (10.70)	39.21 (9.84)	48.78 (10.07)	47.00 (9.23)	56.24 (9.89)	52.75 (10.83)	24.47	<.001	.13	3>2&1	4.58	<.001	.03
GEC	93.95 (19.12)	78.78 (18.42)	101.89 (15.41)	94.30 (13.65)	115.71 (15.79)	104.55 (19.67)	31.61	<.001	.16	3>2>1	10.47	<.001	.03

BRIEF2 domain	Groups based on RCADS-25 T-scores						*Main effect of RCADS$_{anxiety}$*				*Main effect of gender*		
	Low-symptom anxiety group (T-Scores <65)		Subclinical anxiety group (T-Scores 65-69)		Clinical anxiety group (T-Scores ≥ 70)								
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*Tukey post hoc*	*F*	*p*	*partial* η^2
Older adolescents (mean age 17)													
Inhibit	12.52 (2.78)	13.25 (3.33)	13.58 (3.06)	16.50 (0)	15.24 (3.97)	16.50 (3.54)	3.27	.040	.03	3>1	0.73	.394	.00
Self-Monitor	7.01 (1.81)	7.85 (2.02)	7.83 (1.19)	10.00 (0)	8.02 (2.56)	9.00 (1.41)	1.30	.274	.01	3>1	1.32	.253	.01
Shift	13.57 (3.17)	13.44 (2.80)	15.80 (3.38)	19.00 (0)	14.89 (3.61)	20.50 (3.54)	7.02	.001	.06	3>1	6.81	.010	.03
Emotional Control	10.55 (2.47)	9.21 (2.51)	11.80 (2.96)	10.00 (0)	12.85 (2.84)	15.50 (2.12)	10.15	<.001	.08	3>1	0.44	.508	.00
Task Completion	12.53 (3.55)	13.11 (3.40)	14.60 (3.52)	20.00 (0)	14.39 (3.95)	16.50 (3.54)	1.98	.140	.02	3>1	1.45	.229	.01
Working Memory	14.05 (3.52)	14.76 (3.16)	16.40 (3.76)	21.00 (0)	15.72 (3.89)	18.00 (1.41)	2.23	.110	.02	3>1	1.77	.185	.01
Plan/Organize	16.88 (4.06)	18.93 (4.17)	19.07 (3.35)	27.00 (0)	19.37 (4.11)	23.00 (8.49)	2.58	.078	.02	3>1	3.82	.052	.02
BRI	19.73 (4.13)	21.28 (5.12)	22.00 (4.44)	26.00 (0)	23.24 (5.91)	25.50 (2.12)	2.84	.060	.02	3>1	1.14	.286	.01
ERI	24.12 (4.81)	22.65 (4.34)	27.60 (5.77)	29.00 (0)	27.74 (5.75)	36.00 (1.41)	11.27	<.001	.09	3>1	4.08	.045	.02
CRI	43.47 (10.23)	46.81 (9.62)	50.07 (9.31)	68.00 (0)	49.48 (10.29)	57.50 (13.44)	2.74	.066	.02	3>1	2.82	.094	.01
GEC	87.25 (17.05)	90.74 (16.74)	99.67 (16.05)	123.00 (0)	100.46 (19.25)	119.00 (16.97)	5.56	.004	.04	3>1	3.38	.067	.01

Note. BRI = Behavior Regulation Index, ERI = Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite. After Bonferroni correction: $p < .05/11 = .005$ (applied separately for each age group).

Table S4.

Means (SD) and Two-Way ANOVA Results for Main Effects of Depression Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Self-Rated BRIEF2 Domains and Indices

	Groups based on RCADS-25 T-scores						*Main effect of $RCADS_{depression}$*				*Main effect of gender*		
	Low-symptom depression group (T-Scores <65)		Subclinical depression group (T-Scores 65-69)		Clinical depression group (T-Scores ≥ 70)								
BRIEF2 domain	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*partial* η^2	*Tukey post hoc*	*F*	*p*	*partial* η^2
Younger adolescents (mean age 14)													
Inhibit	13.86 (3.17)	12.11 (3.10)	17.00 (2.97)	15.38 (4.24)	18.07 (3.08)	15.56 (3.22)	27.50	<.001	.14	3>1, 2>1	9.92	.002	.03
Self-Monitor	8.49 (2.14)	7.49 (2.18)	9.77 (1.69)	9.62 (2.39)	11.29 (1.98)	10.40 (1.96)	27.61	<.001	.14	3>1, 2>1	2.53	.113	.01
Shift	14.09 (2.87)	12.13 (3.16)	17.31 (2.69)	14.62 (4.24)	19.36 (3.13)	15.56 (3.35)	33.12	<.001	.17	3>1, 2>1	21.62	<.001	.06
Emotional Control	10.83 (2.91)	8.30 (2.32)	13.15 (2.44)	12.25 (3.24)	15.29 (2.23)	11.75 (2.91)	41.30	<.001	.20	3>1, 2>1	20.33	<.001	.06
Task Completion	13.03 (3.61)	10.97 (3.16)	16.15 (2.61)	14.38 (4.10)	17.57 (3.08)	15.94 (3.66)	33.44	<.001	.17	3>1, 2>1	7.54	.006	.02
Working Memory	14.65 (3.51)	12.30 (3.19)	18.31 (3.54)	16.88 (3.09)	19.29 (3.36)	17.44 (3.81)	39.48	<.001	.19	3>1, 2>1	8.01	.005	.02
Plan/Organize	18.11 (3.90)	15.89 (3.72)	22.23 (3.70)	20.62 (5.21)	23.23 (3.72)	21.81 (5.01)	35.71	<.001	.18	3>1, 2>1	5.12	.024	.02
BRI	22.33 (4.80)	19.61 (4.78)	26.77 (4.38)	25.00 (6.23)	29.36 (4.36)	25.40 (3.56)	31.74	<.001	.16	3>1, 2>1	8.95	.003	.03
ERI	24.91 (4.90)	20.44 (4.94)	30.46 (4.29)	26.88 (7.40)	34.64 (4.40)	27.31 (5.45)	48.00	<.001	.22	3>1, 2>1	27.40	<.001	.08
CRI	45.75 (10.11)	39.16 (9.25)	56.69 (9.02)	51.88 (12.16)	60.08 (9.81)	55.19 (11.66)	41.94	<.001	.20	3>1, 2>1	7.79	.006	.02
GEC	93.03 (17.73)	79.12 (17.89)	113.92 (13.70)	103.75 (24.81)	123.92 (16.98)	106.60 (17.71)	45.96	<.001	.22	3>1, 2>1	15.01	<.001	.04

Older adolescents (mean age 17)													
Inhibit	12.74 (3.02)	13.03 (3.19)	14.50 (3.01)	14.75 (1.71)	16.70 (3.59)	16.00 (4.07)	13.91	<.001	.10	3>2, 3>1	0.01	.946	.00
Self-Monitor	7.11 (1.96)	7.83 (2.04)	7.44 (1.50)	9.25 (2.22)	9.04 (2.40)	8.88 (2.10)	6.59	.002	.05	3>2, 3>1	2.79	.096	.01
Shift	13.48 (3.17)	13.24 (2.72)	15.72 (3.14)	15.50 (4.43)	16.57 (3.34)	16.50 (3.55)	13.17	<.001	.09	3>1	0.06	.810	.00
Emotional Control	10.58 (2.46)	8.89 (2.24)	12.50 (2.48)	10.00 (3.56)	14.22 (2.70)	13.00 (2.83)	27.15	<.001	.17	3>2>1	9.78	.002	.04
Task Completion	12.47 (3.46)	12.62 (3.31)	14.61 (3.31)	16.00 (0.82)	16.39 (3.89)	17.25 (2.31)	19.15	<.001	.13	3>1, 2>1	1.00	.319	.00
Working Memory	14.15 (3.56)	14.35 (2.92)	14.94 (3.04)	18.25 (2.22)	17.61 (3.89)	17.88 (3.56)	13.02	<.001	.09	3>2, 3>1	2.48	.117	.01
Plan/Organize	17.01 (4.09)	18.25 (3.91)	19.22 (2.73)	23.50 (2.38)	20.65 (4.01)	24.00 (4.24)	18.74	<.001	.13	3>1, 2>1	10.15	.002	.04
BRI	19.84 (4.35)	20.86 (4.94)	21.94 (4.05)	24.00 (3.56)	25.74 (5.52)	24.88 (5.72)	13.22	<.001	.09	3>2, 3>1	0.46	.499	.00
ERI	24.06 (4.81)	22.13 (4.05)	28.22 (4.75)	25.50 (7.05)	30.78 (5.07)	29.50 (4.50)	26.11	<.001	.17	3>2>1	3.24	.073	.01
CRI	43.62 (10.14)	45.22 (8.95)	48.78 (7.09)	57.75 (4.50)	54.65 (10.05)	59.12 (8.87)	21.27	<.001	.14	3>2>1	4.95	.027	.02
GEC	87.47 (16.95)	88.21 (15.82)	98.94 (13.43)	107.25 (7.68)	111.17 (17.30)	113.50 (14.58)	26.97	<.001	.17	3>2>1	0.97	.325	.00

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite. After Bonferroni correction: $p < .05/11 = .005$ (applied separately for each age group).

Table S5.

Means (SD) and Linear Mixed Model Results for Main Effects of Anxiety Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Teacher-Rated BRIEF2 Domains and Indices

BRIEF2 domain	Groups based on RCADS-25 T-scores						*Main effect of* $RCADS_{anxiety}$		*Main effect of gender*	
	Low-symptom anxiety group (T-Scores <65)		Subclinical anxiety group (T-Scores 65-69)		Clinical anxiety group (T-Scores ≥ 70)					
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Younger adolescents (mean age 14)										
Inhibit	10.02 (3.57)	11.56 (4.30)	8.25 (0.46)	11.13 (4.61)	9.79 (4.17)	13.13 (5.23)	1.07	.344	13.52	<.001
Self-Monitor	6.47 (2.60)	7.53 (2.88)	5.63 (1.77)	7.13 (3.04)	6.50 (3.01)	8.38 (3.74)	0.80	.452	11.70	<.001
Shift	9.92 (3.35)	10.33 (3.23)	9.13 (2.23)	9.75 (1.75)	10.50 (4.20)	11.38 (4.36)	1.23	.296	1.34	.249
Emotional Control	9.38 (3.05)	9.50 (3.46)	9.13 (2.10)	9.25 (3.15)	9.79 (3.38)	10.00 (3.86)	0.32	.726	0.10	.749
Initiate	5.40 (2.23)	6.19 (2.33)	4.63 (1.77)	6.25 (2.71)	5.50 (2.65)	6.50 (2.66)	0.31	.732	9.07	.003
Working Memory	10.18 (3.90)	11.61 (4.10)	8.88 (2.47)	10.50 (3.59)	10.57 (4.29)	12.56 (4.91)	1.16	.315	9.30	.003
Plan/Organize	10.01 (3.26)	11.01 (3.61)	9.13 (2.80)	11.00 (4.34)	11.57 (4.33)	11.88 (3.48)	1.74	.178	5.11	.025
Task-Monitor	7.77 (2.83)	9.93 (3.36)	6.88 (1.81)	9.13 (3.31)	8.36 (3.18)	10.75 (4.33)	1.31	.271	31.50	<.001
Organization of Materials	5.94 (2.00)	6.63 (2.26)	5.13 (0.35)	6.25 (2.38)	6.21 (2.01)	7.69 (2.77)	2.10	.124	9.14	.003
BRI	16.49 (6.04)	19.09 (6.79)	13.88 (1.73)	18.25 (7.42)	16.29 (6.96)	21.50 (8.69)	1.04	.357	13.87	<.001
ERI	19.30 (6.14)	19.83 (6.28)	18.25 (4.20)	19.00 (4.38)	20.29 (7.15)	21.38 (7.49)	0.79	.455	0.62	.432
CRI	39.30 (13.35)	45.36 (14.24)	34.63 (9.07)	43.13 (14.84)	42.21 (15.79)	49.38 (16.76)	1.40	.249	13.55	<.001
GEC	75.10 (24.32)	84.29 (25.26)	66.75 (14.18)	80.38 (22.76)	78.79 (28.50)	92.25 (30.63)	1.31	.272	10.43	<.001

BRIEF2 domain	Groups based on RCADS-25 T-scores						*Main effect of RCADS$_{anxiety}$*		*Main effect of gender*	
	Low-symptom anxiety group (T-Scores <65)		Subclinical anxiety group (T-Scores 65-69)		Clinical anxiety group (T-Scores ≥ 70)					
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Older adolescents (mean age 17)										
Inhibit	8.96 (2.07)	9.35 (2.28)	8.87 (1.68)	8.00 (0)	8.98 (2.42)	10.50 (3.54)	0.07	.930	1.71	.192
Self-Monitor	5.58 (1.48)	5.74 (1.54)	5.53 (1.06)	5.00 (0)	5.65 (1.69)	7.50 (3.54)	0.23	.792	0.91	.342
Shift	8.95 (1.85)	8.56 (1.33)	9.87 (2.92)	8.00 (0)	9.04 (2.12)	8.50 (0.71)	1.40	.249	2.69	.102
Emotional Control	8.60 (1.47)	8.08 (0.44)	9.33 (2.35)	8.00 (0)	8.83 (1.98)	8.00 (0.00)	1.76	.174	6.91	.009
Initiate	4.84 (1.52)	4.63 (1.25)	4.93 (1.28)	4.00 (0)	5.07 (1.96)	4.50 (0.71)	0.32	.723	1.22	.271
Working Memory	9.21 (2.32)	9.04 (1.92)	9.27 (2.52)	8.00 (0)	9.67 (3.33)	11.00 (4.24)	0.89	.411	0.14	.709
Plan/Organize	9.40 (2.40)	9.25 (2.08)	9.47 (2.88)	8.00 (0)	9.83 (3.13)	11.00 (4.24)	0.72	.487	0.11	.739
Task-Monitor	7.16 (1.78)	7.68 (2.11)	6.87 (1.13)	6.00 (0)	7.15 (1.91)	8.50 (3.54)	0.32	.728	3.82	.052
Organization of Materials	5.32 (0.81)	5.24 (0.66)	5.40 (0.91)	5.00 (0)	5.33 (0.82)	6.00 (1.41)	0.11	.900	0.27	.602
BRI	14.54 (3.16)	15.08 (3.62)	14.40 (2.64)	13.00 (0)	14.63 (3.96)	18.00 (7.07)	0.14	.837	1.57	.212
ERI	17.55 (2.98)	16.64 (1.42)	19.20 (5.19)	16.00 (0)	17.87 (3.64)	16.50 (0.71)	1.89	.154	5.37	.021
CRI	35.92 (8.12)	35.83 (7.09)	35.93 (7.65)	31.00 (0)	37.04 (10.65)	41.00 (14.14)	0.48	.619	0.00	.984
GEC	68.02 (12.81)	67.56 (10.72)	69.53 (13.74)	60.00 (0)	69.54 (17.18)	75.50 (21.92)	0.35	.704	0.04	.840

Note. BRI = Behavior Regulation Index, ERI = the Emotional Regulation Index, CRI = Cognitive Regulation Index, GEC = Global Executive Composite. Effect sizes (partial η^2) are not reported for fixed effects in mixed linear models, as SPSS does not provide this statistic for nested data structures.

Table S6.

Means (SD) and Linear Mixed Model Results for Main Effects of Depression Symptom Severity (Low-Symptom, Subclinical, Clinical) and Gender on Teacher-Rated BRIEF2 Domains and Indices

BRIEF2 domain	Groups based on RCADS-25 T-scores						*Main effect of* $RCADS_{depressiony}$		*Main effect of gender*	
	Low-symptom depression group (T-Scores <65)		Subclinical depression group (T-Scores 65-69)		Clinical depression group (T-Scores ≥ 70)					
	Girl	Boy	Girl	Boy	Girl	Boy	*F*	*p*	*F*	*p*
Younger adolescents (mean age 14)										
Inhibit	9.64 (3.33)	11.65 (4.52)	11.17 (5.18)	11.75 (3.69)	10.89 (3.14)	12.36 (4.11)	0.93	.396	14.06	<.001
Self-Monitor	6.20 (2.35)	7.60 (2.97)	7.83 (4.02)	7.75 (3.81)	7.00 (2.60)	7.55 (2.77)	1.26	.285	12.57	<.001
Shift	9.62 (3.10)	10.40 (3.40)	12.42 (5.11)	11.13 (3.18)	10.22 (2.68)	10.09 (2.34)	3.11	.046	1.86	.174
Emotional Control	9.19 (2.86)	9.64 (3.63)	10.42 (3.94)	9.38 (3.11)	10.56 (3.32)	8.55 (1.04)	0.29	.748	0.15	.702
Initiate	5.15 (2.02)	6.11 (2.38)	6.58 (3.09)	6.63 (1.92)	6.22 (2.95)	7.18 (2.56)	3.66	.027	10.14	.002
Working Memory	9.74 (3.44)	11.60 (4.28)	12.42 (6.04)	12.13 (3.27)	11.67 (3.97)	11.91 (3.51)	2.26	.107	10.30	.001
Plan/Organize	9.69 (3.04)	10.94 (3.65)	11.58 (4.10)	11.75 (3.41)	13.22 (4.38)	12.45 (3.33)	5.69	.004*	5.77	.017
Task-Monitor	7.44 (2.44)	9.97 (3.56)	9.33 (4.23)	8.75 (2.71)	9.67 (3.50)	11.00 (2.68)	2.49	.085	32.28	<.001
Organization of Materials	5.75 (1.83)	6.69 (2.40)	6.67 (2.39)	6.63 (1.69)	6.89 (2.26)	7.18 (2.23)	1.60	.204	9.55	.002
BRI	15.84 (5.54)	19.25 (7.11)	19.00 (8.91)	19.50 (7.31)	17.89 (5.56)	19.91 (6.69)	1.08	.342	14.60	.001
ERI	18.82 (5.75)	20.04 (6.58)	22.83 (8.63)	20.50 (5.61)	20.78 (5.49)	18.64 (3.20)	1.50	.225	0.86	.354
CRI	37.76 (12.02)	45.32 (14.91)	46.58 (18.91)	45.88 (11.31)	47.67 (15.56)	49.73 (12.42)	3.36	.036	14.60	<.001
GEC	72.42 (22.24)	84.61 (26.53)	88.42 (35.58)	85.88 (22.07)	86.33 (22.63)	88.27 (20.13)	2.26	.107	11.32	<.001