



LUND UNIVERSITY

Singing the body electric

Understanding the role of embodiment in performing and composing interactive music

Einarsson, Anna

2017

[Link to publication](#)

Citation for published version (APA):

Einarsson, A. (2017). *Singing the body electric: Understanding the role of embodiment in performing and composing interactive music*. Malmö Faculty of Fine and Performing Arts, Lund University.

Total number of authors:

1

General rights

Unless other specific re-use rights are stated the following general rights apply:

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00

Singing the body electric

*— Understanding the role of
embodiment in performing and
composing interactive music*

ANNA EINARSSON

KMH

Singing the body electric

— *Understanding the role of embodiment in performing and composing interactive music*



LUND
UNIVERSITY

KMH Royal College
of Music
Stockholm

This dissertation has been carried out and supervised within the graduate programme in Music at the Royal College of Music in Stockholm. The dissertation is presented at Lund University in the framework of the cooperation agreement between the Malmö Faculty of Fine and Performing Arts, Lund University, and the Royal College of Music regarding doctoral education in the subject Music in the context of Konstnärliga forskarskolan.

Graphic design: Transfer Studio | transferstudio.se

Photography: As credited

Printed in Sweden by Media-Tryck, Lund 2017

ISBN 978-91-7753-260-6

Doctoral studies and research in fine and performing arts, 18 (ISSN 1653-8617)

© 2017 Anna Einarsson

Abstract

Almost since the birth of electronic music, composers have been fascinated by the prospect of integrating the human voice, with its expressiveness and complexity, into electronic musical works. This thesis addresses how performing with responsive technologies in mixed works, i.e. works that combine an acoustic sound source with a digital one, is experienced by participating singers, adopting an approach of seamlessness, of zero - or invisible - interface, between singer and computer technology. It demonstrates *how the practice of composing and the practice of singing both are embodied activities*, where the many-layered *situation* in all its complexity is of great importance for a deepened understanding. The overall perspective put forward in this thesis is that of music as a sounding body to resonate with, where the *resonance*, a process of embodying of feeling and emotion, guides the decision-making. The core of the investigation is the experience garnered through the process of composing and performing three musical works. One result emerging from this process is the suggested method of *calibration*, according to which a bodily rooted attention forms a kind of joint attention towards the work in the making. Experiences from these three musical works arrive in the formulation of an over-arching framework entailing a view of musical composition as a process of construction - and embodied mental simulation - of situations, whose dynamics unfold to engage musicians and audience through shifting *fields of affordances*, based on a *shared landscape of affordances*.

Acknowledgements

As I signed on to this ship, sailing the seas of artistic research, I was full of anticipation, in love with the sea, yet at the same time aware of its treacherous nature and the hidden rocks not always clearly shown on the map.

Thank you Tom Ziemke, for your excellent know-how and sense of humour, always providing maps for new discoveries. Thank you Per Mårtensson for your clear gaze and sharp intellect, helping me navigate this sea, reminding me to keeping a steady course. Thank you also the rest of the crew: Anders Friberg, Susan Kozel, Sten Ternström, Johan Sundberg, Ylva Gislén, Henrik Frisk, Bill Brunson, for your input and efforts. Furthermore, all skilled fellow musicians and collaborators: Sofia Jernberg, Lina Nyberg, Sara Niklasson, Isabel Sörling, Ulla Pirttijärvi, Marita Solberg, Maria Sundqvist and Malmö Operaverkstad, Jörgen Dahlgvist, Markus Råberg, George Kentros, Maurio Goina, Andre Bartetski, Valeria Hedman and many more, without whom this project would never have been set to sea at all. I am deeply indebted to you.

My parents, thank you for your support, reminding me to eat and sleep as well as discussing the journey.

And to Magnus, my life companion, like Jum-Jum in the Astrid Lindgren story of *Mio, min mio*, never leaving my side, urging me to be at my best and challenging me, while at the same time providing unconditioned love and support. Let's keep the music playing...

Preface

I will not begin this thesis by describing how I tweaked my tape recorder as a child or had my first set of gear to mold lead to make loudspeaker elements at the age of 7. Nor will I go into my early fascination for synthesizers, or how I found out about ring modulation just by accident: accounts similar to those given by many composers of electronic music. I won't, simply because that wasn't me. Instead, I stood in the garden outside my parents' house with neighbors assembled, holding a skipping rope, singing at my loudest. I sang my way through my early childhood, my school years, and through the looking "at clouds from both sides", to quote one of my favourites, Joni Mitchell. My first formal training at the Royal College of Music in Stockholm was also as a jazz singer (although to be fair, by the end of my four years I had begun tip-toeing in the composition hallway taking counterpoint classes and consequently was the only jazz vocalist not doing a studio recording as one's chosen final project, but a piece for saxophone quartet, voice and tape instead).

Music technology somehow snuck in the back door. When I was a child my mother travelled a lot to Japan and the US. In those days Sweden was still lagging a few years behind in technical development, at least in terms of making it readily available for the man on the street, and so she brought home a number of devices considered (at least partly) cutting edge. For example I remember a red microphone bought in Japan that I used for making endless recordings of mostly me singing and talking. We had one of the first portable CD Walkmans. And I was at an early age given a synthesizer producing lots of funny noises. But these tools were never at the center of my attention, they were means to an end, namely to engage in music.

It was not until studying composition, again at the Royal College of Music, when I truly discovered the fascination for composing with sound and the aesthetics this entailed. I found out about the full spectrum of possibilities for sound manipulation and sound synthesis, not to mention assigning different behaviours to the sounding in various programming environments.

For a number of years I had been performing professionally and making records as a vocalist primarily in jazz and improvisation, but as my interest in electroacoustic music grew stronger, I also began performing live electronics, mostly using traditional interfaces like knobs and sliders. Not unlike many other musicians making the transition towards live electronics, I missed the bodily aspect of performing, which denotes my experience of singing. So could I somehow embody the live electronics through singing? How was I to combine these two, in for me musically meaningful ways, when composing?

This thesis is my attempt to elaborate on this matter.

juni 2014¹

Bra musik. Vad är bra musik? Fönstren är öppna, dagen där ute lockar, men jag envisas. Försöker forma en musikalisk struktur som resonerar i mig på samma vis som texten finner sin resonans i mitt inre. Förtätningar och förtunningar, en öppning vid ordet "sorg". Det är allt vad det är att vara människa som står på spel, som vandrar upp mot ytan. Alla olika lager av medvetande, som griper genom tiden.

June 2014.

Good music. What is good music? The windows are open, the day out there beckons, but I persist. Try to form a musical structure that resonates in me in the same way as the text finds resonance in me. Condensations and dispersions, an opening with the word "sorrow". All that it means to be human is at stake, rising to the surface. All the different layers of consciousness, claiming us through time.

¹ This is an extract from my process diary from the process of composing *Metamorphoses* (2015) and an example of how bodily states and dynamics underlie and influence my composing.

73

ett hem mot ett an-nat hem en blick
 ett liv mot ett an-nat liv

78

mot en an-nan blick ils - ka mot en an-nan
 ett hem mot ett an-nat hem
 ett hem mot ett an-nat hem

83

ils - ka en sorg bring out mot en
 ils - ka mot en ann-an ils - - - ka
 en sorg mot en ann-an sorg
 liv mot ett an - nat liv ett

Image 1. An «opening» with the word sorrow.

Abstract	3	1. Introduction	15
Acknowledgements	4	1.1. Mapping the thesis chronologically: Vantage points, tours and detours	16
Preface	5	1.2. Aims and contributions	21
 		2. Towards Music as Embodied Experience	23
Mapping the thesis by chapters:		2.1. Delineating the mixed work	23
An overview	10	2.2. Continuing with mixed works: The increase of processing speed and the research centre IRCAM	25
 		2.3. Or is she just checking her e-mail...?	26
Papers and Works included in the Thesis	13	2.4. Questions of mapping and feature extraction	27
		2.5. A prevailing dualistic view on the mixed work	28
		2.6. A note on genre identification: improvisation, interpretation and notation	29
		2.7. What is this thing called interactivity?	31
		2.8. Singing and composing as acts of embodying	32
		3. Perspectives From Embodied Cognitive Science	36
		3.1. Embodied cognition “Second generation cognitive science”	36
		3.1.1. Cognition is situated	37
		3.1.2. Cognition is time-pressured	38
		3.1.3. We off-load cognitive work to the environment	39
		3.1.4. The environment is part of the cognitive system	39
		3.1.5. Cognition is for action	40
		3.1.6. Off-line cognition is body based	40
		3.2. Which embodiment? And which body?	41
		3.3. Embodied cognition perspectives on music	42
		3.4. Gibson’s ecological theory of perception	43
		3.5. Affordances 2.0 - Chemero’s radical embodied cognitive science	45
		3.6. Affordances and music: You should be dancing, yeah	45

3.7. Fly on the wings of love: Feelings, movement and metaphors	46	5.2.3.2. <i>Embodiment, data collection & data analysis</i>	81
3.8. My focus of research	47	5.2.3.3. <i>Results & Discussion</i>	82
4. Methodology	49	5.2.4. Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies	83
4.1. The question on “What is?”	49	5.2.4.1. <i>Aim</i>	83
4.2. Conducting artistic research	49	5.2.4.2. <i>On affordances in general and cultural affordances in particular.</i>	83
4.3. An alternative view on subjectivity	50	5.2.4.3. <i>Practical examples from artistic works</i>	84
4.4. Attentiveness as a way of knowing	51	5.2.4.4. <i>Conclusion</i>	85
4.5. Mixing of methods	53	6. Discussion	86
4.6. Process diaries and reflection-in-action	53	6.1. Embodiment	87
4.7. Interpretative Phenomenological Analysis	54	6.2. Resonance	89
4.7.1. Participants	55	6.3. Calibration	90
4.7.2. Interviews	56	6.4. Situations & Affordances	91
4.7.3. Self-reflection	56	6.5. Looking forward	93
5. Summaries:		References	94
Artistic Works and Papers	57	Appendix	103
5.1. Artistic Works	57	Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera	104
5.1.2. PS. I will be home soon! (2012)	57	We Can Work It Out - Calibration As Artistic Method	110
5.1.2.1. <i>Balancing the whole and its parts</i>	61	Experiencing Responsive Technology in a Mixed Work: Interactive music as embodied and situated activity	121
5.1.2.2. <i>Searching surfaces for interaction</i>	63	Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies	136
5.1.3. Metamorphoses (2015)	66		
5.1.4. One piece of a shared space (2015)	73		
5.2. Papers	74		
5.2.1. We can work it out – Calibration as artistic method	74		
5.2.1.1. <i>On the work</i>	75		
5.2.1.2. <i>Workshops</i>	75		
5.2.1.3. <i>Results</i>	75		
5.2.2. Using singing voice vibrato as a control parameter in a chamber opera	78		
5.2.2.1. <i>Vibrato extraction</i>	78		
5.2.2.2. <i>Method</i>	79		
5.2.2.3. <i>Results</i>	79		
5.2.2.4. <i>Conclusion</i>	80		
5.2.3. Experiencing responsive technology in a mixed work	80		
5.2.3.1. Aim & Method	80		

Mapping the thesis by chapters: An overview

This thesis is divided into six chapters. The *introduction* presents the vantage points for this artistic research project, and continues describing chronologically how the chapters and themes fit together. Important points of departure for the research project are highlighted, such as my background as vocalist and composer, touching upon how bringing corporeality into performing live electronics has been one incentive for taking upon the challenge of conducting artistic research in the field of music. I describe how working with the audio-visual piece *Let me speak* (2008) sparked an interest to investigate further how features from the singing voice, in ways meaningful for the performer, could be used as control mechanisms for live electronics in mixed works (i.e. works that combine an acoustic sound source with a digital sound source). The collaboration with researcher Anders Friberg at the Royal Technical University to isolate and analyze salient singing voice features is touched upon, and how a first application was implemented in the chamber opera *PS. I will be home soon!* (2012) at Malmö Operaverkstad. The process towards the work together with the artistic team led by Maria Sundqvist at the opera gave birth to formulating a theory about the process towards a new work, *calibration*.

Working with *PS. I will be home soon!* had brought on ideas about embodiment and situatedness in relation to interactivity. Both the fact that the audience was moving about when experiencing the performance as well as the experiences collected from the singers performing with live electronics had me thinking about how the computer could evoke both a sense of alienation and a sense of a whole, and I went on speculating about how corporeal awareness would influence the experiencing of interactive relationships. Together with playwright Jörgen Dahlgqvist I staged the work *Metamorphoses* (2015) to investigate matters further. The work involved four singers with four designated interactive computer systems. The process towards the work also for most part followed the idea of calibration towards the work. As I put it, notions of *situation* and *embodiment* were two cornerstones that grew out of these works and accompanied the work *One piece of a shared space* (2015), an audio-visual performance piece in collaboration with sami folksinger Ulla Pirttijärvi and visual artist Marita Solberg. A brief outline of aspects of the situation, as well as clarifications about aims for the thesis, ends the chapter.

Chapter *two* begins by bringing forward how music in my experience is an embodied experience unfolding in a social and cultural context. It then continues by situating the work in the tradition of electronic music and vocal works and the discourse pertinent to this thesis, namely composing and performing works incorporating interaction with a computer. Voice artists throughout history have worked on expanding the palate of vocal sounds, and sometimes this exploration has been pursued in collaboration with composers of electronic

music. Some of these collaborations and artists are outlined, alongside a brief historical expose on electronic music.

Interactivity is a very all-encompassing concept, so the remainder of the chapter is devoted to discussing a number of issues articulating my compositional stance in dialogue with existing theory in the field. Topics include approaches to conceptualization of the computer in mixed works, liveness in electronic music, notion of effort and control, interfaces, notation, interpretation, and mapping. I arrive at discussing singing and composing as embodied activities, drawing upon some of the previous discussions and providing a few examples, anticipating the chapter to come on embodiment.

Chapter *three* focuses on the ways this artistic research claims embodiment, through outlining the general claims of embodied cognition, and engaging in a dialogue with these. Taking the traditional “computational model” (Shapiro, 2007) of cognition as a point of departure, I describe how embodied cognitive theories differ in their ways of explaining human cognition. Walking through the model from 2002 in which Wilson summarizes the claims of embodied cognition (cognition is situated, cognition is time-pressured, we off-load cognitive work to the environment, the environment is part of the cognitive system, cognition is for action, offline cognition is body-based), I draw parallels to my artistic practice.

Moving on, I address the distinction between two branches of embodied theories. The more traditional approach to embodiment, in line with computationalist and functionalist theories of mind, views the body in rather mechanistic terms, and is often that meant in the community of Artificial Intelligence, whereas the other branch builds upon James Gibson’s ecological psychology, radical embodied cognitive science (Chemero, 2009), which emphasises the living body (Sharkey & Ziemke, 2001), the latter being what I will refer to in the following when speaking of embodiment.

I continue by clarifying that the type of body referred to may be the biological body, but also the social, the cultural, the phenomenological and the ecological. Embodied experiences range from experiences of pain and metabolism to moving about in a physical space, to abstract reasoning. The key to understanding the mechanisms behind the embodied perspective lays in the constantly developing empirical support for sensorimotor interaction and the groundbreaking research on mirror neurons.

I finish off the chapter by delineating some important concepts: affordances, perceptual learning, metaphors, and last but not least the important role of feelings and emotions in composing and singing.

In Chapter *four* I go through choices of methods and reasons for doing so. I begin by discussing what ontological foundation this work sits upon and how subjectivity might be just the right place to begin an inquiry from. I argue for how attentiveness may be a way of knowing, particularly pertinent to artistic practice. Tools used are touched upon, and as

many scholars I am indebted to Donald Schön and the reflective practitioner for pinpointing the role of actions in knowledge production. Throughout this project I have also worked with interviewing fellow musicians and I discuss procedures and Interpretational Phenomenological Analyses (IPA) a little more in depth, a method recommended by Holmes and Holmes (2013) when doing explorative research on performance experiences.

In Chapter *five* artistic works and papers are summarised, and in Chapter *six* there is a general discussion, hopefully disentangling some issues and sending new ones forward.

In the *Appendix* my papers are enclosed, works can be accessed at www.annaearsson.com

Papers and Works Included in the Thesis

Artistic works

Einarsson, A. (2012). *PS. I will be home soon!* [Score]. Svensk Musik: Stockholm. Commissioned by Malmö Opera, documentation at <http://www.annaeinarsson.com/#video>

Einarsson, A. (2015). *Metamorphoses*. [Video recording]. <http://www.annaeinarsson.com/#video>

Einarsson, A. (2015). *One piece of a shared space*. [Video recording]. <http://www.annaeinarsson.com/#video>

Papers

Einarsson, A. (2015). ‘We Can Work It Out - Calibration as Artistic Method’, *Ruukku*, 4 (19/03/2015). <https://www.researchcatalogue.net/view/142373/142374/0/0>

Einarsson, A & Friberg, A. (2015). Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera. In *International Computer Music Conference 2015–Sept. 25–Oct. 1, 2015–CEMI*, University of North Texas, USA.

Einarsson, A. Experiencing responsive technology in a mixed work: Interactive music as embodied and situated activity. *Organised Sound*, in press.

Einarsson, A & Ziemke, T. (2017) Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies. *Frontiers in Psychology* (section: Cognitive Science), submitted to a special issue on “*Beyond Embodied Cognition: Intentionality, Affordance, and Environmental Adaptation*”.

Sex meter upp i luften. Selen spänner mot höften, men det gör inte ont. Kanske att det finns en antydning till rörelse i linorna, en lätt pendelrörelse fram och åter. Musikens puls startar med sopranens insats: en, två, tre, min insats startar på fyran, de andra faller in; vi är igång. En gemensam kropp av elektroniska ljud och tremulerande tungspets-r är satt i rörelse.²

Six meters up in the air. The harness presses against the hip, but it doesn't hurt. Perhaps there is a suggestion of movement in the ropes, a slight oscillation back and forth. The music's pulse starts with the soprano's entrance, one, two, three, my part starts at four, the others come in; we're on our way. A shared body of electronic sound and quavering tongue tips are set in motion.

2 My own observation from performing the work *Metamorphoses* (2015).

1. Introduction

When does something begin? It doesn't begin. There is always something else before it.³

Most of the time we do not know when something begins. It only strikes one as evident once something has gone missing. In a similar fashion there is no one pivotal moment when I discovered electronic music. Rather it grew on me as one thing led to another. When one of the major incentives for me towards music is curiosity, I guess it is very likely to find me constantly seeking out new challenges and domains to expand my field of perception. Just as in life, where events and ideas disappear to reappear later just slightly altered or merely seen from a new angle; I guess some of the themes that are part of my thesis have been precisely this. For example, already in 2008 when I did the project *Ljudspår* [Eng. *Soundtracks*] with two fellow composers, where the audience experienced a concert-in-motion inside a tram, the ideas about finding new ways of facing an audience were present, ideas that later reappeared in the shape of the *elektrikal* [Eng. *Electrical*], (a combination of the words electronic and musical, as in musical theatre), *PS. Jag kommer snart hem!* (Eng. *PS. I will be home soon!*)

My understanding of music has first and foremost originated from me being a vocalist. That was how it all began, starting from when I was a very small child, and I believe this has imprinted in me a way to approach and experience music. To me it is a strong physical component that concerns my body in the room, it has a social dimension since I have met and spent time in the context of music with many great friends, and it is something that is profoundly concerned with relatedness and expressing states: to fellow musicians, to an audience, but not least intrapersonally – a way of being with myself. When singing I hear my voice outside my physical body but also internally. Authenticity has always been a key concept for me. Being in a musical situation and being – some aspect of – me.

Turning to electronics, at first glance it may be hard to see how this may relate to the topic at hand. Corporeal experience, authenticity and...electronics? Indeed the advent of digital technology into performance has raised perennial issues of liveness and brought lively debates among scholars from a wide range of research fields: performance studies, cultural and cyber theory (Dixon, 2007), and last but not least music (Emmerson, 2007). Personally, perhaps it was in the intersection between these concepts that my curiosity awoke. The vast possibilities of timbres at the electronic music palate completely knocked me over and I wanted to incorporate them in my musical expression. I wanted to learn how to program to access a way of sounding and a way of thinking about music that I found tremendously liberating and at the same time very much in line with my background in jazz, making mu-

3 Quote from Kerstin Ekman *The dog* (2009).

sic in or through the moment. One aspect of joining these concepts is experimentation and fascination; yet another aspect of greater concern to me, and in line with scholars like Susan Kozel (2007), who does research on dance in combination with different forms of responsive technology, is what working with [music] technology brings ontologically to the artistic practice. Moreover, encountering the concepts of embodiment and situatedness and the underlying theories in cognitive science has helped me catch sight of my own embodied knowing, and to scrutinize and further my understanding of my own compositional and singing practice.

Of course there is a long history in electroacoustic music (EA) of using voice as sound material, but the approach of processing the live input source (the voice) as a key strategy has not been my primary interest. Perhaps the simple answer is that I love the expressiveness of a voice, others' and mine. The quest has been how to combine the singing voice with electronics, to find the mating surfaces and find means of corporeal experience – the aspect I felt had gone missing in my artistic practice - inside the realm of electronic music. This will be addressed throughout the thesis with the comprised artistic works as points of departure.

1.1. Mapping the thesis chronologically: Vantage points, tours and detours

Setting out on the pursuit of conducting artistic research, a road not very clearly marked, I wanted to explore how I could combine these, as I experience them, two different ways or modes of engaging with music when composing and performing: the singing practice and the live electronics practice. During my master's education I did an audio-visual performance work called *Let me speak* (2008) together with Portuguese visual artist André Sière, where I employed the approach of using analysis of singing voice features (me singing) from existing tools, to impact and bring forward electronic sounds executed by a computer in real time. A network was set up to send data from the singing voice analysis to the computer running the visuals; thus the analysis also affected the visuals. Following the experiences from this work, I wanted to scrutinise what salient features of the singing voice could be used for affecting subsequent sound synthesis. Existing tools for analysis, at least those readily available at that time, did not really allow for the sought-after voice specificity. And I envisioned a seamless relationship with the computer devoid of any physical interface. How could the musical impulses I felt when singing be what had an effect on the sounding live electronics layer, without being forced to having an added layer to performing in order to exert influence? How could the responsive relationship towards the computer emerge from engaging in performing? The theme of the seamless – or cohesive – relationship has

been an active part of my ongoing practical evaluations, experimentations and – not least – as an incentive when composing. While writing how some of this work was about isolating parameters in the singing voice, I am thrown back to acknowledging that these are still actualized within the scope of a musical situation, where the interplay between the musical situation and the spatial situation influences the degree to which those parameters are incorporated with remaining musical elements.

A collaboration was formed with researcher Anders Friberg at the Royal Institute of Technology (KTH) in Stockholm. Two criteria guided the work to identify relevant features in the singing voice. One, features extracted from the singing voice should be salient features from a listener's point of view, but also relevant or musically meaningful to the performer. Two, analysis should be carried out live within the framework of the computer software Max/MSP. This part of the work has been marked by discussions with Anders Friberg, Sten Ternström and Johan Sundberg at KTH, hours of testing myself, and studies of the relevant literature. One result of my collaboration with Anders Friberg is described in the paper *Using singing voice vibrato detection as a tool in a chamber opera* (Einarsson & Friberg, 2015), where the classically trained singer performing with the responsive computer system also was interviewed. The *elektrikal* was a commission from Malmö Opera entitled *PS. I will be home soon!* The commission coincided somewhat with accepting the doctorate position, and I had informed the commissioners I wanted to work with a combination of singers preferably from different genres and implementing different kinds of electronics. Why? The short answer is I wanted to make use of the expanded palate of sound this approach has to offer. The long answer is slightly more personal. I found myself in a trajectory where everyday sounds and a sense of expanded or attenuated listening taken together were extremely inspiring. I went searching for sounds, (not necessarily to be used straight off) watching ship bells at the Maritime museum in Stockholm, making my own sound walks in my neighbourhood. I listened to field recordings from Papua New Guinea, a place that connected to the underlying story for the libretto, the life of Pippi Longstocking's presumed role model Calle Pettersson. I also wanted to work with exploring the possibilities of negotiating the traditional divide between performers and audience through movement, for like many artists I was dissatisfied with the traditional ways of presenting electroacoustic music at loudspeaker concerts.

I knew the majority of the audience at Malmö Operaverkstad would be children, which I figured served my purpose well, as children are known to reveal their likes and dislikes quite bluntly. Composing a chamber opera also including technical development of software is a rather cumbersome and time-consuming process. Nevertheless, the suspended time enabled me to take note of the process of the collaborative making and me as a composer playing a role in this development, all held together by the accomplished artistic director/

librettist Maria Sundquist as well as the remaining artistic crew at Malmö Operaverkstad.

One of the virtues of conducting artistic research is the luxury of letting things evolve over time leaving valuable room for reflection. The experiences from composing and working towards *PS. I will be home soon!* resulted in proposing the concept of *calibration* as an artistic method (Einarsson, 2015). With *calibration* I arrive at suggesting how embodied experiences influence attention and form a kind of joint attention towards the work in the making. I put forward it may be applied on at least two different layers: towards the work in the making through a process of workshops, or within the work, acting almost like a cursor pointing at different elements (i.e. relationships) in the work, connecting and enhancing them through embodied resonance.

The piece *PS. I will be home soon!* was structured in five parts where the audience was divided into two groups experiencing the piece as they were moving through it clockwise or anti-clockwise. For starters, I had planned to include interviews with the audience as well and not only the singers, but as in most research projects, some aspects have to be cut due to matters of delimiting the thesis. Therefore I was left with only making observations of the audience. Nonetheless the audience's perspective has throughout the project been a backdrop against which I have been composing my works.

In hindsight, coming across Eric Clarke's (2006) book *Ways of listening: An ecological approach to the perception of music*, it became clear to me that what we in *PS. I will be home soon!* had staged was also an ecological embodied approach to listening from the audience's perspective, among other things exploring the *affordances* of the performance space (e.g. section 5.1.2, or Einarsson & Ziemke, 2017). The ecological approach also applied to the performers moving about in the concert space, albeit to varying degrees. For example, the singer in *Vykort* performed her part sitting on a swing she set in motion to oscillate back and forth. Sometimes air would involuntarily blow into the microphone and cause noise as she sang, and instinctively she just slightly turned her head in response to make it stop and continued to sing. Small adjustments performers make in response to interacting with the situation at hand.

Some of the experiences from the workshops leading up to the final performances in *PS. I will be home soon!*, for example how the artistic director heard me perform and translated her experiences of the performance – the dynamic contours – into the writing of the libretto (see example 1.2 in Einarsson, 2015), can also be read as expressions of the embodied perspective I have come to elucidate more thoroughly during the latter part of my research project.

The notion of embodiment, of the importance of movement for experiencing, and the dynamic relationship between organism and environment as Clarke puts forward, drawing upon the writings of James Gibson, was a fertile conceptual ground upon which to build the

next work. Furthermore embracing a view where the body is pivotal for both action and perception, and for experiencing in a holistic sense – emotions included – I wanted to explore how the body constitutes a hub, or, in Simon Emmerson’s terminology (2009), acts as an anchor in the performance space, specifically in relation to the *mixed work*, i.e. works that combine an acoustic (human) sound source with a digital one (computer). By moving and being moved, singing while walking, sitting, and in elevation in harnesses, I elaborated on embodied experiences of the relationship towards the computer technology, of singing, listening and of the relationship towards fellow musicians; in essence the mutuality between the situatedness of the performer and the situation at hand. I will expand on what I mean by this last bit, but only after having said a few words on the resulting work *Metamorphoses*, some of its additional artistic vantage points and the process towards that particular work.

One conceptual starting point for *Metamorphoses* was to work with becoming, with transformations. I presented the idea to playwright Jörgen Dahlqvist who was attracted by it and he started working on a kind of reinterpretation of Ovidius’ *Metamorphoses* (2000). In addition, the living butterfly with its three transformational stages was a source of inspiration when composing. Some time before starting with *Metamorphoses* I had also come across the essay *On the Marionette theatre* by Heinrich von Kleist (von Kleist in Parry, 1988). The text had set something in motion in me and is in fact as I see it a beautiful image of embodying a situation. I wanted to make use of harnesses positioning the vocalists in the air to examine how the body’s way of constituting the physical anchor in the performance hall may be unsettled. The marionette is described by von Kleist as a vehicle for the movement of the operator, not as an extension but as a complete re-embodying of the puppet. ”He doubted if this could be found unless the operator can transpose himself into the centre of gravity of the marionette. In other words, the operator dances” (ibid). Many additional interpretations of the text are of course possible. In me, it evoked the following questions: Could I achieve this? Could I transpose myself into the sounding, into what is mediated by technology? Could I sing technology?

Finally, one more important strand of thought I carried with me from *PS. I will be home soon!* was the singers’ ambiguous relationship towards the computer, and how performing with interactive electronics affects the singers in both the cognitive and the emotional realm (Einarsson & Friberg, 2015). The feelings revealed in interviews of both comfort and uncertainty in the setup with the computer had formed the first contours of a “relational map” towards the computer. Its shape had been formed during rehearsals and the month of performances. The tentative sketch was one where the interactivity is not perceived as either a separate disembodied “other” nor as an extension of the performer, but as both. This was later confirmed in the accounts of experiences from *Metamorphoses*, as discussed more in detail in Einarsson (in press) (see also Chapter five).

I deliberately refrain from separating the technical and artistic, for it is a distinction I find difficult to make in practice, finding them most of the time mutually influencing each other during the process of composing. Nevertheless, for the sake of clarity, a technical vantage point for *Metamorphoses* was to work with several responsive systems, e.g. four singers each having one designated computer. I also started working on means for vowel recognition, again in collaboration with Anders Friberg and later with composer/sound engineer André Bartetzki. However, the beta version of vowel recognition was not implemented until the last artistic work my research housed, in *One piece of a shared space*.

The process towards the final performance of *Metamorphoses* was set up with workshops following some of the ideas described in the article *We can work it out – Calibration as artistic method* (Einarsson, 2015). The singers have later commented on this workshop process as being very valuable and important for the final result as a way of getting into - in a truly bodily sense - the complexity of a work encompassing interactive computer technology, grasping my (the composer's) artistic intention more completely, but also providing a possibility for personal growth given time to discuss and reflect upon experiences made throughout the process.

Working with voice and computer is in my opinion working with two extremely flexible materials. They both may, albeit to various degrees, hold completely different roles in other situations. The situation, therefore, which I highlight in *Experiencing responsive technology in a mixed work*, (Einarsson, in press) is of great significance. The situation, as I make use of the word, encompasses all the different materials and peoples that the performance holds. When I distinguish the musical situation from the spatial situation I try to distinguish the sounding layer with its intrinsic relationships from the spatial layer, for the sake of pinpointing different aspects. In reality these two are mutually influential and intertwined. The sounding does not exist in a vacuum, but in a physical setting, so what these are, are different aspects of one and the same situation.

Starting already in *PS. I will be home soon!* I have been working on disentangling the performance space, driven by a curiosity about how the situation impacts the performer's experiences of working with live electronics and of themselves, how these experiences are somehow percolated through the situation. With *Metamorphoses*, as part of the workshop-process, we first made a concert version of two thirds of the piece. Then for the staged version, we deliberately worked with layering several aspects of the situation on top of each other, the spatial, the musical, and the virtual. Additions to the music concerned movement in the physical space; the most far-reaching was to sing elevated a few meters above ground in harnesses as depicted in the beginning, noticing the altered bodily awareness this brought - a key part of the investigation. The virtual situation thereby added brought another flavor to the sung expression in the musical situation as well. The ways of interre-

lating with the other singers shifted, as did listening. The meaning of the response from the computer somehow shifted as well. All the different aspects of the situation, the musical, the spatial, tie together and amplify each other. And for each individual singer there is an oscillation between one's own - the practice of singing as an embodying - and the situations: the virtual/spatial and the electronic. By the *practice of singing* I denote the actual bodily experience of one's own singing, a relationship cultivated and polished through years of formal training and/or artistic practice. Singing becomes a sort of homecoming, a very familiar place to return to, but this is not saying that what this relationship contains is always experienced in the same manner (I return to this topic in Chapter two).

The virtual-spatial situation in the staged version amplified sung passages in ways not present in the concert version. Interestingly enough, the virtual-spatial situation was not primarily in accordance with the text, but with the musical situation throughout the work, and the computer interplaying with the singers. Somehow the coupling had more to do with the experienced flow of the work, its dynamic contours. Hence the intensification of the sung expression was not derived from amplification of the semantic content (the text), but with a spatial-bodily engagement. I brought these experiences along into working with *One piece of a shared space*, an audio-visual performance piece featuring jojk-singer Ulla Pirttijärvi. Norwegian visual artist Marita Solberg made the accompanying visuals. Together we added simple everyday actions rooted in her Sami culture, like sewing and undressing pieces of the traditional garment that she wore. This brought a directedness and situatedness to her singing and elevated the performance. Again spatial-bodily engagement went with the dynamic contours of the music, and also assisted the singer when bridging two sections of the work singing solo to feel a sense of progress in terms of where she was coming from, figuratively speaking, and to where she was heading.

Taken together, this journey has contributed in different ways to my understanding of performing and composing music as an embodied activity in dialogue with the situation at hand.

1.2. Aims and contributions

For a number of years there has been a move towards re-embodiment of electronic music, partly resulting from a number of issues identified as problematic pertaining to traditional ways of presenting electronic music on stage. This artistic research shows ways in which performing with live electronics in a mixed work is situated and how the relationship towards the computer is experienced from a performer's perspective. Put in a framework of embodied cognition and situatedness, implications for performance practice as well as composition are delineated and future research is suggested.

Contributions include:

- Clarifying ways of emphasizing the situatedness, giving way to a negotiated concert practice (Chapter three, five, six).
- Proposing the method of *calibration* in order to facilitate the process towards new musical works incorporating technology (Einarsson 2015, Chapter six).
- Asserting an alternative view on conceptualizations of the relationship towards the computer in the field of music (Chapter five).
- Developing knowing about performing mixed responsive works as an embodied situated activity (Chapter three, five, six).
- Contending a holistic view on composing where emotion plays a vital part, as suggested by the idea of *resonance* (Chapter two, five).
- Outlining a framework for the work of the composer as a process of constructing situations, through shifting *fields* of affordances, based on a shared *landscape* of affordances (Einarsson & Ziemke, 2017).

What the thesis is not/Clarifications

As always in such works as this, some issues have to be put aside. One such, dear to me, is how matters of gender influence technology, both its development and use. In the field of electronic music issues range from who performs it and who composes it down to matters of sounds' gendered connotations. Hopefully my work is imbued by an awareness of my subject's position and acknowledges that choices made throughout this work must be seen through this lens.

As previously mentioned, the audience perspective had to be omitted from my scope of investigation.

Finally, to be clear, the relationship between being embodied and being situated is far from clear-cut, but I adhere to the view that embodiment is a vehicle for being situated in a physical, social and cultural context. Questions of embodiment are posed within the scope of an artistic exploration, which also is reflected back on choices of procedures and methods.

2. Towards Music as Embodied Experience

"I don't understand. But I really liked it." I have encountered similar statements many times in relation to performing contemporary music, and in particular electroacoustic music (EAM). Each time leaving the conversation equally frustrated, but somehow also impelled and urged to explore matters further. What is there to understand that is not related to experiencing?

The comment, a person liking the performance but not understanding it, is not a strange comment given the common conceptualization of music as language and the precedence for language as a sole bearer of meaning in our western society. Provided one sees meaning-making as a process of registering sensory data, performing mental operations on it and to then assigning meaning to it, I guess it makes even more sense. But what if that is not the case?

According to my experience, music for all involved parties (performer, listener, composer) is an embodied experience unfolding in a social and cultural context. Thus, as documented in my research project, here somewhere the challenge and the fascination arise – both as composer and performer – when music performance encounters music technology.

I will continue this line of thought in the chapters to come, starting with discussing the mixed work and some of the issues that have arisen when performers started entering the stage with laptop only, arriving at discussing composing and singing as embodied activities at the end of this chapter.

2.1. Delineating the mixed work

While mixed works may involve any instrument in combination with electronically generated sound, my field of investigation is works that combine the singing voice with computer technology.

The singing voice has always had a certain appeal to composers of electronic music and already some of the earliest electronic music pieces utilized the voice, such as composer Karlheinz Stockhausen's landmark tape piece *Gesang der Jünglinge* from 1956, featuring a boy soprano.

Finding the contact surface between the vocal sounds – traditionally belonging to the pitched domain – and electronically generated sounds – often belonging to the non-pitched domain – has been a challenge accepted by many composers and vocalists throughout history, and long-lasting collaborations were often formed between vocalists and composers to explore these possibilities. Vocalists Joan LaBarbara and Cathy Berberian both worked

in close collaboration with composers such as Luciano Berio, Milton Babbitt, John Cage and Morton Subotnick. Theda Weber-Lucks and Hannah Bosma (Weber-Lucks, 2003; Bosma, 2003) have pinpointed how these collaborations mostly consisted of male composers and female vocalists, so unfortunately the list of examples becomes somewhat one-legged from a feminist point of view. As in many of these works, one way of finding these mating surfaces between the different sound sources has been having the vocalists perform extended vocal techniques, i.e. experimenting with non-traditional ways of singing (Listen for example to *Sequenza III* by Luciano Berio or *Stripsody* by Cathy Berberian). Hence in these cases the use of electronics has mutually been influencing the voice and been influenced by it.

Yet another approach towards marrying the singing voice and electronically produced sounds has been using the singing voice as sound material subject to transformations and distortions. Starting out in the 60's and 70's, voice artists like Diamanda Galas, Meredith Monk or Laurie Anderson made use of different common analogue devices available at that time, like microphones, filters, feedback and reverberation, to manipulate the voice live. The latter vocalist Laurie Anderson has throughout her career had an emphasis on storytelling (Goldberg, 2000), which brings out yet another important keystone in combining singing voice and electronically generated sound. The presence of semantic content when including singing voice has indeed formed a watershed between composers. As a result, the singing may be with or without words, or - as in the work *Ommaggio a Joyce* performed by the before mentioned duo Cathy Berberian and Luciano Berio - with onomatopoeics. Nevertheless the presence of a voice, no matter how distorted it may be, is hard to erase from human perception, and to use the voice as sound material has been a very common approach up to today.

The different approaches to joining singing voice and electronics can be traced historically in part due to different aesthetics, but also as a result of advancement in technology over time. It was not until the 90's that computers became powerful enough to do extensive real-time computing on stage. Before this, it was either tape pieces or (in most cases) analogue devices manipulating sound that was staged. American-born John Cage was a pioneer of the latter, experimenting with tape pieces, and combinations of instruments and unusual technical devices like radio receivers. The use of live electronics marked a blurring of the divide between composer and performer, quite different from the fixed tape pieces rendered in the studios where composers exerted minute control over details (Salter, 2010). Artists like Pauline Oliveros did not have much concern for minute control over details. Improvisation was a core element in her artistic practice, alongside the use of home-made circuitry fusing her accordion with electronically generated sounds (Oliveros, 1995). Pauline Oliveros also had profound ideas on what she denoted "deep listening" (ibid), and reading her notes *Some sound observations* in the book *Audio culture* (Cox & Warner, 2004), a truly

embodied approach to perceiving sound is depicted: “hearing seems to take place in my stomach” (Oliveros, 2004, p. 103).

A final comment regarding this section: There are of course a great number of works utilizing the voice in profound ways, adding more approaches than those accounted for here, like Hildegard Westerkamp’s *Kits Beach Soundwalk* (1989), or the whole text-sound movement in Sweden (Hultberg & Bock, 1994), but these do not specifically make use of the singing voice and are therefore omitted in this context.

2.2. Continuing with mixed works: The increase of processing speed and the research centre IRCAM

In the 1977 the influential centre IRCAM opened in Paris. Its aim was to facilitate collaborations between composers and performers with different scientific approaches to acoustic science. A number of different research teams focus on subjects such as musical representations, analysis of musical practices, sound design and sound synthesis/analysis. The direction of the centre’s real-time department was imbued by Pierre Boulez’ aesthetics of serialism and a reliance on notated music. Moreover, much focus was placed on the development of real-time technology with synthesis and analysis of sound. Later, Miller Puckette developed the software there that would become the widespread computer program Max, for use in real-time processing.

Over the years IRCAM has collaborated closely with a number of composers to develop new tools for music performance and analysis. One of these has been Philippe Manoury, whose beautifully executed work *En Echo* (1993) for soprano and electronics has appealed to me. It may represent the *score-following* approach, where software is designed to keep close track of the score and dynamically follow the sung part as the piece proceeds. Another composer associated with IRCAM for many years who has been a great source of inspiration for me is Finnish composer Kaija Saariaho. Her work *Lohn* (1996) for soprano and electronics employs an *event triggering* approach with prerecorded soundfiles activated by MIDI-pedal as well as additional processing such as reverberation and spatialisation. Technology is actually quite simple in this work, but the result, with smooth transitions between different sound sources and the voice calling from afar, is far from trivial.

Canadian-born composer Zack Settel, also associated with IRCAM for a number of years, has had an approach similar to mine, of using analysis of the singing voice to influence sampling, synthesizers and synthesis engines, for example in his piece *Hok Pwah* (1993) or *L'enfant de glace*, an electr’opera from 2000.

2.3. Or is she just checking her e-mail...?

The laptop era marked a radical aesthetic turn where performers began entering the stage with laptops only. Many aesthetic debates have followed as a consequence. One pivotal question has concerned what it actually means to perform something live, and the disembodied performance situation using the computer keyboard for sound control has been thoroughly disseminated (Emmerson, 2007). Some of the issues concern the dissociation between cause and effect. In general terms, means for controlling sound, which in traditional instruments is a feature integrated with sound production, became an area of exploration with the advent of the computer as sound generator. The inherent connection between sound production and sound generation was lost. On the one hand this opened up an array of new possibilities. Any action or gesture could be the origin of any sound. On the other hand the very same notion became a problem, not the least in terms of performance intelligibility. When the laptop keyboard is used as an interface, how can the audience tell sounds apart from one another or anticipate the character of the next sound produced? For example, many digital interfaces display a lack of physical effort, effort which is a key feature in many acoustic instruments' sound production (e.g. Ryan, 1991).

The matter of interface development has gained lots of attention and there is a whole conference devoted to the subject, *New Interfaces for Musical Expression (NIME)*. What connections are relevant and what should be the guiding principles when developing new interfaces have been some of the research questions. Some developers stay with the acoustic instrument as the prototype when designing new music instruments. For example the concept of effort has been a guiding light for some developers (e.g. Fels et al, 2002). Others say that we need thinking outside the box and not clinging to an old paradigm (e.g. d'Esquivan, 2006).

Looking at artists' practices, some artists have focused more on the development of physical interfaces for control, like "the glove" by Michel Waiswiz at STEIM in Amsterdam (Salter, 2007) or the "body-synth" used by American artist Pamela Z (Pamela Z, 2003). Here I would also mention Swedish composer/professional opera singer Carl Unander-Scharin, exploring the design of new interfaces for controlling sound in opera performance with external interfaces, in this case primarily sensor-driven technology (e.g. in one implementation embedded in a glove). He represents an approach towards the mixed work where the use of an interface is almost choreographed and design-wise visually very prominent.

Other artists have researched means for analysis of physical gesture or audio signal from acoustic instruments to control or influence sound. The latter has also been the approach of collaborations at the IRCAM-centre for many years.

My approach has been striving for a seamless relationship towards the computer, having

the voice as the only sound controller, devoid of any physical interface. Now the voice is an interesting exception in relation to using any other instrument for sound control. Many singers give accounts of an interesting ambiguity of both being and having their singing voice, which I will discuss further below. However I don't want to call the voice an interface, since I then would be introducing a homunculus in the system, i.e. giving way to the question "who is playing the voice?". Also this would go against my holistic conception of singing. So where does this lead me? There is an interesting parallel in the Human Computer Interaction (HCI)-community/tech-community bringing forward the concept of *no user interface (No UI)* or *zero user interface (Zero UI)* (Aube, 2015; Winter, 2016). According to this view nothing is intended to stand in the way between user and content. As Donald Norman wrote in 1990: "The real problem with the interface is that it is an interface. Interfaces get in the way. I don't want to focus my energies on an interface. I want to focus on the job..." Some of the available applications of today are text messaging, but many more applications seem to be in the starting blocks.

I will not go further into these issues, but I want to draw attention to the need of mastering a new instrument. One obvious advantage of using the singing voice for professional singers as sound control, as in my work, is that there is no need to learn a completely new interface, but rather they can build upon previous knowledge. Nevertheless, as this research has shown, one cannot neglect the necessary learning involved, learning that pertains to questions of embodiment and to the psychological realm rather than to a mere technical know-how.

2.4. Questions of mapping and feature extraction

In order to produce sound, the interface needs to be connected to a sound engine of some sort, and the way this configuration is made is usually referred to as *mapping*. One whole issue of the British music journal *Organised Sound* was devoted to the topic of mapping (Volume 7, issue 2, 2002), and many music scholars and composers have dealt with the subject in relationship to designing new interfaces or developing interactive systems. Swedish composer Palle Dahlstedt has in numerous papers (e.g. Dahlstedt, 2008) described different approaches towards mapping as part of his in-depth exploration of computer based algorithmic composition, evolutionary algorithms in particular. In my research I have made use of one-to-one mappings but also many-to-one and one-to-many; I have however not systematically evaluated the matter, this not being any focus of my research.

I have also applied the mapping through metaphor approach, discussed in Einarsson (in press), which is interesting not least in its closeness to a embodied cognitive stance (more on embodied cognition in the chapter to come).

The salient features of the singing voice are generally assumed to be harmonicity, formants, vibrato and tremolo (Regnier & Peeters, 2009). Throughout this research project I have had an ongoing collaboration with researcher Anders Friberg, and Sten Ternström, both at the Royal Institute of Technology in Stockholm, searching for singing voice features according to the following conditions: musically meaningful for a performer, extractable in real-time and possible to implement in the software environment of Max/MSP. We set out working on vibrato as a perceptually salient feature. In parallel I translated Anders Friberg's application *cue extractor* (Friberg et al, 2007) from the software PD to Max/MSP and experimented with combining its extracted features. A great difficulty appears when singing voice features are to be measured from audio signal only. Many features of the singing voice demand different kinds of measures, such as sub-glottal pressure data or glottal closure. This is of course known to voice researchers but something I was not fully aware of when setting out to conduct this artistic research. Yet another example is female vowels, where the human auditory system actually adds psychoacoustic data that is not present in the audio signal. Despite this we attempted a tool for vowel recognition, a sort of spectrum matching approach towards vowels, and Andre Bartetski created a program drawing upon a simple form of machine learning. Vowel sounds are recorded beforehand and fed into a library, where an algorithm during performance attempts to find the closest match. This was implemented as basis of spatialisation in the work *One piece of a shared space* (2015). There it also became evident how mapping onto spatial data is not at all equivalent to mapping onto pitch-domain or rhythm-domain. Of course this relates to our sensibility towards distinguishing pitch and rhythm in comparison to distinguishing location. The latter is not at all as fine tuned, but depends on the frequency components of the sound being moved.

Due to the abundance of noise when extracting parameters from the voice, Fasciani and Wyse argue that voice-control is best suited for mapping timbral continuous parameters and leave mapping of note triggering to traditional touch-interfaces (Fasciani & Wyse, 2013). They even suggest a dual-interface approach.

2.5. A prevailing dualistic view on the mixed work

Other issues relate more to performance practice such as how to enable and display a virtuoso quality. The more powerful computers have also made possible more computationally heavy processing in real time, and in mixed works, the electronic part previously performed on tape is more often replaced by processing executed in real time. This has provided grounds for the notion of the disembodied other – referring to the electronically generated sound source – which has become quite a manifest conceptualization (Emmerson, 2009) for mixed works.

Mike Frengel (2010) proposes a framework designated for analyzing mixed works containing nine dimensional axes (segregational, proportional, temporal, timbral, behavioural, functional, spatial, discursive and pragmatic) focusing on the relation between live and non-live sound sources. He makes the claim that the disparity between physical gestures made by the performer and gestures implied by the music, causing an inconsistency in the relationship between live and non-live components, is the cornerstone of mixed works. Frengel builds his analytical framework on the assumption of a dualistic relationship between live and non-live sound sources, and even though his examples are from tape pieces only, he claims the framework is equally applicable to live electronics.

Polymorphological interpretations arise under conditions of plurality, where combined components are heard as having more than one musically significant identity. The live/non-live dualism is strongest here, with components displaying some degree of independence or interdependence (Frengel, 2010, p. 98).

The claims he makes are somewhat of "a view from nowhere". What is the basis for claiming live/non-live dualism to be strongest in the above example, and is it necessarily a dualism? Contrary to Frengel who does not consider there to be any difference whether the electronics are performed live or not, - "the difference is solely technological" (Frengel, 2010, p. 103) - my work puts forward that to most performers this matters a great deal when experiencing performing the mixed work. For example, the degree to which it is possible to anticipate the behaviour of the computer influences how the computer is experienced and conceptualised, in concert with other situational cues during performance. Furthermore, an exploratory approach and an element of waywardness in the relationship towards the computer is accounted for as valuable and musically meaningful (see Einarsson, in press).

2.6. A note on genre identification: improvisation, interpretation and notation

Performers and composers of course differ in approaches and backgrounds, on a personal level, but also on a more general level. As described in the introductory chapter, I have been collaborating with both classically trained singers and jazz singers, thus it makes sense to say a few words about the different points of departure for these traditions regarding improvisation, interpretation and notation, but also about my take on these matters, without any claim or intent to fully cover these large subjects.

The soil from which ideas about improvisation grew and are active in the present day differs quite a bit regarding western traditional classical music and the free improvisation stage and jazz. This is illustrated by George Lewis with two quotes, one from avantgarde composers of the 60's and 70's who, according to Lewis, saw improvisation as a well-defined rule-based maze to walk through with a more or less successful outcome, and one from a performer's perspective, improvisation being a matter of preparation, opening the ears and just playing the moment (Lewis, 2006). I think I house both these approaches to some degree; as a composer I hold more of the former, while as an artist I hold more of the latter. In terms of notation I adhere to a rather traditional Western-oriented way of notating my works as proposed by Blatter (1997), but this is by no means one uniform style; choice of solutions and the amount of detail differ greatly among composers identifying with western classical music. The influence from jazz in my works is present in oral instructions and in their encompassing improvisation, although improvisation in my work is often structured, for example as box-notation containing suggested musical material.

Unfortunately the stance in traditional classical music regarding improvisation is often less forgiving. As musicologist Christopher Small contends 'the tension and the possibility of failure which are part of an improvised performance have no place in modern concert life' (Small, 1997, p. 283 - 284), and this is the paradigm according to which many classically trained musicians of today act. Thus, preconceptions circumscribing the approach towards a new work differ a great deal depending on to what genre one identifies foremost with and what formal training one has. For even if genre is not a separate set of features, but of features dependent on listening strategies and performance situations (Emmerson, 2007) and thus in many ways a cultural construction, many institutions in society keep consolidating these differentiations. So generally speaking, to a jazz musician making an addition and a personal contribution to the music presented in terms of a personal imprint is almost paramount, whereas to a classically trained musician, the self-image and preconception of one's role is more one of being a vehicle for the composer's intention. This has not always been the case, and looking at the baroque era, before the work-concept became too widespread, there was much more improvisation also in classical music.

But is it as simple as either improvisation or no improvisation? Benson (2003) suggests eleven shades of classifying improvisation, from subtle interpretation within a fixed work to free creation, serving as a reminder of the great span of expressions there is. In his view, all music - scored or not - is partial, unfinished and constituent by improvisation. Thus there is no one original musical object, which questions the common way of the western classical tradition to consider notation as productive and performance as re-productive (Frisk & Östersjö, 2006). Indeed working with composition utilizing responsive computer technology in an artistic context raises issues about authorship, a point emphasized by many

scholars (the interested reader may see for example Garnett, 2001; Frisk, 2008 or with a historical outlook on the work-concept: Goehr, 2007).

Finally, there is no one agreed-upon standard for how to notate electronic music or mixed works, and many efforts are being made to find new software tools as well as styles of representation (e.g. Kojs, 2011). Often graphical scores have been used and are used for representing music that moves beyond the traditional note-paradigm as electronic and experimental music often does. Cathy Berberian's score on *Stripsody* from 1966 is one example of a score for performance, Brian Eno's score for *Music for airports* (1978) is an example of using the score foremost for visualization.

2.7. What is this thing called interactivity?

Interactive music systems do not lend themselves easily to classification since the same system may be used in very different contexts, and these in turn may differ radically (Drummond, 2009). Also the concept interactivity itself is applied to such a wide range of research areas, and has become so all-encompassing – it can denote anything from a CD-ROM to highly complex computer systems and robots facing numerous tasks in natural environments; it has almost lost its meaning altogether. Despite this, many scholars begin by using the often-quoted taxonomy suggested by composer and researcher Rowe in 1993, to then continue on delineating their own viewpoint. However, his classification was formulated at a time where MIDI was prevailing, and it is very much based upon an information-processing view of music with input to a system, which is making manipulations and then generating an output. Other suggestions have been made, for example by Winkler (1998), Bongers (2000), Birnbaum et. al (2005), but for most part they seem to lack perceptual, psychological and/or ecological dimensions. Accepting these dimensions would entail assuming a more phenomenological perspective on interactivity where not only the computer system and the needed input are taken into consideration, but also its situatedness (see introduction). Continuing this line of thought, I will tentatively sketch how such an approach could be outlined in relation to my own practice with mixed works; at least what kind of questions could enunciate these dimensions.

Once having settled on the number of performers and the number of interactive systems, similar to the classification by Bongers (2000)⁴, these additional steps could be pursued.

First, in the psychological realm (fully aware that psychological and perceptual overlap), how much are the performers depending on a score for interacting with the computer

⁴ Bongers (2000) suggests: 1) performer with system, 2) audience with system and 3) performer with system with audience later augmented by Drummond (2009, p. 127) with the categories “multiple systems interacting with each other and/or multiple performers”.

(score in contemporary music is of course a wide notion, but here I make use of the word in a traditional sense)? How much freedom in relation to a score and in relation to the computer-generated responses do the performers experience as having when deciding how to interact with the computer as the piece progresses? Do the performers feel restrained? Very much, or little to none? Perhaps it goes without saying that these are the poles but it is intended as a continuum, in this case describing perceived degrees of freedom when performing.

Looking at *Metamorphoses*, the score provides directions that frame the improvisation and build bridges between sections, similar to how the computer acts. In *PS. I will be home soon!* the score is very important as a result of working with mostly classically trained musicians and singers and using only a little improvisation as part of the work. In *One piece of a shared space* there was nothing but verbal instructions and mutual discussions about content. The singers in *Metamorphoses* generally did not feel restrained at all, neither by the computer response nor by the score, nor in *One piece of a shared space*; but in *PS. I will be home soon!*, in the part *Vykort* the singer felt rather restrained, particularly in relation to the computer response (see also Einarsson & Friberg, 2015).

A system consistently providing precise and predictable interpretation of gesture to sound would most likely be perceived as reactive rather than interactive, although such system would function well as an instrument in the traditional sense. Conversely, where there is no perceptible correlation between the input gesture and the resulting sonic outcome, the feel of the system being interactive can be lost, as the relationship between input and response is unclear. It is a balancing act to maintain a sense of connectedness between input and response while maintaining a sense of independence, freedom and mystery; the system is in fact *interacting* and not just *reacting* (Drummond, 2009, p. 128, emphasis in original).

2.8. Singing and composing as acts of embodying

The voice is indeed one important means of (social) interaction, be it with or without technology. And speaking of music as an embodied activity, what can possibly be more embodied than a human singing voice? The many metaphors making use of the voice in our everyday language reveal its position at the core of the human condition: to have a strong voice in a matter, to give voice to ideas, to be silenced, and many more. Our voice reveals

bodily states in terms of emotions, degree of alertness, or pains. In the article *Triptyk om rösten* (Einarsson, 2010) in the magazine *Nutida Musik* I elaborated on some of these issues, the voice as a fingerprint and the voice as a medium.

As a means for participating in a musical context, the voice is extremely agile and multi-faceted. Many artists have explored these possibilities to the fullest, experimenting with singing range, timbres and language, a topic I touched upon earlier when discussing the mixed work. Different genres call for different voice production, for example differences in how to use singing voice vibrato (see Einarsson & Friberg, 2015), which ties to the preceding discussion about how interpretation and improvisation is influenced by formal training and genre identification.

The practice of singing as I denote it, is an act of embodying in dialogue with the situation at hand, of feeling, sensing, stretching, and listening. As stated in Chapter one, it is the bodily experience of one's own singing, a relationship cultivated and polished through years of formal training and/or artistic practice. Rather than being a state, it is a dynamic process of becoming, where the familiar ground constituting the practice always urges a rediscovering. In my view it is not a place where time is arrested in the way folk singer Susanne Rosenberg describes in her dissertation (Rosenberg, 2013) her concept of *nukänsla* (sense of presence), and which she relates to the concept of *flow* (Csikszentmihaly, 1990), but an active process highly connected with the different aspects of the situation.

Unander-Scharin suggests the concept *vocal embodiment*, which is interesting, hence I will spend some time outlining it. He writes that singers experience a certain “experiential quality” that relates to learning about one's vocal technique when interacting with the electronic instrument, and he calls this quality “vocal embodiment” (Unander-Scharin, 2014, p. 112). The term experiential quality is adopted from Ståhl, Löwgren & Höök (2014) and taken from its description resembles a concept related to (but not to be confused with) *affordance*, namely von Uexküll's *functional tone* (Susi & Ziemke, 2003, see Chapter three). One of the singers in Unander-Scharin's thesis gives an account of a heightened awareness and a developed listening, although in what way it was developed is never explored. Another singer mentions how she through the use of one of Unander-Scharin's instruments gained awareness on how certain vocal sounds of hers projected more than others. These findings of attenuated listening are very interesting, but how much of the alterations of vocal technique can be ascribed to culture – these are all formally trained opera singers having the perceptual learning resulting from such training– and how much can be ascribed a general notion of vocal embodiment?

Unander-Scharin talks of embodiment and makes references to Paul Dourish's book *Where the action is* from 2004, but apart from making the reference never discusses what kind of embodiment he is drawing on. Towards the end of the passage he seems to equate

embodiment with bodily awareness.

When influencing and changing important musical factors through bodily interaction, the vocal production alters and a deepened bodily awareness emerges. Through the use of these novel interactive instruments for opera, singers have experienced how their vocal practice has reached a deeper relation to their bodily practices, expressed an enriched sense of embodiment between their voices and the overall performance, in short – Vocal Embodiment (Unander-Scharin, 2014, p. 116).

In addition, the distinction between vocal practice and bodily practice leaves a question mark for the reader. What is voice if not bodily? I think what is intended is something much more profound, but it is never really elaborated on.

As previously mentioned, many singers involved in this research project give accounts of an interesting ambiguity of both being and having their singing voice. The singing voice is so intimately tied to a social identity, deceptively static, yet simultaneously it is an unveiled surface subject to constant influence from the surroundings, thus at times it may surprise. Perhaps in part also due to the peculiar way a person may hear ones own voice through skull vibrations simultaneously with the body capturing air molecules set in vibration, the singing practice is an iterative process of embodying where closeness and distance is tightly intertwined.

I want to highlight how feeling guides my knowing when singing, and I don't mean this in the more mundane way of feeling what the song is about. Drawing upon my artistic experience, singing for example an interval of a minor second in harmony with another voice or an electronic timbre, is a *felt* experience. In this case the dissonance is first and foremost a bodily experience.

Turning to composing, in a similar vein the act of composing is to me something deeply rooted in my embodied being in the world. Hence the decision-making when composing does not originate from a “self” operating the body performing rational calculations, but is a matter of finding *resonance* between a bodily state and the sounding, and to navigate this flow of exchange between sounding material and the bodily states they induce or have originated from. It is a matter of *feeling* impulses that attract or repel, and being attentive towards a pendulum movement between the whole and its parts, towards the unfolding situation.

As Estelle Barrett writes on materiality in artistic practice: “In creative production, there is no opposition between inside and outside: consciousness and materiality are mutually constitutive, enfolded and emergent (Barrett, 2013, p. 72). She is not saying artistic practice remains on a conscious level. On the contrary, she argues for an artistic knowing that

exceeds what can be captured by the symbolic, citing Dewey in that “action, feeling and meaning are one” (Dewey in Barrett, 2013, p. 67). However, Barrett, drawing upon the writings of Julia Kristeva, introduces the concept of an “aesthetic image” as a sort of intermediate link towards the artwork, or in her words “structural aspect” of the artwork. She writes, “the aesthetic image is not the art work *per se*, but a materialization of the object as it is felt and a structuring of symbolic elements in ways that disrupts customary codes” (ibid, p. 66). I follow her with great interest when describing the reflecting back and forth between artist and artwork (in her terminology aesthetic image) bringing about potentially new perspectives and understandings of the world, and I agree with her on the role of affect in artistic decision-making, but I don’t see a need for introducing the mediating layer of an aesthetic image, which of course also verges on my view on the ontological status of a musical work. To me the work resides in a reciprocal relationship between the person experiencing and the sounding. As T.S Eliot (1941) writes: “You are the music, while the music lasts”. Barrett makes some references to the research of neuroscientist Antonio Damasio and in the chapter to come I will delineate my reading of Damasio in relation to compositional practice. Also I will return to epistemological implications of attentiveness towards the sounding in Chapter four, but for now it suffices to say I regard attentiveness as a way of knowing, and the described embodying of the compositional process a way of shaping ones knowing.

The molding of the sounding material when composing results in a movement which at times is experienced as the sounding having some autonomy, but which in fact is a result of the continuous interaction with the material. This latter is many times referred to as a perception/action loop (Vaggione, 2001; Östersjö, 2008). For Vaggione this is the instance where the relationship between different musical layers may be controlled and validated, i.e. where compositional control is exercised. He contends: “Action and perception lie at the heart of musical processes, as these musical processes are created by successive operations of concretization having as a tuning tool – as a principle of reality – an action/perception feedback loop” (Vaggione, 2001, p. 61). Although I fully agree with Vaggione on the outline of the general musical process, it is important to note that his vehicle for perceiving is listening alone, while for me it involves an act of embodying in a much more holistic sense. Also he is not being very clear on for whom perceiving acts as a validation of the composer’s intention, whether it is a general notion or pertinent to the composer only.

The notion of singing and composing as acts of embodying is expanded upon in Chapter five (e.g. section 5.1.3.), but also constitutes part of the more general discussion on embodiment in the chapter to come.

3. Perspectives From Embodied Cognitive Science

The divide between body and mind has since long been a debate among philosophers and scientists, and is inevitably a backbone of many religious beliefs, in many ways deeply interwoven in our western culture. The dualistic worldview is commonly associated with the ideas of French philosopher René Descartes in the 17th century, according to whom mind and body are seen as two different substances. Behaviourism arrived in the early 20th century as a kind of reaction against dualism. The behaviourists thought only overt behaviour worth studying, and explanations for human behaviour were sought in classical and operant conditioning, in chains of stimuli and responses. Still, little attention was given to the embodied aspect of being (Lindblom, 2015).

When psychologist James Gibson later formulated his ecological theory of perception, drawing upon some of the ideas from the Gestalt school, it was in opposition to the existing (disembodied) cognitivist paradigm, where conclusions about human behaviour were drawn from experiments conducted with human test subjects sitting in front of a computer screen. In Gibson's view, the organism was active, which - among other things - called for completely different research methods. Instead of seeing the stimulus information in the environment as insufficient and chaotic, the environment to Gibson already contained the information an organism needed for navigating. Also, according to this view, the body is paramount for how we experience the world. Hence, in stark contrast with the dualistic worldview, this assumption, to some extent the theoretical underpinning of embodied cognitive science, asserts that the body is constitutive of our everyday being and meaning-making (Clark, 2008 in Shapiro, 2007; Johnson, 2007). In many ways it requires us to re-think what it means to be rational, to be in the world, and to be human.

3.1. Embodied cognition “Second generation cognitive science”

The traditional outlook on cognition of today is “the computational model”, where reason is seen as comparable to symbol manipulation of inner processes as found in a computer (Shapiro, 2007). Since this process takes place detached from the world, there is inevitably a gap between human thinking and the outside world, thus a unit for bridging this divide had to be inserted in terms of mental representations that bring meaning to the scene.

Embodied cognitive theory offers a different set of explanations for human cognition. Countering the traditional view, the important major claims of embodied cognition, following Margaret Wilson (2002), may be summarised as follows:

- Cognition is situated
- Cognition is time-pressured
- We off-load cognitive work to the environment
- The environment is part of the cognitive system
- Cognition is for action
- Offline cognition is body-based

3.1.1. Cognition is situated

There is broad agreement concerning the first claim that cognition is situated. The relation between situated cognition and embodied cognition is not yet fully settled, but I will adhere to the view that embodiment is part of the mechanism enabling situatedness (Lindblom, 2015). It is, for example, by means of my embodied being I can participate in many shared social and cultural practices. My body is affected by the environment, be it, say, room temperature or how crowded the space is, but I also act in the situation through the constraints of my body; for example, my hand span decides if I can reach a duodecima on the piano or not. As Johnson puts it, “the body carries forward the meaning of the situation” (Johnson, 2007, p. 84).

Already in 1930, philosopher John Dewey discussed how the situation with its complexity of physical, biological, social and cultural conditions constitutes any given experience (ibid, p. 72). Despite this, being situated is many times interpreted in a very narrow sense of a “being here and now”, e.g. in the case of so-called situated robotics (Ziemke, 2001). But, as pointed out by Jana Rambusch (2010), situatedness also encompasses additional layers. There is the social and cultural knowledge brought to the situation, embedded in tools and artifacts, and the communities of practices to which people hold membership. For example, in a music performance situation such as *Metamorphoses*, there are several layers that include (but are not restricted to): musicians’ formal training, identification with music genre, associations evoked when working with computers, the familiarity or unfamiliarity of taking stage directions, and so forth. The physical space itself also has connotations with certain institutions and kinds of audiences. Furthermore, people are situated through their bodies and the type of interaction this allows for. Again in *Metamorphoses* this was really the centre of attention when performing whilst moving about in the performance space or elevated in harnesses. Modes of interaction commonly used in a music performance situation such as kinaesthetic cues inevitably became highly restricted between performers when singing in elevation, in favour of a heightened awareness of music gestural cues. The equipment interacted with also restrains which skill that can be employed and developed. In the following I want to replace this notion of equipment with material encountered in the performance situation, to also include elements such as the performance space. This latter aspect of the coupled relationship between the bodily interaction and environmental features

is many times explored with the help of the concept of *affordances*, a discussion explored in detail in Einarsson and Ziemke (2017), to which I will return to later on in this chapter.

When singing and listening to the flow of the music there is simultaneously a ‘listening out’ for what is not present, or where the music is experienced as being headed. This is especially the case when the music holds elements of improvisation and interactive technology, and is hence not entirely predictable. There is a parallel flow of the “here and now” explicit situation and the imaginative, implicit situation, traditionally in the cognitive science literature referred to as on-line cognition and off-line cognition. Psychologists Ludger van Dijk and Rob Withagen (2016) expand on how these concepts relate to the notion of abstract time, and instead argue for a notion of time based on agent-environment couplings, where the division into online and offline cognition as underpinned by two different neural mechanisms no longer would apply⁵. In a similar vein, philosopher-psychologist Eugene Gendlin (in Johnson, 2007, p. 82) discusses these two aspects as a felt sense and a formally expressed sense, but warns us from making a sharp distinction between the two, these being two dimensions of one single meaning-making activity.

The felt sense is part of the situation, it is not pre-verbal and it is not vague; it is extremely precise. Our situations are embodied, thus meaning is embodied. “Our bodies imply the next words and actions to carry our situations forward” (Johnson, 2007, p. 84).

3.1.2. Cognition is time-pressured

The notion of cognition as being time-pressured applies first and foremost to a real-world situation. Even though we are not always under a felt time-constraint, sensorimotor co-ordinated activities require *timing* (Lindblom, 2015, p. 91), which is indeed the case in a music performance situation. Working with the responsive technology, perhaps an improvisation needs to happen within a certain time-span in order to engage the desired response. Likewise, in order to make musical sense, one performer needs to form a response to what another performer just sang in close enough time. However, how time in a piece of music is experienced is a completely different story. A well-recognised fact in the literature of performing with live electronics is how some performers experience performing against a fixed beat as restrictive to their expressiveness (Emmerson, 2007). One might speculate that, perhaps the demands for sensori-motor co-ordination then differs from previous experiences, which in turn creates this experience of being “trapped” between the barlines as Elizabeth McNutt (2003) puts it. There are findings suggesting that cognitive load has an impact on timing, drawing upon a study made with opera singers (Corlu, Maes, Muller, Kochman & Leman, 2015).

5 Online and offline cognition sharing the same mechanism has also been proposed by other scholars. For a full account, see Lindblom, 2015, p. 95, p. 124-135.

3.1.3. We off-load cognitive work to the environment

What is actually meant by an off-loading of cognitive work to the environment is often exemplified by a study in which participants were seen to utilise rotation on screen in a game of Tetris, to ease the cognitive load (Kirsh and Maglio in Lindblom, 2015). Offloading is the way people alter or make use of the environment to handle cognitive demands placed upon them. Having a score is one way of off-loading, but also visual representation and feedback on a computer screen, although distracting for some, assist in keeping track of where the performer is in the musical form, thus offloading. Interesting aspects are also physical gesturing when improvising, or putting up stage props in order to remember what action precedes the current one. There may be a strong association formed between the location on the stage and what part of the music is to be performed. Finally the computer also assists in coordinating the actions of the singers, providing cues for events to happen or supplying pitch information. In my experience from this research project, the computer as a facilitator is the most obvious role of the computer for someone not used to working with computer technology.

3.1.4. The environment is part of the cognitive system

This claim relates to the previous one in that offloading cognitive work onto the environment functions as scaffolds for the cognitive work (Lindblom, 2015). Seeing the environment as part of the cognitive system implies that the cognitive system does not end at the surface of the skin or by the skull, but extends its boundaries to include the whole body and the environment. Wilson is somewhat critical about this claim but mostly in terms of the unit of analysis. There is a common example with the blind man and his stick; does his cognitive system include the stick or not (Hirose, 2002)? Hirose argues for an ecological perspective: “If an inorganic tool, such as a blind person’s stick, supports information pick-up activities, the tool is regarded as a component of the perceptual system. Thus, appendages and tools can constitute a potential functional extension of the user; it plays a central receptive surface, provided they have a susceptibility to physical influence” (ibid, p. 291).

Turning to music, a phenomenon that has been penetrated in this research project is how the performers experience the relationship towards the computer, i.e. as an extension or as a separate entity. In my work, does the sounding computer response provide information about the environment as the stick does? And may the environment be sensed through the music? To begin with, similar to the earlier question of what exactly constitutes a situation, one might ask what is actually the environment in the musical work? It has been touched upon; the material in the performance situation includes the space, the performers, the audience, assisting staff, the computer technology, the score etc. The sounding response does

say something about the space we are in, its acoustics. It may say something about the audience – how do they respond? It also has something to say about group dynamics, although this is of course also restrained by other components such as the score and the composer’s overall artistic intention. But does the sounding response have susceptibility to physical influence from the environment? Only the influence originating from the performer, I would say, even though one could argue loudspeaker placement and projection also impacts the response, which constitute elements of the environment. In addition there are of course notable differences regarding materiality between a sound and a stick, where the sound has an inherent process in the shape of an envelope.

3.1.5. Cognition is for action

This claim is about how cognitive processes aim at guiding and controlling situation-appropriate behaviour. It also concerns stressing how an organism actively interacts with the environment. For example the robot Herbert, developed by Rodney Brooks (1991), makes no distinction between perception, planning and action when performing the task in a laboratory of collecting soda cans. He has no communication between inner layers and there are no commands like “grasping-commands”. However, whether or not advanced cognition functions this way is an on-going debate.

Recent research findings indicating that perception and action make use of the same neural systems thus put to question the distinction between action and perception (e.g. Galtese, 2003). As I am pursuing the act of singing, I am simultaneously hearing the sound of my voice and may also alter it in response to what I am hearing. As others sing, I tend to feel their singing in my own voice apparatus. There are for example many singers who can witness how they experience hoarseness after listening to someone talking or singing with a pressed voice. Also when composing I hear music “internally” and take action to put it into sounding. I feel the flow of it, I hear the sounding of it and an iterative process is set in motion, somewhat conflating the action with the perception, the subject with the object.

3.1.6. Off-line cognition is body based

This last claim is perhaps the most supported one, at least according to Wilson (2002). The work by Lakoff and Johnson arguing for bodily rooted metaphors forming the bases for all abstract thinking is one prominent example (see Ziemke, 2003). Removing from the equation overt behaviour such as counting fingers while keeping the priming action inwardly, it can be argued that offline cognition continues to function utilising sensorimotor capacities. This is a way of explaining how “offline” cognition and “online” cognition make use of the same mechanisms and is seen as a mental strategy in the form of a simulation process, or

reactivation (Lindblom, 2015, p. 95, p. 130), also at times referred to as theories of cognition as *embodied simulation* (Svensson, Lindblom & Ziemke, 2007). In a performance situation, this could be the way to discuss what is actually embodied when a situation of everyday actions is added to a performance as in *Metamorphoses* or *One piece of a shared space*, and when later removed, bring about the same scenic sung expression even without the added actions. In other words, the act of embodying happens as a covert primed previous experience. In this case there is a distinction to be made between embodiment as a state, for example in previous research showing how language is related to bodily activities, and the act of embodying, for example how a blind man over time no longer feels his stick but senses the ground (still holding the stick) (Hirose, 2002).

In a similar vein, during one workshop the performers were themselves triggering the actions performed by the computer by pressing the key space bar. Somehow the sense of control gained from this experience remained during later performances, even though a technician/fellow musician later performed the action.

Finally, in Einarsson & Ziemke (2017) we argue for, among other things, how composition may serve as the site for construction and embodied mental simulation of situations, addressing issues of embodied off-line cognition.

3.2. Which embodiment? And which body?

Roughly speaking, two branches can be said to exist within embodied cognition: One is embraced more by the Artificial Intelligence (AI) community and researchers like Rodney Brooks, according to which a robot – unlike computer programs – is embodied because it has a physical body, and it is situated since it exists in the world (Shapiro, 2007) (i.e. mechanistic embodiment). The other branch, described more in detail in Sharkey and Ziemke (2001) arrives in radical embodied cognitive science (Chemero, 2009), and has the living body as a cornerstone (i.e. phenomenal embodiment). This latter branch is what I will be drawing upon in the following when referring to embodied cognition. The philosophical underpinnings of the latter are American pragmatism with philosophers like Dewey and James, but also phenomenology, in particular the writings of Maurice Merleau-Ponty (Johnson, 2007). Yet as Käufer and Chemero (2015) show, there are ontological differences between Merleau-Ponty on the one hand and Gibson on the other, which may create some tension in the field.

Before continuing, one question that may have come to mind concerns what body am I actually referring to? Following Johnson (2007), the type of body may be the biological body, but also the social, the cultural, the phenomenological and the ecological. Embodied experiences range from experiences of pain and metabolism to moving about in a physical

space, and to abstract reasoning. The key to understanding the mechanisms behind the embodied perspective lies in the constantly developing empirical support for sensori-motor interaction and the groundbreaking research on mirror neurons (a large body of work by Giacomo Rizzolatti, e.g. Rizzolatti et al. 1988, or with reference to music: Molnar-Szakacs & Overy, 2006). Learning from others is not primarily inferential but direct. Watching someone perform a goal-oriented action elicits the same response as if we ourselves had performed the action.

Furthermore, starting from early childhood and onwards we develop a sense for the contour or feeling of flow of our experiences, in what child psychiatrist David Stern refers to as *vitality affects*. These are intermodal and share similar envelopes of neural firings, although in different domains of the neural system (Stern in Johnson, p. 55).

3.3. Embodied cognition perspectives on music

Music has been addressed from the perspective of embodied cognition, but mostly in accordance with what Chemero (2009) would call mainstream embodied cognition. One prominent voice in the field of embodiment in relation to music and technology is musicologist Marc Leman. In a review of the research from Maes and Leman's research centre IPEM, Geeves and Sutton (2014) comment that although Leman is indeed pushing for embodiment, "we can still see in their work a number of subtler traces of their initial and jarring conceptualization of cognition as distinct from embodiment" (ibid, p. 248). This concerns, among other things, the view on action perception, which is somewhat at odds with the current state of embodied cognitive research, for example viewing the body as a mediator between "music as encoded physical energy" and the "mental level in which experiences, values, and intentions form the basic components of musical signification" (Leman, 2007, p. xiii). So at the same time as they emphasise the need for a new embodied paradigm, they treat cognition as distinct from, for example, sensory system, as if, as put by Geeves and Sutton (2014, p. 248) "[...] the realms of the cognitive and the sensory are entirely mutually exclusive", as in: "The discussed empirical findings demonstrate that embodiment is only one component in an interconnected network of sensory, motor, affective, and cognitive systems involved in music perception" (Leman & Maes, 2014, p. 236).

On culture, Leman (2007) asserts a reductionist view on culture that conveys dualistic tendencies, which do not sit well with embodied cognitive theories either. In his view, natural and cultural restraints are related, yet: "[...] cultural constraints are effective in the mental domain, while natural constraints are effective in the physical domain" (Leman, 2007, p. 56). Moreover, he asserts: "The most important observation is that these two fields are unified in the subject through action. It is action which allows the subject to transform

physical energy to the cultural level and vice versa” (ibid, p. 72). However, according to a number of researchers as brought forward by Geeves and Sutton (2014, p. 249), there is no gulf between nature and culture that needs bridging.

As for the understanding of musical signification, Leman (2007) and Maes and Leman (2014) make a sharp distinction between cerebral intentionality and corporeal intentionality, which, although they interact, are treated as fundamentally different from each other. This separation is also evident in the following: ”While involved with music, the human body interacts with physical energy and the human mind deals with interpretations that are built on top of that corporeal interaction. But how are body and mind related? How can we bridge the gap between physical energy and mental interpretation” (Leman, 2007, p. 51)?

To summarize, I would subsume the research from the lab of Maes and Leman, although impressive and pertaining interesting research on the role of motor processes in musical meaning formation, as weak embodiment (Shapiro, 2007) where the body is not held as constituent of human cognition, thus not in line with the more radical view on embodiment of which I am a proponent.

3.4. Gibson’s ecological theory of perception

Most of James J Gibson’s ecological psychology and his theory of perception was formulated in the late 1960’s and -70’s, i.e. long before embodiment became a popular topic in the cognitive sciences. His work was a reaction against a mechanistic worldview and a move away from seeing cognitive processing as causation. The dominating view at the time was also that environmental information was insufficient and chaotic. Gibson, on the contrary, presented a view where information is structured and available for what he denoted *direct perception*. His work was first and foremost on visual perception, for example his influential theory of the visual field and the *optic array* (Gibson, 1986), used in many navigation systems up to today. Think for instance of moving from one galaxy to another in an episode of *Star Wars*: the location to where we are heading is still, the stars float from the centre and out, and that is an optic array.

Gibson emphasised the importance of context, for example when it comes to judging size, and he proposed that information is perceived in body scaled terms, exemplified through the famous stair climbing experiments (Warren, 1984). Also he introduced an element of subjectivity, for example regarding how we experience where the horizon intersects in relation to our height (Gibson, 1982). Two important elements of his theory are *affordances* and *perceptual learning*. The concept of affordance, its application in cognitive sciences in general and music in particular, is discussed and explained thoroughly in Einarsson and Ziemke (2017) so here follows only a brief outline.

First a few words on perceptual learning, which is also part of ecological psychology's explanation of learning, in particular the work of Eleanor Gibson (1963). Imagine a pine tree at seashore bending over to the side as a result of endless days and nights facing the wind coming in from the sea. This is one way of picturing how the neural system in the brain is shaped by the different conditions we are confronted with throughout life, literally acting upon us and moulding our neural configurations. A great deal of this process is due to brain plasticity (Hurley & Noe in Clarke, 2006). In Gibson's view, perceptual learning provides grounds for the individual's detection of affordances.

Affordances are opportunities for action in the environment. In Gibson's original sense they have a peculiar ontological status; they are neither a property of the environment nor a feature of the animal, but both. They are specified by the pick-up of invariant information from the ambient light, whilst the animal – its body, legs, hands and mouth – is coperceived (Gibson, 1979/1986, p. 141).

[...] an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer (Gibson, 1979/1986, p. 129).

So a key thing to know about affordances is that they are not just physical properties, thus they have to be – among other things – measured relative to the animal. The reciprocity between organism and environment is fundamental. Meaning is not added a posteriori; it is imbued when perceiving. In Gibson's view affordances are permanent, and they do not change relative to the organism's needs and motives. Gibson writes: "Something that looks good today may look bad tomorrow but what it actually offers the observer will be the same" (Gibson, 1982, p. 410). It is worth emphasising that information does not equal affordances – information only points towards affordances. Finally affordances cut across the subject-object dichotomy. As Shaw and colleagues (1982) pointed out, the Gibsonian ecological approach urges the use of one single language to describe both the object of experience and the object of reference, instead of treating the two separately using, on the one hand, physics (or, more generally, the natural sciences) and, on the other hand, psychology (or, more generally, the cognitive sciences).

3.5. Affordances 2.0 - Chemero's radical embodied cognitive science

Chemero's (2009) take on modernizing Gibson is, in a nutshell, to combine dynamic system theory with Gibson's theory. It is part of the formulation of what he refers to as *radical embodied cognitive science*. He has two major concerns regarding Gibson's theories of affordances, namely (1) what are affordances and (2) what in the animal are they relative to? First, he asserts that affordances are *relations* in a similar vein as one entity is taller than another. He also makes an important distinction between *feature* and *property*. "It [perceiving a feature] is a matter of perceiving that the situation as a whole has a certain feature, that the situation as a whole supports (perhaps demands) a certain kind of action" (ibid, p. 148). Perceiving a property presupposes much more previous knowledge than does perceiving features, and perceiving affordances is, according to Chemero, placing features. Secondly, Chemero argues, that instead of talking about an individual's capacities in terms of body scales, we should consider how an individual's ability is more relational. Dispositions never fail, but abilities may, thus allowing us to account for occasions when performance does not meet up with for example biological expectations (or where musical performances fail!). For example, one day somebody might simply be too tired to walk the steep stairs. Affordances and abilities, according to Chemero, causally interact and are causally dependent. That means, what Chemero refers to as *affordance 2.0* is a relation between the abilities of the individual and features of the environment.

3.6. Affordances and music: You should be dancing, yeah

Existing applications of the concept affordance to music vary greatly and deviate more or less from Gibson's original notion, as discussed at length in Einarsson and Ziemke (2017). In the article we stress that it is *the situation as a whole*, which has an ensemble of affordances, entangled in various ways. We then take the framework of *cultural affordances* recently described by Rietveld and Kiverstein (2014) and developed further by Ramstead and colleagues (2016) as our point of departure for discussing interactive music utilising responsive technologies. In the framework there is a distinction between, on the one hand the relatively stable *landscape of affordances* shared by organisms in a niche, and on the other hand the individual's *field of affordances*, varying as a function of current internal states, interests, etc. Affordances are thus both stable and varying, which is also supported by recent research findings in cognitive neuroscience (Sakreida, Effnert, Thill, Menz, Jirak, Eickhoff, Ziemke, Eickhoff, Borghi & Binkofski, 2016). A more exhaustive summary of the article is found in Chapter five.

3.7. Fly on the wings of love: Feelings, movement and metaphors

In the previous chapter I concluded how I regard composing and singing as acts of embodying, in which emotion and feeling have an important role to play. That music in general concerns emotions is rather accepted and perhaps more common knowledge (Gabrielsson, 2001; Sloboda & O'Neill, 2001), but how and in what way is not settled. Surely there is a vast field of research and a large body of works describing perceived emotion in music and the many ways in which music may be utilised to induce, control, or regulate feelings (together with a whole lot of other things), but this is not of particular interest here as we speak (see for example the volume *Music and Emotion* edited by Juslin & Sloboda, 2010). Much of this research, with a few exceptions like Alf Gabrielsson's seminal work (e.g. Gabrielsson, 2001), presents a very instrumental view on music⁶. This I am not a proponent of.

Feelings indeed constitute and orchestrate much of our lives. Whilst affordances can be seen as setting the table, offering an abundance of opportunities for possible actions to undertake, feelings I am inclined to believe play a role in making the selection. As Antonio Damasio writes: "As far as I can fathom, few if any perceptions of any object or event, actually present or recalled from memory, are ever neutral in emotional terms" (Damasio, 2003, p. 93). I think music has the ability to provide the person engaged in music with access to emotions he or she is not fully aware of, perhaps by means of imitation, thus facilitating a felt and conscious experience. This latter is of course pure speculation. Yet there is research showing how people can experience the emotional states of others, not by talking, but through bodily imitation (Dautenhahn in Lindblom, 2015). Likewise how people become worse at processing emotional content if they are blocked as an experimental condition from making facial expressions in line with what they are hearing (Barsalou et al, 2003).

A common way to think about how we feel about things is: first we feel something and second we have a bodily sensation, for example clenching our fists in anger. The expression visible for others would then signal the hidden feeling. But in fact, as Damasio (2003) has proven, it works the other way around. Supported by a large body of research Damasio describes us humans as constantly monitoring our *bodily states* in order to preserve homeostasis. The word monitoring may be somewhat misleading; he makes very clear there are no other instances monitoring, i.e. no separation between body and mind is intended.

An emotion, drawing upon Damasio's definition, is both a neural structure, a process in the brain and a bodily response. With each emotion there is an automated reaction - a movement - for example a movement in facial muscles or intestinal activity. These being automated makes perfect sense from an evolutionary point of view, where knowing what is

⁶ However in the last couple of years there has been a growing interest also for felt musical emotion and *how* music induces emotion, see for example Zentner, Grandjean & Scherer, 2008 or Juslin & Västfjäll, 2008.

dangerous and what is beneficial is a matter of survival, and a time-pressured event. There is no time to consider whether or not a bear is a source of danger as it is about to attack you. Emotions are part of a validation process; they contribute to appraisal of meaning determining what a situation means for us, and they provide us with agency to act. And most of this happens before we are the least bit aware of it.

Once aware of the emotion we experience what we usually refer to as feeling (ibid). Feelings make us conscious of the sad, happy or other ongoing emotion in our body. And these are often accompanied by emotionally laden thoughts. From people with brain lesions, severe injuries to the brain, it is possible to know that without the ability to feel we would be doomed to ambivalence. Thus feelings are carriers of knowledge (if only we pay attention to them). The means by which we become aware of bodily states are emotions and feelings. Essentially these are constituents of organism-environment interactions and a way to keep constant contact with the world (Johnson, 2007). Again, the body is paramount for how we experience the world, being the hub from which action originates.

Considering these bodily states, or *bodily maps* as Damasio (2003) also refers to them, I believe them to be similar to what I, in the process of composing, try matching with the musical material at hand, as described in Chapter two. Thus the bodily maps with their associated emotions are of great concern, and both of these relate to movement.

Movement is pivotal for the way we learn about the world, both being moved and moving about. Johnson makes the claim that human meaning-making is founded in two central metaphors emanating from an embodied being in the world: *Moving Time Metaphor* and *Being Moved Metaphor*, both of which - according to Johnson - are fundamental also to understanding music (Johnson, 2007, p. 244-247).

The notion of movement has also been a pivotal part in the works *PS. I will be home soon!* and *Metamorphoses*, the former emphasising the moving audience as well as the performers, the latter exploring to the fullest different ways of moving about when performing with live electronics.

3.8. My focus of research

All in all, the sensorimotor relationships established from the body moving and being moved, emotions, which are also constituent of the organism-environment interaction and part of the many-layered situation holding an ensemble of affordances, come together to form a situated and embodied activity when composing and singing. This is a dynamic process unfolding over time under the influence of passing events and repeated performances, with emphasis on the reciprocity between the material and the artist, as expressed in shifting fields of affordances.

How may this act of embodying when singing, entailing a manifest conflation between subject and object, combine with performing with responsive live electronics in a seamless approach?

How can I account for the experience of music as a sounding body to resonate with?

If music is situated and embodied activity, how can I as a composer construct a musical performance situation based on the ideas of a landscape of affordances shared by composer, performers and audience, as well as continually shifting individual fields of affordances as the situation unfolds?

These and similar questions have guided my artistic research project as it has progressed.

4. Methodology

4.1. The question on “What is?”

Every researcher is faced with the question “what is there to know”? Music in my work is mainly conceptualised as performance and as sounding (see Leavy, 2009, p. 101-122 for different approaches towards conceptualising music in research). The embodied experience of music is unique to the individual and yet the individual experience exists within a certain constraining framework, namely a subject position (Johnston, in Clarke, 2005, p. 92-94) making it possible to avoid the pitfalls of relativism on the one hand and essentialism on the other.

I hold the belief that to a large degree, it is through language and through our actions and interactions we shape our society and our relationships and gain knowledge about the world and ourselves as being part of it. However, when referring to the body, I am not stating that the body is metaphor only. Indeed, it also presents a very corporeal aspect of an embodied being-in-the-world. For instance, the human voice carries inscriptions, social as well as cultural, but simultaneously it can be fatigued or behave differently depending on humidity or room acoustics, certainly very physical aspects. Both these aspects of embodiment matter and play a part when exploring experiences of singing voice encountering music technology.

4.2. Conducting artistic research

The debate on artistic practice’s validity as research, which has lasted for the last three decades, is hopefully somewhat passé and not something I will particularly address. The interested reader can trace the discussion for example in the volume edited by Biggs and Karlsson (2011). I believe artistic research has matured enough to operate independently while still having traditional academic research as a methodological working partner. Artistic researchers Henrik Frisk and Stefan Östersjö make a similar analysis stating, “the field of artistic research is now stable enough to embrace qualitative research methods found in social sciences to create a hybrid methodology that also includes artistic methods” (Frisk & Östersjö, 2013, p. 45).

Mäkelä et al (2011) identifies three trends in the field of artistic research:

[...] the three trends appear to pursue different core questions:

(1) Art as research: Can artistic practice represent forms of inquiry acceptable within academic settings? (2) Academically-attuned practice-led research: Can art practice and research practice cooperate as equal partners within the university context? (3) Artistic research: Can the academic notion of research be extended to include the unique results possible through artistic research?

Even though I find the classification somewhat artificial as classifications often tend to be, it serves a starting point for further describing my position and I would, rather than seeing these as impermeable, prefer seeing them on a continuum where I would place my contribution somewhere between a position of being equal partners (2) and extending the academic notion of research (3). I like the statement by composer and musicologist Gerhard Eckel: "Artistic research should be understood as a productive *enfant terrible* in the academic field" (Eckel, 2011, emphasis in original).

Thus my humble wish is to highlight *experiential* aspects of performing with, and composing for, technology, a perspective which hopefully may encourage further explorations in performance practice circumscribing works in general, the process towards new works involving computer technology in particular. My wish is also to expand - or at least challenge - the space for what kind of knowledge that is put forward in a traditional academic context, joining those scholars advocating situated lived experiences as a necessary part of the body of knowledge and likewise making a call for a slight renegotiation of the researcher's role (e.g. Kozel, 2009).

4.3. An alternative view on subjectivity

Over the years the issue of objectivity in research has been thoroughly dealt with, not the least by feminist scholars like Donna Haraway claiming situated knowledge (Haraway, 1988), and to scientists in general it should no longer be of any major concern. Qualitative researcher Morrow (2005) pinpoints how subjectivity is the very nature of the data gathered as well as the analytic process. However, as Frisk and Östersjö (2013) comment, artistic researchers tend to go one step further and make use of the subjectivity as an asset in their research. Turning the tables, moving beyond the subjectivity-objectivity axis it is perhaps possible to pose questions from a different viewpoint, one of participatory consciousness, which is more in line with an approach emanating from ecological psychology, or the late Merleau-Pontian notion of reciprocity (Kozel, 2011, p. 210, discussing a phenomenological take on methodology in artistic research). Participatory consciousness is described in an

article by educational researcher Lous Heshusius (1994), who in an unapologetic manner makes the claim that subjectivity cannot (and should not) be managed or controlled. She argues for a “participatory consciousness” that challenges the subject-object position and asserts that the questions when doing research should be posed from an idea of “self-other unity” (Heshusius, 1994, p. 17). This is described as an allocentric stance. Heshusius makes clear it is not a matter of methodology or a procedure like “participant observation”, but a concern with awareness (ibid, p. 16).

[...] the essence and starting point of the act of coming to know is not a subjectivity that one can explicitly account for, but is of a direct participatory nature one cannot account for (Heshusius, 1994, p. 17).

This view is in line with my idea of artistic knowing as elaborated in the following. Could it be also that human computer interaction has a particular potential to emphasise this modus of being in the world? All the more reason then, to make the inquiries emanating from this notion, as is the case in this artistic research.

4.4. Attentiveness as a way of knowing

I am arguing for attentiveness as a form of artistic knowing. It is not attention on one hand and material and agents (human or non-human) on the other, forming yet another dichotomy, but a relation between the two, a reciprocal movement. As Johnson (2010) recognises, an altered view of knowledge demands a step away from seeing knowledge as something fixed and an embracing of sensory-motor processes as well as emotions as part of our capacity for knowing. I consider this attentiveness to be very much about interrelatedness, about reacting upon and responding to. It involves the whole organism with all of its senses, distant from the idea of impulses starting as an intellectual thought, but rather a corporeal attentiveness that forms the basis for decision-making and differentiation between materials. The rational self in this view is not in opposition with the emotional or embodied self. Antonio Damasio (2003) describes how what begins with an emotion in the shape of an embodied map, gives rise to a thought, which in turn potentially elicits action.

I reckon that this attentiveness has been moulded over time through repeated practice and many years of engagement with (in my case musical) ideas and materials. All these different facets, informed by my subject position, come together in the way I reach for, and am reached by, the materials at hand in my artistic practice. Is it possible to distinguish experience from knowledge? As Howell writes, they are very much intertwined, even synthesised,

occupying the same space (Howell, 2011). Surely there are the often-cited classical concepts of knowledge from the writings of Aristotle: *techne*, *episteme* and *fronesis*, but it is beyond the scope of this account to delve any deeper into the theory of knowledge.

Someone who has touched upon attention as knowledge is Bengt Molander. Molander, who has continued and developed many of the thoughts from Donald Schön, writes of what he denotes as "knowledge-as-attentiveness-in-practices" (Molander, 2013, s. 3). True to the idea of "the reflective practitioner," he emphasises how this form of knowledge is expressed through action. He exemplifies this by describing a cello lesson where the student is supposed to imitate the master precisely. Without here giving a full recollection of the event, the point made is that the goal is not the imitation, but teaching a way of being attentive towards the music (*ibid*). Molander never goes further into the mechanisms of being attentive and he does not mention any corporeal dimension of this way of knowing.

But how can this attentiveness be captured? On the one hand, the imprints from this attentiveness as knowledge rests assured and could be said to exist contained within the artwork. But if seeing knowledge as something more than a fixed state and framed in the context of research, it presents to us a *fait accompli*. The process has already taken place and it is somewhat like looking in the back mirror – traditionally this has been where musicologists enter. Following also the conceptualisation of music as performance – as sounding – this form of knowing exists as experiences when performing the work, and these are the experiences I am particularly interested in and have attempted to pull out, in others through interviews and conversations and in myself through reflexively being in the situation of composing or performing. My own experiences from being in the practice of performing or composing are deepened when encountering the viewpoints of fellow musicians, as they are contrasted or emphasised, and so again the division self/other is blurred. A critic may counter by saying I run the risk of regression to a mean, that I even out differences and see similarities and patterns where they do not exist. Yet as has already been concluded, interpretations are always present, even in quantitative studies. There is a value of *not* being an outsider, of *not* having to make preparations for entering a field of study, already being part of the field. As Holmes and Holmes (2013) argue "[...] the life world of the researcher will inevitably have some impact, it follows that a common understanding of the context and terminology of [music] performance is likely to be advantageous" (*ibid*, p. 78). "Understanding is participatory and involves discourse; it is bound with language and is produced, not reproduced, by the researcher analysing and interpreting the data" (Howell, 2011, p. 166).

4.5. Mixing of methods

In the thesis I have employed a mixed method approach. Ideally, for it to be a true mixing of methods as Yin (2003) describes it, the mix should be practiced at all levels in the method, from research questions to units of analysis. I cannot say I have fulfilled this, but hopefully future practitioners will. I can affirm it has been a struggle finding my path. The methods are chosen in relation to the epistemological underpinnings in the presented artistic projects, where works presenting one or several performers interacting with computer technology, i. e. live electronics, are staged in different contexts. My intention has been a shift from *what* to *how*, a move from taxonomies and technical procedures towards accounts of embodied experiences of responsive technology. Nevertheless, as the reader will see, it has been necessary to describe part of the whats in order to contextualise the how. This also makes sense in terms of phenomenological method, where "thick" descriptions of context are strived for. We do not exist in vacuum but in a fine web of relations between material and humans. Even more so, focusing on the experience sheds a different light on the "what", and as in most design processes, the pendulum swings back and forth between these positions. Approaching the area of interest from several angles – also called triangulation – has been my approach and my motivation for both keeping personal records of the process working towards and during these works as well as conducting open and semi-structured interviews according to acknowledged interview procedures (Lantz, 1994).

4.6. Process diaries and reflection-in-action

By now "reflection in action," originally from Donald Schön (1983) and the book *The reflective practitioner*, is well known and quite widespread. Criticised for not being a thorough method (see Finlay, 2009) it is nevertheless a landmark book, propagating a view that embedded in practice there is knowledge, which is realised through action. "Understanding is a joint exercise and knowledge is "discovered" as it "emerges" from the context or research environment" (Schön, 1983. p. 300).

Using process diary as a vehicle for reflection has enabled a zoom in on attentiveness and sowed the seed for discovering the search for a "resonance-bringing process" as a vital constituent of my artistic method. Extracts from these notes are put forward in Chapter five in relation to my compositional practice, and they also underpin to varying degrees the body of articles published. Yet, for example, this notion of resonance cannot be said to have arisen from readings of the diary only, but also as a consequence of the hermeneutic circling between the making and the reflection, which has fed back into the practice over again. Other possible readings of the diary have also been attempted and dismissed when

read by an independent scrutinizer. As part of the mixing of methods I would also say the notes taken have served a purpose of triangulation. For the last part of my thesis the everyday process diary was dropped in favour of reflections circling in on workshop-experiences.

4.7. Interpretative Phenomenological Analysis (IPA)

The method that has strongly influenced the working method, Interpretative Phenomenological Analyses (IPA) was chosen due to its focus on lived experience and its closeness to embodied theoretical approaches (Larkin et al., 2005), which I found resonated well with my ideas starting from early on in my research project. IPA is also denoted by a high degree of transparency (Smith et al., 2009). As Holmes and Holmes (2013) write concerning research in music performance: “[...] phenomenological analysis and interpretation can reveal an idiographic relationship between the subjective conscious awareness and the cognitive landscape of the individual” (ibid, p. 74) and they recommend the choice of IPA when doing explorative research on performance experiences (ibid, p. 80).

Phenomenology is not only a description but also an interpretive process in which the researcher makes an interpretation (i.e., the researcher “mediates” between different meanings; van Manen, 1990, p. 26) of the meaning of the lived experiences (Creswell et al, 2007, p. 253).

Smith describes this as a “double hermeneutic” where the researcher is trying to make sense of the participant trying to make sense of what is happening to them (Smith & Shinebourne, 2012, p. 74). Inevitably there is an interpretative act to this, and this is encouraged during analysis. “[...] the researcher aims to formulate a concise phrase at a slightly higher level of abstraction that may refer to a more psychological conceptualization” (ibid, p.77). Holmes and Holmes (2011) continue this line of thought by saying the interpretative aspect is particularly valuable in situations where the use of metaphor is prominent, such as when reporting experiences from and conceptualising music performance. “Metaphor connects thinking and language and, as such, forms the backbone of much linguistic interaction in music (ibid, p. 80).

IPA aims to understand how people make sense of events, relationships, and processes in the context of their particular life worlds. Whatever phenomenon is being studied, the aim is to understand “what it is like to be experiencing this, for this

particular person, in this context.” Often IPA researchers will use the terms *Being-in-the-world* and *lived experience* to express this. “Being-in-the-world” captures the sense of an intentional, embodied, and situated person; and “lived experience” is intended to encompass the interpreted and meaningfully lived aspect of our being-in-the-world. In other words, IPA aims to understand the lived experience of a conscious, situated, embodied being-in-the-world (Larkin et al, 2011, p. 330).

Nevertheless, employing a method not designed for artistic works is not without friction. A number of things suddenly do not apply within a context of artist as researcher, and in particular an artist such as myself who from the beginning holds two roles, one of composer and one of performer. Either this presents a problem or a challenge; the answer in part seems to depend on whom you ask. In the end, with respect to the described method, I can only go as far as saying I have used the approach of IPA, but not applied the rigour of true IPA. Moreover it is primarily the singers’ perspectives that have been highlighted with the use of IPA.

Elsewhere in artistic research, when interviews are put forward they are mostly open interviews presented as raw material (Sandell, 2013; Unander-Scharin, 2015) without any real attempt at structured analysis. And still, interpretations are made. Here I take the step of making an interpretation. Others may see other openings in the material and I thereby run the risk of someone claiming I am wrong, yet this is how the method of IPA is intended to act.

I agree that in many ways we need to safeguard keeping things as indefinite as they are within the arts. Henk Borgdorff (2011) discusses artistic thinking as unfinished. Bengt Molander (1996) puts forward how questions are vehicles for knowledge, a view that seem dovetailed by Frisk and Östersjö (2013). Yet when some matters need to be made more definite in order to pass on the knowledge when performing research, the challenge is perhaps to make these closures drawing on the phenomenon (Dahlberg & Dahlberg, 2003), or as in the case with artistic research, from the artistic practice.

4.7.1. Participants

A stark distinguishing factor in artistic research is (of course) that participants in artistic works are chosen first and foremost on artistic merit and not from an idea of representation. Yet as for broad context, I have chosen to focus on three different settings regarding both the number of participants and their music cultural background. The first work involved a single performer who was classically trained. The second work housed four vocalists trained in jazz and improvisation, me being one of the four. The third work was a

collaboration with a traditional folk singer (jojk). I believe these contexts complement each other and provide different perspectives on performing with live electronics. Only tentatively may findings from each situation transfer to another, since so many contextual factors are unique.

4.7.2. Interviews

In the beginning of the project *Metamorphoses* the interviews were open, guided only by my preconceptions of the field from theory and practice. They were performed together as a group, perhaps bearing resemblance to focus group interviews. We began with everyone writing down reflections from the workshop; thereafter the talk began, lasting about an hour. During the first workshop I also had tape running documenting things said when experimenting with applications. Conversations were transcribed and they have been part of my writing and rewriting, readings by peers and served as material to form a platform for my own reflection.

In the latter part of the project *Metamorphoses*, as with the preceding project *PS. I will be home soon!*, the interviews were directed and semi-structured. In the open interview it is the respondent who frames the topic, while in the directed, some questions are decided on beforehand (Lantz, 1994) and there is the use of an interview guide. My take on researcher bias and social desirability was touched upon earlier in the text. The latter was addressed by explicitly telling them they should not mind saying things that could be seen as a criticism of the project or me.

The interview, which lasted for about an hour, was recorded and then transcribed verbatim. It was then analysed in four steps as prescribed by the method, each time trying to capture the essence on a slightly higher conceptual level. When all interviews were transcribed and analysed their themes were put together. Here also, open interview material and notes from my process diary were put beside the large summarized table below for comparison.

4.7.3. Self-reflection

As for the semi-structured interviews I conducted in the work *Metamorphoses*, I chose to answer the same questions myself in writing, as did the other performers, but I then left these out for the comparison of themes between tables and forming of the large table. This relates to the topic of self-reflection, commonly used and sometimes in a too arbitrary way. Frisk and Östersjö warn that reflection is by no means a quick fix to replace artistic method (Frisk & Östersjö, 2013). Still I suggest, as in this case, that it may serve a purpose of framing one's own perspective, in order to more consciously incorporate these reflections into the later discussion.

5. Summaries: Artistic Works and Papers

In this chapter I chronologically present the core of my empirical work, beginning with the three musical works, to then continue with summaries of my four papers. I will attempt to show how questions have emerged and been refined throughout the research project. Significant for an exploratory approach is setting out and not always knowing beforehand the exact route, but having a sense of where to one is heading, a directedness.

5.1. Artistic Works

5.1.2. PS. I will be home soon! (2012)

Starting with *PS. I will be home soon!*, a commission from Malmö Opera somewhat coinciding with accepting my doctorate position at the Royal College of Music, I wanted to work with a combination of singers and different forms of live electronics and tape electronics. The work addressed issues of technical development, where finding salient voice features to analyse and implement as control signals towards the electronics was one aspect. My approach there already from the start was one of zero interface, to liberate the singers from not musically relevant actions added to the performance. Through this work I also sought ways of negotiating the performance space, of applying an ecological perspective onto the performance situation with an active audience, bridging the divide between performers and audience, and finding ways of making the interactive elements meaningful in the context. Much of this is described more in detail in Einarsson (2015).

PS. I will be home soon! is a music piece in the form of a written score. *Elektrikal*, or *electrical*, was the neologism I entitled the work-to-be (combining the words electronic and musical, as in musical theatre), suggesting the intersection of different musical styles in my compositional language.

The parts included are: Vykort (Postcards), Vrakgods (Wreckage), Skeppsbrott (Shipwreck), Big Charley and Kompass (Compass).

<i>Vykort</i>	Mezzo-soprano, tenor saxophone and live interactive electronics.
<i>Vrakgods</i>	Assembled physical sound objects and objects rigged with motion detectors for the audience to interact with by touching, lifting, opening, shaking etc. Tape part creating the environment for the other sound events to take place in.
<i>Skeppsbrott</i>	Tape electronics, live electronics, all four singers (2 soprano, 1, mezzo, 1 baritone) and all six instrumentalists (DB, vlc, vl, el. git, bar. sax, live el.).
<i>Big Charley</i>	Live electronics, violin, 2 sopranos.
<i>Kompass</i>	Live interactive electronics, violin.

Table 1. *Instrumentation.*

The narrative in *PS. I will be home soon!* is non-linear. The parts can be assembled in different ways to provide different meanings. Thus, the focus is on the individual experience. In the piece the audience is divided into two groups, each group guided by an actor and following the piece clockwise and counterclockwise. There were no chairs, so the audience was free to move about or sit down as they wished, scenography allowing (for a sketch on the audience's trail - see *Image 2* below).

The interactive technology implemented was a motion-tracking system in the scene *Kompassen*, voice analysis in the scene *Vykort*, and found objects reacting to touch, elevation etc. in the scene *Vrakgods*. The analysis tools for voice and motion capture were developed in collaboration with Dr Anders Friberg, researcher at the Royal Institute of Technology in Stockholm. (The voice implementation is further described in Einarsson & Friberg, 2015.)

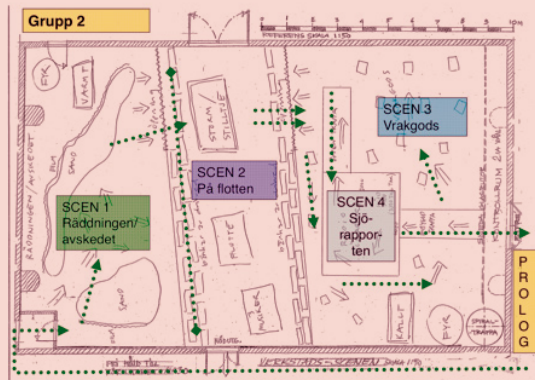
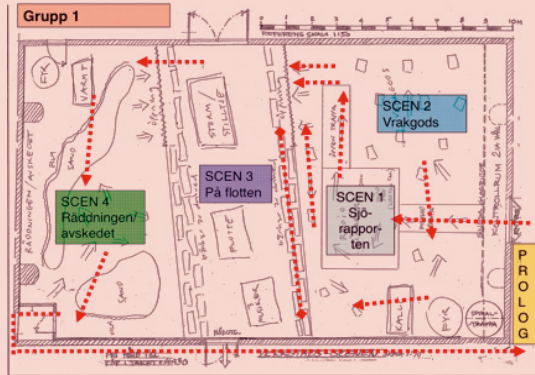


Image 2. The audience's trail through PS. I will be home soon! Graphics: Lars Fembro.

In my notes from the working process with *PS. I will be home soon!*, it is evident how the two processes of technical development and composition, held apart in theory, are entangled with the working process. The procedure is a mixture of imagining, testing, refining ideas, employing ideas, again rejecting and/or refining, a trajectory which can be traced throughout the working process, often by means of what I come to describe as *resonance* (see also Chapter two; Chapter six). There is also the pendulum movement between the whole and its parts, between the bigger structure and detail, and a search for how to create meaningful surfaces for interaction.

5.1.2.1. Balancing the whole and its parts

Gör en schematisk storform. Spånar på instrumentation samt vart signalstyrning ska ligga. Letar ljud och karaktärer på ljud. Varmt? Kallt? Stomljud, fragment. Rytmiserar texten. Börjar skapa melodik. Sjunger.

Make a schematic overall design. Ponders instrumentation and where the signal controls should lie. Search for sound and the character of sounds. Warm? Cold? Structure-bearing sound; sounds borne through matter. Fragment. Give the text rhythm. Begin to create melody. Sing.

*

Skrivit in samtliga melodigestalter till del 3 med utkast till harmonisering. Lösa funderingar kring inbördes form. Funderar över val av röstfack till respektive. Försöker hela tiden höra de klingande rösterna i mitt huvud. Vilka är de? Försöker upprätthålla en tillåtande sfär för samtliga idéer. Pentatonik genomsyrar ett avsnitt - i enlighet med grundidé från Papua Nya Guinea-musik.

Write all the melody lines for part 3, with draft harmonies. Loose thoughts on the internal form. Consider choice of types of voice. The whole time try to hear the sounds, the sounding of the voices in my head. What are they? Try to establish a permissive/ indulgent sphere for all ideas. Pentatonics penetrate one passage - in accord with the basic ideas in Papua New Guinean music.

*

Skissar på hur delarna ska följa varandra inom del 3. Vart de ska sammanfalla och repriseras. Lösa idéer om instrumentation från impulser väckta då klangerna spelades på piano. Reviderar underliggande harmonik på sina ställen. Dialog med Anders: Hur ska systemet i Max/MSP fungera? Fler parametrar av datadiskriminering, större källa till felfaktorer. Ska flera kunna använda systemet? Ska man förstå vad som händer? Ska utfallet vara styrt eller slumpmässigt?

Sketch how the sections should follow each other in part 3. Where they should overlap and be repeated. Loose ideas about instrumentation from impulses prompted when the harmonies are played on the piano. Revise the underlying harmonics at certain points. Dialogue with Anders: How will the system in Max/

MSP function? Several parameters of data discrimination, greater source of error. Should several be able to use the system? Should one understand what happens? Should the result be controlled or random?

*

Hur ska delarna hänga samman inom del 3? Hur få ljuden att gifta sig utan att skapa för stora glapp nu då det ej är orkester? Banta ned matchandet till knaster? Ja, funkar. Balans live vs tape? Lång intensiv period för att skapa känslan av stiltje. "mistlurside" i instrumentalform - sätt att skapa gemensam nämnare mellan delar.

How should the sections fit together in part 3? How to marry the sounds without creating too large gaps now when there is no orchestra? Reduce the matching to crackle? Yes, it works. Balance live vs tape? Long intensive period to create a feeling of calm or stagnation. "Sound of foghorns" in an instrumental form - a way to create a common denominator between the sections.

*

Testar olika instrumentkombinationer i huvudet. För många möjligheter. Kan inte bestämma mig för vilken instrumentkombination jag vill ha. Arbeta i piano och instrumentera sedan? För stora elektroniska ljud. Ger ingen plats. Provar att angripa med liten instrumentering.

Test different combinations of instruments in my head. Too many possibilities. Can't decide on what instrument combination I want. Work on the piano and arrange later? Too much electronic sound. Leaves no room. Try to tackle this with less instrumentation.

*

Lyssnade igenom sibelius-filer, granskade frågor och la ut materialet framför mig. Bestämde mig för att använda delarna och satte igång att utveckla det allra sista fragmentet - en slags transkription, en fantasi, kring ett ljudfragment från Evolvern.

Listened to the Sibelius files, considered questions and laid out the material in front of me. Decided to use parts and started to develop the absolutely last fragment - a kind of transcription, a fantasy, around a sound fragment from the Evolver.

5.1.2.2. Searching surfaces for interaction

Jag har en text. Jag har en sångare. Tonhöjd? Det känns för transparent, d v s ointressant. Jag sjunger högt, ett visst utslag, lågt, ett annat. Då är vi inne på mickey-mousing. Vibrato/non-vibrato? Vokaler? Funkar egentligen bara på melismer? Annars är det fråga om statistiska samband, vilka kan vara kul men i det närmaste aleatoriska. Uthållna toner? Kräver högre grad av improvisatorisk färdighet. Ska jag i denna del våga göra en mer "öppen" sångstämma? Jag landar nog i att kombinera parametrar. Vibrato/non vibrato över tid och register? Segmentering, dvs synka tal och sång? Analysera olika sångstilar och utifrån det extrahera features? Slösat förmiddagen med att skruva Evolver och leta efter en bra brusmiljö. Hopplöst. Försökt återskapa ett ljud. Igen. Vokaler? Vad är problemet? Jo, att vokalisten, om det är en given text, inte kan påverka interaktionen nämnvärt. Och kan man då tala om en interaktion?

I have a text. I have a singer. Pitch? It feels too transparent - that is, uninteresting. I sing high, a certain effect, low gives another. Now we're into mickey-mousing. Vibrato/no vibrato? Vocals? Is it that only melisma actually functions? Otherwise, is it a question of statistical correlation, which can be fun but almost aleatoric. Sustained notes? Demands a higher level of improvisational competence. Should I, in this section, dare to make a more "open" vocal part? I'll probably end up combining parameters. Vibrato/no vibrato over time and register? Segmenting, that is, synchronizing speech and song? Analyze different song styles and from there extract features? Wasted the morning with scrolling through Evolver looking for a good noise milieu. Hopeless. Try to recreate a sound. Again. Vocals? What is the problem? Well, that if there's a given text, the vocalist cannot influence the interaction that much. And then can you talk about interaction?

*

Ritat en struktur. Ställt frågan "vilken är utvecklingen"? Varje kompositör har nog sina nyckelfrågor, knutet till vilken falang han sluter sig till. Överväger att låsa sångfraser växla mellan talade när de är refererande och sjungna när det är direkta repliker. Kanske melismer efter textmassa. Det öppnar för möjlighet till andra former av interaktion. Möjligt styrbart är antal stämmor i polyfonin och bredd över register. Kanske skapa genom att hela tiden ha en bred åtta-stämmig sats och sedan påverkar sångaren antalet lager ur detta?

Sketched a structure. Posed the question, “what is the development”? Every composer probably has key questions, tied to what faction he or she joins. Contemplate letting the song phrases alternate between being spoken when they are referring and sung when they are direct replies. Maybe melisma after the text material. That opens up possibilities for other forms of interaction. Possibly controllable is the number of voices in polyphony and breadth of register. Perhaps to create through having throughout a broad 8 part set and then have the singer influence the number of layers from that?

*

I arbetet föds idéer, reminiscenser, associationer som öppnar upp nya vägar. Klanger i en kontext långt från storband öppnar för möjligheten till “drop-teknik”.

—

Working conjures ideas, reminiscences, associations that open up new paths. Sounds in a context far from a Big Band’s open up the possibility for “drop technique”.

From *PS. I will be home soon!* a set of thoughts emerged, which constituted the backdrop framing the exploration in the next project to come, *Metamorphoses*. First, a number of things in *PS. I will be home soon!* suggested a dynamic relation between the perceiver and the perceived. The audience-work-relation, the singer-work-relation and the process of composing are three such areas, although additional relations exist. This spurred my interest in ecological psychology and ecological theories of perception. In brief, ecological psychology describes how there are opportunities for actions embedded in the organism's environment, i.e. affordances, thus similar to what I had observed in the audience and experienced when working with *PS. I will be home soon!*

(1) A question that arose and was carried forward, underpinned by this theory, was how the sounding computer response could somehow suggest the work. In other words, how could means for affecting the computer, including decisions underlying mapping procedures, be integrated in such a way that the singers' actions eliciting responses would be close to already suggested? The seamlessness sought for is thus not only a matter of absence of physical interface, but of forming a situation where actions somehow are suggested. (2) Another strand of thought that arose – albeit related to the first – was how performing with interactive electronics affects the singer in both the cognitive and the emotional realms. Interesting ambiguous findings were reported from a singer of feeling both comfort and uncertainty in the interactive setup with the computer. This hinted at how interactivity was not experienced as either a separate disembodied other or an extension of a self, but as both. In the next project *Metamorphoses* I went further into these inquiries, trying to disseminate how different sensory modalities may be affected and how the sense of the embodied “me” in relation to “you” (the computer, the audience, the fellow musicians) comes about. For example in *PS. I will be home soon!* a concern reported from all of the participating vocalists in relation to electronics in general terms, was a demand in performance for altered listening strategies.

While the first bit of reading for my thesis was very much concerned with the *what* of things, i.e. what interactivity is, what the difference between live/non-live really means and the directness of the response, gradually there has been a shift towards the *how*: How may the body be negotiated as the anchor on stage; how may an altered bodily awareness affect the experience of the live-electronics; how does it feel to perform in this setup? This has connotations with embodied cognition, which I have come to focus in on in my thesis. (3) A third matter I brought with me from *PS!* concerned artistic method. To work process-oriented in a way that allows reflection to feed back into the project was very fruitful, and has been articulated as a method called *calibration* towards the new work. I have gradually become more and more aware of the tenet of embodiment in this notion of calibration, which is tied together in the final chapter of the thesis.

5.1.3. Metamorphoses (2015)

Metamorphoses is a work that explores ideas of transformation and embodiment, primarily in terms of the text and in terms of conditions for corporeality when interacting with responsive technology. It is a work for four singers and four responsive computer systems. The desire to work with several singers and several parallel responsive systems came from the part *Big Charley* in *PS. I will be home soon!*, where two singers perform a duet accompanied by live electronics (although not interactive). The text, written by Jörgen Dahlgvist, contains four characters undergoing different kinds of non-physical transformations, and in my compositional work I juxtapose these characters in different ways. The work is divided into three parts, each part inspired by the life cycle of the butterfly: caterpillar (moving), chrysalis (a steady state) and butterfly (flying). The ideas for the work are also described in Einarsson (in press). As mentioned in the introductory chapter, reading the essay *On the marionette* by Heinrich von Kleist (von Kleist in Parry, 1988) also fed into this project, conjuring a feeling I wanted to achieve and resonate with musically. Moreover, I was curious about whether or not experiences of the relationships towards the computer would be affected by an altered bodily awareness, as in moving about in the concert space and singing in elevation, in harnesses, without the common point of reference – the feel of the ground. Hence embodiment was at the core of the investigation.

A new series of workshops were set up designed to explore different subjects. The workshops were extended over a period of approximately one and a half years. Due to the limited financial support, the number of days for workshops was not as generously assigned as I would have wished for. What was then cut back was part of the collaborative exploration preceding the work. The line had to be drawn a little straighter between beginning and end, which was unfortunate but necessary.

In my notes from the working process, again it is prominent how the compositional process is experienced as an act of embodying; here follows some examples:

Det första jag gör för dagen är att lyssna; försöker lyssna *igenom/bortom* de mekaniska Sibelius-filerna. Jag sjunger parallellt på den inre scenen, försöker uppfatta vart verket vill, vartåt det pekar i en förhandling med hur jag vill att det ska framstå. Vad fattas? Vilken är utvecklingen?

The first thing for today is to listen: try to listen *through/beyond* the mechanical Sibelius files. I sing in parallel with the internal scene, try to understand where the work wants to go, where it's heading, in a negotiation with how I want it to appear. What is missing? What is the development?

★

Kanske kan det kallas att ge sig ut på skattsökarfärd? Snubblar över en patch som efter en stunds tweakande genererar ett plaskande rytmiskt ljud som jag genast går igång på. Lustigt, man vet med en gång när det blir rätt. Nu var detta inte vad jag var ute efter, men det var rytmen jag for efter. Det känns i kroppen; lusten att sjunga, att pröva och ibland att lägga till, uppstår.

Perhaps this can be called setting off on a treasure hunt? Stumbling over a patch that, after a bit of tweaking, generates a splashing rhythmical sound that I immediately take to. Funny - how you know at once when it's right. Now, that was not what I was after, but it was the rhythm I went for. I feel it in the body; the desire to sing, to test and sometimes to add on.

Wavesh segmentation & repeating playback

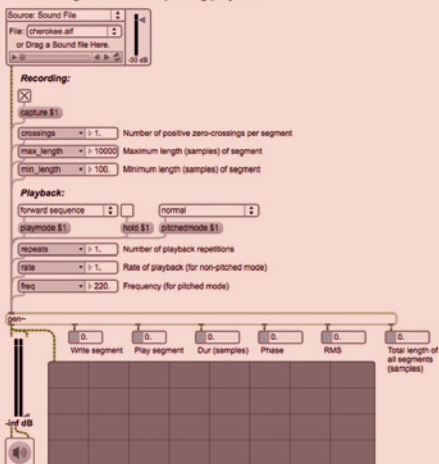


Image 3. Patch gen-chopper_repeat.maxpat

*

Hela tiden checkar jag av mot min upplevelse av det klingande, av att sjunga med den aktuella patchen, mot den känsla som det ger när jag lyssnar. Beslutsfattandet därför, är ingen torr process, den är hela tiden i samklang med kroppen, med känslan som uppstår.

The whole time I'm checking against my experience of the sound, of singing with the patch, against the feeling it gives when I listen. Making decisions is therefore not a dry process, it's always in tune with the body, with the feelings that surface.

*

"att varda, ett liv i vardande" (J. Dahlqvist). Läger märke till många "v" i textstycket som är i fokus. Smakar på v:et i munnen - känner en intuitiv parallell till del ett (det sätt varmed jag låter ord pressas fram, ibland med en kraftig ansats: "smärtan"), börjar artikulera fraser.

"To be, a life in being" (J. Dahlqvist). Notice the many "v's" in the texts focused on. Taste a "v" in the mouth - feel an intuitive parallel with part one (the way I let the words be pressed out, sometimes with a heavy emphasis: "pain"), begin to articulate phrases.

impro on [v] [f]
 filter noise w. toungue, press teeth aganist lower lip etc.

f *q.n.* *mf simile*

v-f - -

Image 4. An intuitive parallel.

*

Det är något med slutet. Det känns inte slut. Vad behöver tas om eller utvecklas?

Something about the end. It doesn't feel like an end. What needs to be redone or developed?

*

Laborerar med delay och granularsyntes i en ny patch. Bär med mig erfarenheten från workshopen i december med de andra sångarna med problemet som det medför att känna sig tillbakahållen av delay. Dels, det får konsekvenser för lyssnandet; Ska man inte längre lyssna på elektroniken? Dels, det får konsekvenser för sitt eget sjungande, det blir svårare att vara rytmiskt pregnant, vara tight, fullfölja accenter. Ett sätt är att växla aktivt mellan långa uthållna fraser och snabba ord, korta attacker. De långa fraserna repeteras då som en fond, samt vice versa och det blir kontrastverkan. Men, ledan uppstår snabbt. Variation, variation, liksom alltid behövs variation, dynamik och asymmetrier. Hur kan jag bygga ut, bygga till, modifiera?

Work with delay and granular synthesis in a new patch. With me are the experiences from the workshop in December with the other singers, the problem that comes with feeling restrained by delay. Partly, there are consequences for listening: should you stop listening to the electronics? Partly, there are consequences for one's own singing: it becomes more difficult to be rhythmically concise or meaningful - tight - to follow the accent. One way is to alternate actively between long sustained phrases and rapid words, short attacks. The long phrases are repeated like a background, and vice versa and then work as a contrast. But, tedium arises fast. Variation, variation, as always variation is needed, dynamics, asymmetries. How can I build out, build on, modify?

*

Lyssnar in olika möjliga övergångar med grova klipp lagda omlott i skissen i ProTools. Läser texten som sitter på väggen ("Varje ord smärftar") medan ljuden klingar, försöker "känna in". Var kommer musiken ifrån? Var är den på väg? Vilken är gesten? Går den fram? Till vilket musikaliskt rum vill jag?

Listen to various possible transitions with rough cuts overlapping in the draft in ProTools. Read the text pinned up on the wall ("Every word hurts") while hearing the sounds, try to immerse myself. Where does the music come from? Where is it going?

What's its gesture? Does it work? To what musical space do I want to go?



Image 5. Sketches pinned on the wall.

★

När lusten kliver fram och idéer finns så flyter arbetet sömlöst på och de olika faserna av att implementera, testa, modifiera avlöser varandra. Justerar velociteten (expr, table) och skapar möjlighet att genom rösten påverka den globala ljudstyrkan. Enkelt men effektivt. En sorts datamässig parallellföring! Eftersom sample-patchen nu inte blir det enda bärande lagret kommer den att behöva innefatta mycket mer pauser. Tystnader kan läggas in i coll-objektet så att de uppträder slumpmässigt - eller så får sångflödet styra. Kanske ett korrelat mellan antal sång-onsets och vilket lager i coll? Provar att göra en sådan

funktion m h a en tröskelregel.

Det verkar som om pitch-fönstret är för litet när jag testar. De fem tonerna hinner bli desamma. Detta hänger såklart ihop med detektionen jag just nu slö-använder. Den är inte tillräckligt precis och släpper igenom för många värden. Men manuellt börjar det låta riktigt bra nu...!

Fastnar, eller fångas, i en lång improvisation i patchen. Ingen uppfattning om tiden, dras in, dras med. Gester växer fram och åter, jag blir sugen, vill hänga på, utveckla, styra. Plötsligt är det ett rum fullt av möjligheter som öppnar sig. Blir sugen på att skriva mer, skriva instrumentalmusik. Nu! Fort! I allt det klingande är jag också samtidigt medveten om de doftpustar som kommer ibland från en ensam ros i ett glas på fönsterbrädet och varse den fuktiga efter-regnet-luften som då och då sveper in genom det öppna fönstret. Känslan är njutning. Så infaller till sist ett intressant ögonblick av leda. Idéerna går inte att utveckla mer (inom patchen), musiken jag hör i mitt huvud - orkester - behöver plötsligt spränga gränserna mot något annat. Plötsligt känner jag min kropp obekvämt mot stolen, träsmak i rumpan och underarmarnas tyngd mot skrivbordet. Förtröllningen är bruten, jag stänger av inspelningen och börjar skriva text.

When the will, desire and ideas surface and conflate then work proceeds smoothly and the various phases of implementing, testing, modifying follow along, one after another. Adjust velocity (expr, table) and create possibilities through the voice to affect the overall force of the sound. Simple but effective. A sort of computer parallelizing! // Since the sample-patch is now not the only sustaining layer, it will need to contain many more pauses. Silences can be added in the coll object so that they perform randomly - or let the song line lead. Perhaps a correlation between the number of song onsets and the layer in coll? Try to make such a function have a threshold rule. // It seems as if the pitch window is too small when I test. The five tones have time to be one. This of course is connected to the detection I just now sloppily use. It's not precise enough and allows too many values. But manually it begins to sound really good now!

Get stuck in, or is captured by, a long improvisation in the patch. No idea of time, sucked in, carried along. Gestures develop to and fro, I get into it, want to continue, develop, control. Suddenly a room full of possibilities opens up. Want to write more, write instrumental music. Right now! Quick! In the midst of all the sounds I am also conscious of the scent that sometimes wafts over from a single rose in a glass on the window

sill and sense the damp after-rain air that now and then sweeps in through the open window. The feeling is pleasure. Then finally land in an interesting moment of tedium. Can't develop my ideas (in the patch), the music I hear in my head - orchestra - suddenly need to break the boundaries towards something else. Suddenly my body feels uncomfortable against the chair, rump against wood, and arms heavy against the desk. The enchantment is broken, I stop the recording and begin to write text.

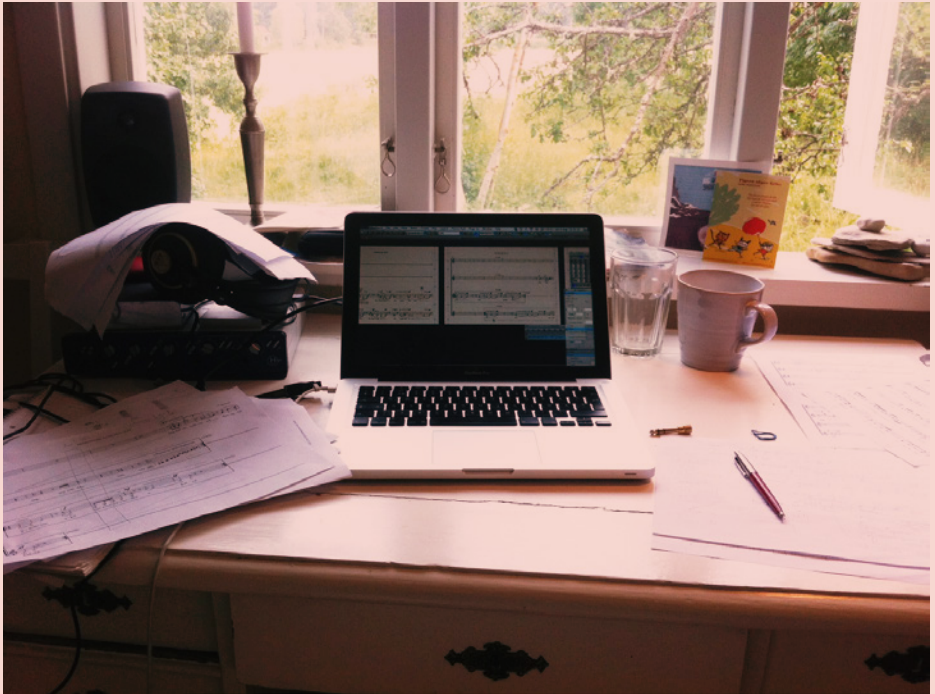


Image 6. My working desk.

In conclusion, following the work with *Metamorphoses* was:

(1) a strong sense of wanting to widen the scope and lay my compositional approach inside a framework of a dynamic relation between the context (situation) and myself. Core elements being a bodily rooted attention towards material and a way of decision-making, both of which I would assign to the embodied being in the world, where the process is of resonance between bodies- as described in Chapter two. In a similar vein, awareness was also formed such that when working with composing text, my approach was not primarily to establish the semantic meaning word by word, but working with the feeling the text evokes. My questions concerned how I could tie this framework together, taking the complex reciprocity between myself, materials involved and embodiment into account? (2) Working and discussing with director and playwright Jörgen Dahlgvist had also brought about a heightened awareness of the situation and its many layers. I could now join in dialogue with theories of embodiment to highlight aspects of my artistic practice, and working with situatedness became a cornerstone in the last work this research project would contain, *One piece of a shared space* (2015). (3) A number of issues from the working process, such as the role of triggering electronics as part of a learning process, remained puzzling. For example, how was the embodying happening?

5.1.4. One piece of a shared space (2015)

For the last work this research project comprised, the audiovisual performance *One piece of a shared space*, I did not keep a strict process diary. It was a collaborative work with jojk artist Ulla Pirttijärvi and visual artist Marita Solberg, supported by the Nordic Culture Point and the Nordic Culture Fund, where we address aspects of the situation of the Sami people in Sweden today, and touch upon matters of tradition (in transformation) and identity. Again a workshop structure was set up, which contained shared experiences in forms of study visits and watching the film “Jojk” by Maj-Lis Skaltje (2014), as well as joint explorative sessions.

Technically there was an implementation of a vowel recogniser built by Andre Bartetzki, inspired by the ideas of Anders Friberg, where sung vowels would impact spatialisation in an 8-channel system, mimicking front-back placement of vowels as they appear in the mouth cavity.

In the work I integrated many ideas of forming situations for the singer to embody, musically and spatially. By assembling sounds from different aspects of the singer’s cultural identity that I had learned about from interviewing her, as well as many discussions with Marita who is also of Sami origin, I attempted to give her material to perform with and against that would provide her with platforms to explore different feelings- something she

also explicitly desired, since this would fit with her approach towards performing. Materials included sound from the LKAB mine in Gällivare, interviews with Swedish and Norwegian Sami children, sounds from deer herding, archival jojks and much more.

When singing jojk, Ulla explained, you don't sing about a situation, you sing the situation. It is not a depiction; it is expressing how something is. This notion is deeply interwoven in the Sami culture (see for example Skaltje, 2014). In my humble opinion, not being a sami, but drawing upon experiences from our year of collaborative work, I would suggest this exemplifies and pinpoints singing practice as an act of embodying.

When staging the work, the spatial situatedness was emphasised through adding everyday actions to her performance, like sewing and undressing pieces of the traditional garment that she wore. As described in the introductory chapter, this spatial-bodily engagement brought an intensification to the sung expression and a directedness, assisting the singer when bridging two sections of the work singing solo to feel a sense of progress in terms of where she was coming from, figuratively speaking, and where she was heading, which taken together raised the performance. Yet another example from *One piece of a shared space* is brought up in Einarsson and Ziemke (2017), which refers to adding the action of the performer turning towards the sound as it is spatialised as a result of her singing. This added action made the section more meaningful to watch and made more sense to the performer.

Experiences from this work became a final building block to the thesis, and thus constitute part of the synthesis and discussion in the final chapter.

5.2. Papers

5.2.1. We can work it out – Calibration as artistic method (Einarsson, 2015)

In this article I begin by outlining the artistic incentives for the commissioned chamber opera in question: my compositional practice of working with combining acoustic instruments and electronics; the book *Kung Kalle av Kurrekurreduktion* by Joachim Langer and Helena Regius (2002) about the presumed role model of Pippi Longstocking; and a desire to negotiate the performance space and the divide between audience and performers. As for the latter, I sought an expansion of listening and attention to influence the performance situation, reminiscent of personal sound walk experiences and working with everyday sounds as musical material. A previous work, *Ljudspår [Eng. Soundtracks]* (2008), was a concert-in motion performing on trams, and the opera-to-be was an exploration of an audience-in-motion. One additional backdrop to the discussion in the article is the commissioning procedure as such, and claims that composers would be somewhat unsuited for fruitful collaborations

(Hayden & Windsor, 2007), highlighting a need for exploring new ways of pursuing this process. Thus, benefits and challenges of a workshop method for the process towards a work, summarized as a multi-layered concept of *calibration*, is the overall aim of the article.

5.2.1.1. On the work

PS. I will be home soon! is a musical composition with a written score, fixed time between events and performing musicians and artists; it is not musical theatre with a script nor an installation where one can enter or leave at will. *Elektrikal* was the neologism I entitled the work-to-be, suggesting the intersection of different musical styles in my compositional language. The parts included are: *Vykort (Postcards)*, *Vrakgods (Wreckage)*, *Skeppsbrott (Shipwreck)*, *Big Charley* and *Kompass (Compass)* (for a table on instrumentation, consult paragraph 5.1.2 and Table 1).

In the piece the audience is divided into two groups, each group guided by an actor and experiencing the piece clockwise and counterclockwise. There were no chairs so the audience was free to move about or sit down as they wished, scenography allowing (for a sketch on the audience's trail – see 5.1.2. Image 2).

5.2.1.2. Workshops

The three workshops and study visits are then described in a step-by-step manner, with photo documentation included. Their outcomes are then delineated and discussed, drawing upon practical examples.

5.2.1.3. Results

The main themes I identify are summarised in the following three items:

- To establish a common frame of reference and platform for dialogue;
- To experience unorthodox phenomena;
- To define the playing field and identify challenges.

In brief follows a recap of the examples accompanying each identified theme.

To establish a common frame of dialogue

I bring forward how this is done by means of listening and sharing work-related experiences, for example through performing possible scenes in a playful manner or by having workshop participants take part in a synopsis and individually see what elements from the account lingered. This guided the choice of elements for the emerging story, but also



Image 7. One piece of a shared space, featuring Ulla Pirttijärvi-Länsman. Photo: Marita Solberg.



Image 8. One piece of a shared space. From left: Anna Einarsson, Ulla Pirttijärvi-Länsman, Marita Solberg. Photo: Auditorama.

formed themes that all parties (the scenographer, the librettist and I myself) incorporated in their work to come.

Perspective taking, as a concept to bring to the collaborative process, was fuelled by sharing the experience with the scenographer of an exhibition by Pascale Marthine Tayous at Malmö Konsthall, influencing scenography and music in the final work.

To experience unorthodox phenomena

This denotes how the workshops served as an important platform for evaluating, experiencing and giving way to unorthodox phenomena. One example provided is an exploration of having one singer guiding the audience while simultaneously singing. There, it was discovered to be too actuating and not the sought-for expression. Furthermore, the interactive technology was introduced and examined in a playful way during workshops.

To define the playing field and identify challenges

As described, a workshop may serve the purpose of zeroing in on the playing field, i.e. defining the frameworks within which a musician/ensemble/institution may be challenged. Identifying the need for specific technical know-how far in advance to anticipate challenges ahead is one example.

Calibration

The article ends up discussing the suggested concept of *calibration*. The concept is twofold: calibration towards the work, involving the artistic team (composer included) and the receiving institution; and calibration within the final work, a principle functioning almost like an amplifier of core elements, directed at the relationship towards the audience.

Calibration is a notion used for the harmonisation process where pre-compositional ideas and concepts are explored: tested, rejected or refined, as well as sanctioned. Within the term “ideas and concepts” is also encompassed the sharing of an experience related to the work-to-be. This emphasises an important facet of calibration, namely that the embodied knowledge brought along into the workshops and study visits by each participant is made part of the process through acts involving reflection, action, sensing and decision-making. This entails that calibration is not only a means to an end but part of an ongoing development of existing embodied knowledge, transformed through the material and the shared experiences in the workshop process. A vital part of this embodied way of knowing stems from feelings, approaching or estranging material and other beings, human or non-human. As Johnson puts it, “[...] we must recognize the role of the body, especially sensori-motor processes and our emotions and feelings, in our capacity for understanding and knowing” (Johnson, 2010, p. 145).

A comparison is made with Carter's concept of *discursive momentum* (Carter, 2009), but as put forward, *calibration* is more of a process than the former, which is interpreted more as a state. In the end Barbara Bolt (2009) is referenced, saying it is not the talking but the making that is at stake, it is the dialogue mediated through the material specific for each art discipline that brings a shift in perspectives and a potential to transform knowledge, as in the case of *PS. I will be home soon!*: vocalising, performing or moving about in the concert space and experiencing, adjusting and trying anew. Hence by emphasising the word perspective, having a corporeal sense of knowing the world in mind, the discussion arrives at suggesting that what is calibrated is a bodily rooted attention, forming a kind of joint attention towards the work in the making.

5.2.2. Using singing voice vibrato as a control parameter in a chamber opera (Einarsson & Friberg, 2015)

The article begins by stating that the multifaceted voice with its expressiveness ought to be ideally suited for being used as a control parameter in musical works. Although a vast number of tools for analysing the voice exist, not so many focus on the singing voice, and even fewer focus on analysis from a perceptual viewpoint. Thus, making new implementations from compositional needs seems almost mandatory and the described collaboration between researcher Anders Friberg and composer Anna Einarsson is an offspring of one such effort in the framework of the chamber opera *PS. I will be home soon!*

Different aspects of singing voice vibrato are described. On the one hand it is relatively easy to isolate and manipulate for singers, on the other hand this is very much dependent on genre identification and individual preferences. Interesting to note: technology may work in two ways, both by being affected by the voice and by informing the singer of (perhaps to this point unexplored) resources and possibilities. Vibrato is not an altogether uncomplicated matter to make use of in composition either. Perceptually it is part of the affective prosody that reveals emotional states to the listener. The amount of vibrato can be used as a deliberate cursor for style, or its absence can be a demarcation against undesired associations.

5.2.2.1. Vibrato extraction

The vibrato extraction is explained as follows: The input is the monophonic audio signal from the singer. (1) In the first step pitch and sound level are extracted using the YIN module provided by IRCAM [11]. (2) A determination of a "proper" tone is done using a combination of pitch range, sound level limits, and the quality estimation factor from YIN. Only

when all requirements are met is the extracted pitch passed on for analysis (gated). (3) The pitch signal is divided into two parts. The first part is slightly low-pass filtered. The second part is median filtered using a window corresponding to one vibrato cycle assuming a vibrato rate of 6 Hz. This will cancel out any regular vibrato around this frequency. (4) The two parts are subtracted. The resulting signal will be zero when no vibrato is present. (5) Finally the absolute value of the signal is averaged using a median filter twice the length of a vibrato cycle. The resulting signal is proportional to the vibrato breadth in cents.

Furthermore, mapping and then sound synthesis is described. The singer cast for performing this part in the opera where this software was implemented was classically trained and modestly comfortable with manipulating her singing voice vibrato.

5.2.2.2. Method

The application was tested during rehearsals and during the month of performances. A written semi-structured interview with open-ended questions was then conducted and analysed with the help of Interpretative Phenomenological Analysis (IPA).

The structure of the piece and some compositional considerations pertinent to the work, such as mapping, are also accounted for.

5.2.2.3. Results

The encounter with a new score may be regarded as an expression for the expectations that a musician brings into a musical project. Core elements of this encounter, which interestingly also could be traced throughout the work, was that it seemed *exciting, challenging and uncertain*. The uncertainty was of course in part due to the electronic layer being at that point yet unknown to the vocalist; the score only contained notated clusters with possible sound material for each bar, but no timbres were known.

The relationship to the computer was experienced as interestingly ambiguous and paradoxical. One aspect is the challenge of performing against a fixed beat, a recognised fact in the literature. This was evident and resulted in a sensation of being *controlled by the computer*. Another recurrent theme is that *the relationship to the computer evolved over time*, from being one denoted by reluctance to a rewarding one. Two other themes emerged dealing with the stance towards the computer. On the one hand the computer was indeed experienced as a separate thing detached from the performer, with reference to the concept of the computer as the disembodied other. A few examples are provided, suggesting how listening is also affected. On the other hand there is a strong feeling of connectedness and a sense of cohesion. So taken together, the computer was a source of both comfort and uncertainty. Also the response was experienced as slow. This underlines an experience of the computer as

separated, but also relates to the theme of being controlled by the computer.

5.2.2.4. Conclusion

As the concluding remarks have it, the notion of uncertainty may have technical reasons, both in terms of an arbitrary choice of scale for mapping, and singer's ability to alter vibrato. The two-sided experience of the computer is an interesting finding since, in part, it combines two different strands of thinking about the relationship to the computer in mixed works, i.e. the computer as separated from or the computer as a prolongation of the musician. In the current case it seems to provide comfort and uncertainty, detachment and cohesion simultaneously. Or it may be that it is a story told from the perspective of otherness, where the separation is a condition for feeling the sense of unity as reported. As for the singer's account that the response from the application was experienced as slow: here there was a negotiation between the compositional desire to have a stable shift of chords with each new bar and the performer's need to have a more direct response. A different structure in the synthesis would have made the response more flexible and possibly more satisfactory.

5.2.3. Experiencing responsive technology in a mixed work (Einarsson, in press)

The aim of the article is to discuss how performing with responsive technology in a mixed work is experienced by singers. Drawing upon interviews from singers' accounts of performing *Metamorphoses* (2015), results are discussed in the light of sensori-motor processes and bodily human meaning-making, i. e. theories of embodiment.

The introduction outlines the fundamental role that physical and social interaction have in our everyday lives, and emphasises the importance of phenomenological accounts capturing the interplay with computer technology in the performance situation, identifying the sparseness of accounts treating the affective dimension. The notion of control is recognised as a recurring topic when discussing approaches towards the responsiveness of a system. The ecological approach to apprehension of musical meaning, as brought forward by Eric Clarke (2005), hints at the particularities of the performance situation, where the separation between music and performer tends to blur. According to Clarke, the type of instrument performed plays a role in determining how the particular relationship between action and perception is expressed in the particular situation. In the article it is suggested how this conflation is taken to its extreme when singing.

5.2.3.1. Aim & Method

How do singers conceptualize the computer? And how can their accounts be understood

when situated in a framework of radical embodied cognition and ecological psychology (Chemero, 2009; Clarke, 2005)?

The investigation is a continuation of composing and working with the chamber opera *PS. I will be home soon!* (Einarsson, 2015; Einarsson & Friberg, 2015) and takes place in the work *Metamorphoses*, a responsive work for four laptops and four vocalists, where singing voice features affect the subsequent sounding electronics. Data is collected with semi-structured interviews and analysed with the method of Interpretative Phenomenological Analysis (IPA) as a touchstone. Holmes and Holmes (2010) recommend the choice of IPA when doing explorative research on music performance experiences. IPA was also chosen due to the focus of lived experience and how performers try to make sense of their experiences, with an emphasis on a particular context (i.e. *Metamorphoses*) as well as its proximity to embodied cognitive approaches (Smith, Flowers & Larkin, 2009).

5.2.3.2. Embodiment, data collection & data analysis

The article continues with a broad outline of the kind of embodiment the work claims, where the work of Chemero (2009) and Damasio (2003) are cornerstones. The work is described more in detail: its technical description, mapping and sound synthesis. The section ends by presenting methods for data collection. Two major data collections were made. On the first occasion the singers were first asked to write down their experiences from the day, to facilitate recall and avoid regression to mean. Secondly an hour-long open structured interview with all three singers took place. During the whole day testing was recorded and the resultant discussions taking place while testing were also transcribed. For the second data collection an interview schedule was constructed to cover areas of interest. The interviews lasted for about an hour each, and were recorded and transcribed verbatim.

Five superordinate themes were identified from the process of repeated reading, where each of the 4th (and final) interview transcriptions were juxtaposed finding psychological conceptualisations at slightly higher levels: (1) Singing, body and emotion, (2) Listening and seeing, (3) Relating and interplaying, (4) The process towards the work, (5) The score (see appendices). This article focuses on the themes (1) – (3) presented in the subordinate themes:

- The computer as extension or separated,
- The computer as a fickle playmate,
- Body and gesture,
- Participation and uncertainty: influence by culture,
- An expanded sphere,
- A sense of whole,
- Listening in dynamic dialogue with the situation at hand,

- Experiencing in an altered bodily awareness,
- Looking for a response,
- The character of the response,
- Situational factors.

5.2.3.3. Results & Discussion

Singers' accounts reveal there is a shift in the experience throughout the work between the computer as an extension of the singer's instrument and the computer as a separate entity. Examples are provided in support of these experiences, referencing sections in *Metamorphoses*. The role of preconceptions towards the computer is pointed out, and how to one singer, a sense of play emphasises a sense of separation. On the other hand an imitative quality in the response enhances a sense of being connected.

The debate on whether it matters if the relations between electronics and singer are real or inferred is addressed from the singers' points of view and discussed in relation to cultural background and the way culture, also according to the literature, is part of what we perceive.

Moreover, singers describe in slightly different ways singing with responsive technology as having an expanded sphere, a sort of branching out, which impacts singing as well as listening. Furthermore, emphasis is given to the sense of a whole in listening and performing. Since the situation encompassing responsive technology comprises many layers there is an oscillating movement between the singers' own expanded sphere, the others' expanded spheres, and the resultant whole.

Technically there are different parameters for analyses and synthesis in different sections of *Metamorphoses*, so the computer will respond differently at different moments in time, as the sounding environment changes, which has an impact not only on the course of musical action, but on available affordances and, in extension, meaning-making.

Looking for a sounding response in the computer technology is suggested as having many facets of different value: one is of putting something on display, one is of neglecting the interplay with fellow musicians, and one suggests that looking for a response is perhaps a necessity if the computer technology is intended to act as a partner in dialogue. Furthermore, the length of the response, the character of the response, the immediacy of the response and the possibility of anticipating it are all factors influencing the experiencing of computer technology. Additional parameters touched upon are the makeup of the situation, i.e. what musicians are involved and if the composer is present. Finally when performing in an altered bodily awareness, some modalities, such as listening, become attenuated.

In the concluding discussion emphasis is put on the impact of the situation, and experiences of extension/separation are viewed in the light of existing theory. Relationships to-

wards the responsive technology are not static but evolve over time. A discussion is also set up on affordances, concluding how the structure of the sounds, their behaviours, qualities and placement, are all important facets to consider when trying to determine what causes the singer's readiness to act and shift of attention.

5.2.4. Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies (Einarsson & Ziemke, 2017)

5.2.4.1. Aim

The starting point of the article is the question of how an understanding of performing with responsive technologies can be furthered, taking its complexity into account, with a view of music as an embodied and situated activity. Using Gibson's notion of affordance as a point of departure, its employment in music theory is scrutinised, and a widened concept, cultural affordances, incorporating sociocultural forms of life, following Rietveld and Kiverstein (2014) and Ramstead et al (2016), is suggested. Hence the aim of the article is threefold: (1) to clarify previous interpretations of the concept affordance as well as limitations to its present use, (2) to suggest an application of the framework cultural affordances (ibid), previously not applied to music, and (3) to make a contribution towards bridging the conceptual gaps between the seemingly disembodied work of the composer, the concrete embodied activity of musical performers, their interaction with more or less 'invisible' technologies, and the - according to some - highly abstract social and cultural practices that they are part of.

5.2.4.2. On affordances in general and cultural affordances in particular.

The article continues outlining notions of the concept affordance in psychology/cognitive science in general and its use in music research in particular. At first James Gibson's presentation of the concept, emphasising the reciprocity between organism and environment, is outlined, followed by Turvey, Shaw and Mace's development of the theory into dispositional properties (1981). Moving on to Chemero's view of affordances as relational abilities, the exposition then arrives at Rietveld and Kieverstein's (2014) suggestion of applying affordances more broadly, as aspects of a sociocultural environment, a notion which is penetrated more in depth, alongside Ramstead et al's (2016) concept of *cultural affordances*.

According to both Rietveld and Kiverstein (2014) and Ramstead et al (2016), organisms do not encounter affordances one by one, but as an ensemble of affordances, which themselves are entangled in various ways and appear as nested, depending on each other, hiding, enabling or revealing other possibilities for action. Certain affordances, in this view, are highly influenced by joint intentionality, social and cultural normativity and shared expectations (implicit and explicit), codetermining the *landscape of affordances* (Rietveld

& Kiverstein, 2014; Ramstead et al, 2016). The landscape of affordances is relatively static and more or less shared by a population in a given environment, and distinct from the individual's *field of affordances*, which dynamically varies as a function of current internal states, interests, etc. According to Ramstead et al., the field of affordances is experienced as "solicitations", in that they solicit (further) affective appraisal and thereby prompt patterns of 'action readiness,' that is, act as perceptual and affective prompts for the organism to act on the affordance". This idea of affective appraisal causing readiness to act, the article puts forward,, is of much relevance to a performer or composer's practice.

Next follows a discussion on how the concept of affordance has been applied within the musical discourse. Most scholars agree upon that music affords movement or synchronisation/entrainment, but from there, interpretations deviate greatly. The article takes us through a number of these as suggested by Clarke (2005), Windsor and Bézenac (2012), Kreuger (2014), and Menin and Schiavio (2012).

5.2.4.3. Practical examples from artistic works

In the next step, with the aid of practical examples from *Metamorphoses* in particular, the key concepts of the theory are applied and discussed. This section emphasises how social influence and enculturation impact the musical situation, thus influencing available affordances, and how situation and affordances are deeply intertwined.

It is suggested how the *field of affordances* of the individual singer is dynamically changing: referencing recent findings in neuroimaging, some affordances may be stable while others are changing. Different ideas are presented, for example that the words that the singer sings potentially impact the appraisal of the available field of affordance, since these evoke emotions that in turn will affect appraisal.

Another central concept in this context is *skilled intentionality*, which captures the way organisms orient towards their environment so as to *maximize their grip* on their interaction with the environment. The issue is then how prerequisites for achieving the optimal "position" for performance, through enabling multiple affordances in music performance, is created. Some suggestions are optimization of feedback monitoring, placement of equipment, positioning in relation to the audience and/or fellow musicians, controlling muscular tension/ level of anxiety in order to perform at his or her best, minimizing possible distractions, acknowledging and adapting to present room acoustics, but also learning new behaviours, for example finding new listening strategies. Striving towards *optimal grip* for a composer, drawing upon first author's experience, is reflected in having concrete tools readily available for composition (computer, instruments, synthesisers etc.), but also in terms of having access to the desired bodily state (as Damasio denotes it), pertaining to feelings and cognitions in accordance with the idea for the work. This also shows how an

activity such as musical composition - by some considered disembodied, or belonging to “higher cognition” - may indeed be embodied through affective appraisal.

Furthermore, the impact of attention and *joint attention* is discussed in terms of how they impact the performer’s engagement with the field of affordances. Lastly, the role of the composer is discussed and it is suggested how considering the dynamic between the shared landscape and individual fields of affordances is at the heart of the music composer’s practice. It is proposed that composers create their field of affordances to operate within, relying on mechanisms of predictive processing and embodied simulation. Quiet inner listening brings about action cues, and extracts of musical passages or certain sounds projected over loudspeakers in the studio likewise suggest musical action in an embodied manner. Anticipating and forming relationships, as well as playing with expectations, is many times at the core of the composer’s practice.

5.2.4.4. Conclusion

One of the driving forces behind this research was the question of how we can begin to account for the complexity of interactive music performance situations and analyze details without losing sight of the whole. The article’s claim is that what is still missing from the discourse on musical affordances is an encompassing theoretical framework incorporating the sociocultural dimensions that are fundamental to the situatedness and embodiment of interactive music performance – facilitating a detailed account of the underlying mechanisms, but also providing a more holistic approach that does not lose track of the complex whole constituted by the interaction of composers, performers, audience, technologies, etc. The article concludes that the crucial departure from the original Gibsonian notion of affordances, and many later variations and interpretations thereof, lies in the position that it is the situation as a whole that has affordances. Drawing upon analyses of and experiences from the artistic practice, the article also argues for a need for an intermediate level between landscape and field, an arena of affordances, to capture the local ontologies founded on shared embodied expectations and social and cultural practices.

6. Discussion

[...] the central challenge that this field faces is not one of improving technology, but rather one of developing an understanding of its implications – the changes in mindset and sensibility of artists as they try put it to use (Wechsler, 2011, p. 75).

This artistic research has attempted to show the transformative powers of the relationship towards computer technology. Through the artistic works and singer's accounts of performance experiences comprised in this research project, I have deepened my understanding of how the practices of singing and composing are embodied activities; they cannot be separated into processes of body and mind respectively, for they act as one conjugated entity. In close dialogue with embodied cognitive theories and ecological psychology, I have pointed out how aspects of the embodied practice of singing get accentuated and put in perspective, and how composing for responsive technologies can be conceptualised as a process of shaping and shifting fields of affordances.

In these chapters I have brought forward how singing a mixed work does not takes place in a void, but rather in a coupled relationship with the situation at hand in all its complexity, encompassing social and cultural layers in addition to the materials and people involved, skills employed and tools used. I have shown how the relationship between singer and situation is dynamic and one denoted by reciprocity. They both evolve over time, in the short as well as long term.

To then introduce the computer, more specifically responsive computer technology, into this setting, as one does in a mixed work, offers the challenge of incorporating a material, traditionally regarded as disembodied, into an existing embodied activity of singing. It is true that most performances purport a dimension of first time discovery in one way or another, and new materials are introduced when encountering new musical works or performances. However, responsive computer technology is not just any random material. As brought forward throughout the work it is a highly flexible one, conveying a diverse range of connotations, which poses a challenge to both the performer(s) and the composer of the mixed work.

Furthermore, I have shown how performing with and composing for responsive computer technology includes many facets: for instance elements of imitation, play, or mere selectiveness in musical gesture, suggesting directions for the music to proceed in – thus exerting an influence on the performer, and implying an agency of some sort. I have suggested a stance, drawing upon a framework as suggested by Ramstead et al (2016), where the many

layers of the work and the many materials involved (human and non-human) can be seen as a shaping of fields of affordances. Emphasising the embodied aspects of the compositional practice, it is not a matter of denying rationalisation processes when composing, but rather saying, “certain aspects of the process of emotion and feeling are indispensable for rationality” (Damasio, 1994, p. xii-xiii). Or in the words of Pelinski (2005, p. 5): “embodiment plays a decisive role in the production of musical meanings primordially lived in the subjective experience in a pre-conceptual and ante-predicative way, at the same time open to the social and natural environment and informed by it”.

All in all, my concern has been to investigate how the responsive computer technology may be integrated when composing with an approach of seamlessness, and how performers experience this relationship. In other words, with the practice of singing being a process of embodying a situation, I have addressed the emergent oscillation taking place between experiencing technology as either an extension of, or as separated from, the lived body, and the implications this has for singing and for composing (e.g. Einarsson). Put in more all-encompassing terms, I have outlined ways of conceptualising the role of computer technology. My exploration has concerned the singing voice, so it is therefore beyond the scope of this thesis to say much about any other instruments.

6.1. Embodiment

Recall the imagery of the blind man holding his stick, over time sensing the ground through the stick (Hirose, 2002). Due to the many materials (and humans) included in the performance situation, there are in fact many “sticks” that provide both a scaffolding and a susceptibility on the part of the performer in a mixed work. A whole field of tension between materials emerges, which oscillates between being an extension and being detached, guided by attention, emotion and situational cues, social and cultural dimensions included. I am reminded of a singer’s account in *Metamorphoses*, describing how every performer has their own sphere or extended arm to consider during performance, forming a dense web of relations, high in complexity. As noted, the oscillation between extension and detachment may appear even in relation to the singer’s own voices. In that particular case, perhaps it is no longer applicable to refer to the image of a stick, but rather to an abduction and adduction of a body part, which slightly turns the tables. However, if embodying is a process, ought there not be layers of embodiment? According to one singer, this notion is in accordance with her experience; different musical works demand different degrees of embodiment. What these differences might be, and what might solicit these different approaches, I have not looked into, but it would indeed be an interesting matter to investigate in future research.

The fluid dynamic and sense of whole described in this work, where the object in the situation is neither separate, nor an extension, but both, resting on a foundation of situational cues, diverges from the position by Emmerson (2009) described in the beginning, which contrasts the musicians' "anchoredness" on stage with the "otherness" of the live electronics. Why is this so? Emmerson discusses an instance with a performer's sounds displaced in time, as described in the following:

It is possible, although extremely difficult, to retain a singular identity of live and time-displaced events with instrumental sound. This requires well-integrated amplification and recording and spatially "tight" mixing of the two (ibid, p. 175).

Are homogeneity in sound and tight spatialisation the only ways to form a singular identity between sound production and response? One reason for our differences in conclusions may simply be our choice of perspective. Emmerson discusses from a third-person perspective, with a descriptive approach, while I primarily draw upon a first and second person perspective, grounding my discussion in a phenomenological approach. We may know something - in theory - as being separate from us, but we may still *experience* it as extended, or both extended and separated. One singer begins by describing this double nature in terms of "I don't regard it [the live electronics] as something outside of myself, although it is." Then she portrays experiencing a mutual enfolding between her and the live electronics, which I came to associate with a principle of complementarity, of yin and yang (see 5.1, Einarsson, in press).

Flutist Jean Penny (2011), although frequently referring to the spatialised voice as disembodied, recognises the transformative powers of the electronic part on the performer's identity, and quotes theorist Steven Connor saying: 'One cannot be fully "here" unless one is silent; one cannot vocalise without being "there" as well as here, without being drawn out into the ambivalence of being here and there at once' (Connor, in Penny, 2011, p. 190). In a way, as I see it, the production of sound (of any kind, that is, although Connor specifically refers to the voice), emphasises our embodied being in the world. And acting in concert with responsive technology, this ontology is even further accentuated.

Penny (ibid) makes strong distinctions between "inner" and "outer". This view differs greatly from my findings of embodying as a process through which performance actions undermines any sharp distinction between inner and outer. Also, as discussed in Chapter three, there is embodied cognitive theory suggesting convincing evidence for overlapping neural perception- and action-cycles.

The singing voice can indeed both affect and become affected by technology. One example from my research, as discussed in the article *Using singing voice vibrato as a control*

parameter in a chamber opera (Einarsson & Friberg, 2015), is how technology may be affected by the vibrato, but may also be informing the voice of limitations and possibilities. Again the blind man's stick becomes both detached and an extension; it is utilised and it is put aside. A similar account of the voice being affected by technology is provided by one opera singer participating in a work by Unander-Scharin (2014), describing the reciprocity of how her vocal technique was affected by the use of technology even while she affected technology.

As for interface, my overarching compositional approach is one of zero interfaces or no user interface. Seamlessness between performer and computer enables attention to be directed towards sounding gestures instead of hand- or feet-actions, the latter not always compatible with the sounding layers. Despite this, the way bodily gestures may facilitate the formation of meaningful relationships towards the computer technology as part of a rehearsal process must not be neglected. At least this is how I have come to understand the unexpected findings of computer triggering from a physical interface being a beneficial part of a learning process progressing towards a new work, again to be compared with existing simulation theories under the umbrella of embodied cognition (see Chapter 3). My conclusion is thus that physical triggering may serve as a step along the way to embody the situation, but should be weaned away as the performance approaches in order to liberate degrees of performance freedom on the part of the performer.

6.2. Resonance

How is the interplay between performer or composer and computer technology made possible? As a prerequisite, it is reasonable to believe that the interplay presupposes some form of "willingness" to be part of a situation where a resonance may arise between the sounding and the performer/composer. In her doctoral thesis, singer Julianne Klein provides the reader with much hands on advice about how to apprehend the repertoire of mixed works and contends that "diligence, great patience, dedication and an unfailing cooperative spirit are required from all parties involved in this endeavour" (Klein, 2007, p. 51).

In Chapter three I discussed, also exemplified in Chapter five, how I see decision-making when composing as a form of resonance between the composer and the sounding material, which is a view radically different from exchange of communicative input-output signals, a common way of describing interaction between agents (Lindblom, 2015). What I propose is a matter of susceptibility towards the situation, possibly a form of covert mimicry, allowing for the dynamic contours (cf. Stern's idea of *vitality affects*, Chapter three) of the sounding to be apprehended. Recall for example one vocalist describing her experience of performing and interacting in *Metamorphoses* as "moving like a school of fish", incorporating a strong element of movement, yet also depicting her role as part of an experienced whole.

It is through these and similar experiences that music – in this case mixed works – as a sounding body to interact with is actualised, suggesting an outlook on performing with responsive technology with emphasis on the process of embodying and resonance between bodies. This may be taken into consideration for example through a negotiated concert practice, where bodily experiences for all parties must be acknowledged to a much larger degree than has been before.

6.3. Calibration

The resonance is also moulded by attentiveness towards the situation at hand. In the article *We can work it out – Calibration as artistic method* (Einarsson, 2015), I have discussed how bodily rooted attention, in dialogue with materials and people, is a vehicle enabling shared experiences towards the work in the making. Through an array of practical examples from *PS. I will be home soon!* I highlighted how this could form an active aspect of a commissioning procedure as a harmonisation process between the artistic team and the receiving institution, as well as a principle within the work. In hindsight, some of the examples may seem slightly elementary, so I want to elaborate on how they nevertheless highlight the role of embodiment, and how acknowledging this may facilitate exploring new ways for commissioning and forming collaborative works. It is the notion of *felt* experience during workshops, serving not as an add-on but as a vital part of a decision-making process that is at stake. Words, images, collages created and experiences shared found their way into the creative process by means of multi-modal interaction. A shared frame of reference (cf. subject position, see Einarsson, 2015, or Clarke, 2005) is established through this process in ways not restricted to talking only.

Provided attentiveness is seen as a way of knowing, calibration towards the work entails not only a shaping of a joint way of being attentive towards the work in the making, but a shared basis of knowing for the artistic team to draw upon and depart from. The knowing rendered from group exercises is not separated from embodied activity; non-verbal knowing is not separated from verbal knowing, but they act in concert to both enrich yet draw upon the same embodied foundation. The point I want to make is the need for taking all these modalities into account, to not discard some aspects as superfluous.

As a method, a workshop process may help analysing the role of technology in the work-in-becoming. I agree with performing artist and researcher Robert Wechsler, who says “there are stronger and weaker justifications for employing technology in a piece of art and an ability to analyse which are paramount to creating good work in this idiom” (Wechsler, 2011, p. 69). Also, creative arts practitioner Susan Broadhurst (2011) comments on how collaborative exercises help to ensure that technology is not experienced as an

add-on to an existing performance. In *PS. I will be home soon!* the use of interactivity was in part motivated by a wish to encourage a more active audience, without assigning it compositional choices. It built on an idea of mine that perceived staged interactivity would be facilitated and possibly potentiated by an audience engaged in interactivity, actively participating in the performance situation. This line of thought also accompanied the preceding works *Metamorphoses* and *One piece of a shared space*, both employing a workshop-method towards the work. However, I disagree with Broadhurst that one must add meaning to the digital. She writes: "The digital, like all formal systems, has no inherent semantics unless one is added. One must add meaning" (Broadhurst, 2011, p. 147). This approach disconnects technology from the situation into which it is interwoven, something I would claim verges on the impossible. I would contend there is always relatedness, although this on the other hand may be consciously negotiated, re-contextualised and challenged. Something, which may assist in that process, is the notion of affordance in general and the landscapes and fields of affordances in particular, as discussed in the following.

6.4. Situations & Affordances

The article on calibration was written at the beginning of my research project, so today I would like to tie the notion of calibration to a discussion on affordances, forming a larger arch between these different aspects of the embodying of the situation of performance and composition. Together with Tom Ziemke, (Einarsson & Ziemke, 2017) I have suggested an expanded concept of affordances in line with Rietveld and Kiverstein (2014) and Ramsted et al (2016), one that includes sociocultural forms of life. The reason for this is that when discussing music, it verges on the impossible to not include these dimensions, and as Ramsted and colleagues contend (*ibid*), these dimensions underpin any form of affordance in human life. It is through regimes of shared attention and sociocultural practices that affordances are transmitted. Hence the aforementioned concept of calibration may be integrated into a larger framework suggesting that what takes place during the process of calibration is a pointing out of available affordances, which themselves are entangled in various ways by means of feedback and looping processes. Joint intentionality, social and cultural normativity and shared expectations (implicit and explicit) codetermine the encounter with the ensemble of affordances.

Affect, attention, and affordances interact to sculpt a field of solicitations out of the total landscape of available affordances, adaptively and dynamically moving the organism toward an optimal grip on situations through action-perception. (*ibid*, p. 13).

On the one hand, as described in Einarsson and Ziemke (2017) and in Chapter three, there is the relatively static *landscape of affordances*, more or less shared by a population in a given environment, and on the other hand the individual's *field of affordances*, which dynamically varies. The role of the composer in this is then to consider the tension between the shared landscape of affordance and individual fields of affordances, to shape dynamic fields of affordances accounting for their possible interactions, based on a shared landscape of affordance. Hence within the larger landscape of affordances, shared by composer, singers, and the audience, and within the musical performance situation with all its parties, there are clusters and overlaps: the specific set of affordances that the singers share (e.g. the way they can influence the music through their voices), the specific set affordances that the audience shares (e.g. the way they can move in the performances space), but also general affordances that are shared by audience and performers (e.g. the way people tend to orient towards sound sources). Understanding this rich space of affordances and the complex web of their interrelations and interactions – consciously or unconsciously – is part of the composer's practice. Even when composing, the composer creates her field of affordances to operate within; anticipating and forming relationships, as well as playing with expectations, is many times at the core of the composer's practice, and there is always emotion and valence involved to some extent. Also in relation to the audience, even though not explicitly studied, my approach through the encompassed works of having the audience either be seated if they wish, or moving about and allowing for exploration, is a matter of acknowledging and working with the audience's specific set of affordances.

Emmerson discusses instances where performers experience musical communication as building on other aspects than sight and sound, for example an experience of "multi-sensory feel" when interplaying, or "responding to an atmosphere" (Emmerson, 2009, p. 182). I suggest these and similar notions could be subject to future exploration within the framework hereby suggested, which is a framework accounting for the complexity of interactive music performance situations, i.e. providing a detailed account of the underlying mechanisms but also providing a more holistic approach that does not lose track of the complex whole constituted by the interaction of composers, performers, audience, technologies, and so forth. The position proposed through this research is that it is the *situation as whole that has affordances*. This also sheds new light, as discussed in detail in Einarsson and Ziemke (2017), on musical composition as the site for the construction – and embodied mental simulation – of situations, whose dynamics unfold to engage musicians and audience through the shifting fields of affordances, based on a shared embodied 'vocabulary' as constituted by a shared landscape of affordances. Also, a heightened awareness of the impact of the many-layered situation may inform the concert practice as such (e.g. 5.1.3.).

6.5. Looking forward

In conclusion, there is always the challenge, in art as well as in life, of focusing in on details without losing a sense of the whole. The aim has been to find ways of – at least in part – grasping this great intricacy, not neglecting the far end of the gauss curve, while carrying some of my experiences forward for others to discover in their artistic practices.

I have felt a need for an integrative framework, offering, with a phenomenological approach, a terminology to discuss and depict the complexity of performing with responsive technologies, from a composer's point of view as well as a performer's. Hopefully, my thoughts and the application of this suggested theoretical framework also to others' works incorporating performers and live electronics, may assist in a continuous deepening of the understanding of compositional practice incorporating computer technology, and potentially be of interest to other performing arts as well. Questions may also emanate from the artistic practice and be directed back to theory. Might there be interaction effects between affordances? The many layers of the work *Metamorphoses* suggest there may be. Given that embodiment may be experienced as a process, are there layers of embodiment?

As stated in the beginning, an obvious omission from my field of investigation is the audience, and future plans involve including their perspective in the shared landscape of affordances to find out more about the experienced web of reciprocal embodied relationships unfolding throughout the musical work.

Can I sing technology? In truth, the journey has just begun. Nevertheless I am inclined to say yes, I can, and future discoveries, both my own and others', will continue unveiling this path of developments in the realm of combining singing voice with computer technology in performance and composition.

References

Books & Articles

- Aube, T. (2015, Nov 11). No UI is the new UI [Web log post]. Retrieved 2016, Dec 14, from: <https://techcrunch.com/2015/11/11/no-ui-is-the-new-ui/>
- Barrett, E., & Bolt, B. (Eds.) (2013). *Carnal knowledge: towards a 'new materialism' through the arts*. London: I.B. Tauris.
- Barsalou, L.W., Niedenthal, P. M., Barbey, A. K., & Ruppert, J. A. (2003). Social embodiment. *Psychology of learning and motivation*, 43, 43-92.
- Benson, B. E. (2003). *The improvisation of musical dialogue: A phenomenology of music*. Cambridge: Cambridge University Press.
- Biggs, M., & Karlsson, H. (2011). *The Routledge companion to research in the arts*. (1. ed.) Oxon: Routledge.
- Birnbaum, D., Fiebrink, R., Malloch, J., & Wanderley, M. M. (2005). Towards a dimension space for musical devices. In *Proceedings of the 2005 conference on New interfaces for musical expression*, 192-195. National University of Singapore.
- Blatter, A. (1997). *Instrumentation and orchestration*. (2. ed.) Belmont, CA: Wadsworth.
- Bolt, B. (2009). The Magic is In Handling. In Barrett, E., & Bolt, B. (Eds.). *Practice as research: Approaches to creative arts enquiry*, (pp. 26-34). London: I B Tauris.
- Bongers, B. (2000). Physical interfaces in the electronic arts. In Battier, M. (Eds.). *Trends in gestural control of music*, (pp. 41-70). Paris: IRCAM Centre Pompidou.
- Borgdorff, H. (2011). The production of knowledge in artistic research. In Biggs, M., & Karlsson, H. (Eds.). *The Routledge companion to research in the arts*. (1. ed.) Oxon: Routledge.
- Bosma, H. (2003). Bodies of evidence, singing cyborgs and other gender issues in electrovocal music. *Organised Sound*, 8(1), 5-17.
- Broadhurst, S. (2006). Digital Practices: An aesthetic and neuroesthetic approach to virtuality and embodiment. *Performance Research*, 11(4), 137-47.
- Brooks, R. A. (1991). Intelligence without representation. *Artificial intelligence*, 47(1-3), 139-159.
- Carter, P. (2009). Interest: The Ethics of Invention. In Barrett, E., & Bolt, B. (Eds.) *Practice as research: Approaches to creative arts enquiry*, (pp. 15-25). London: I B Tauris.
- Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, Mass.: MIT Press.
- Clarke, E. F. (2005). *Ways of listening: An ecological approach to the perception of musical meaning*. Oxford: Oxford University Press.
- Çorlu, M., Maes, P. J., Muller, C., Kochman, K., & Leman, M. (2015). The impact of cognitive load on operatic singers' timing performance. *Frontiers in psychology*, 6, 1-10. doi:10.3389/fpsyg.2015.00429
- Cox, C., & Warner, D. (Eds.) (2004). *Audio culture: Readings in modern music*. New York: Continuum.
- Creswell, J. W., Hanson, W. E., Plano, V. L. C., & Morales, A. (2007). Qualitative research designs selec-

- tion and implementation. *The counseling psychologist*, 35(2), 236-264.
- Csikszentmihályi, M. (1990). *Flow: the psychology of optimal experience*. (1. ed). New York: Harper & Row.
- Dahlberg, H., & Dahlberg, K. (2003). To not make definite what is indefinite: A phenomenological analysis of perception and its epistemological consequences in human science research. *The Humanistic Psychologist*, 31(4), 34-50.
- Dahlstedt, P. (2008). Dynamic mapping strategies for expressive synthesis performance and improvisation. In *International Symposium on Computer Music Modeling and Retrieval* (pp. 227-242). Springer Berlin Heidelberg.
- Damasio, A.R. (1994). *Descartes' error: emotion, reason and the human brain*. London: Picador.
- Damasio, A.R. (2003). *Looking for Spinoza: joy, sorrow and the feeling brain*. London: Heinemann.
- d'Escriván, J. (2006). To sing the body electric: Instruments and effort in the performance of electronic music. *Contemporary Music Review*, 25(1-2), 183-191.
- Dixon, S. (2007). *Digital performance: a history of new media in theater, dance, performance art, and installation*. Cambridge, Mass.: MIT Press.
- Dourish, P. (2004). *Where the action is: the foundations of embodied interaction*. Cambridge, Mass.: MIT Press.
- Drummond, J. (2009). Understanding interactive systems. *Organised Sound*, 14(02), 124-33.
- Eckel, G. (2012) Four challenges of artistic research. Retrieved from <http://www.kth.se/blogs/art-design-science/files/2012/02/Eckel2011.pdf>
- Eigenfeldt, A. (2011). Real-time composition as performance ecosystem. *Organised Sound*, 16(02), 145-153.
- Einarsson, A. (2010). Triptyk om rösten. *Nutida Musik*, 3(4), 20-25.
- Einarsson, A. (2015). 'We Can Work It Out - Calibration as Artistic Method', *Ruukku*, 4 (19/03/2015) <https://www.researchcatalogue.net/view/142373/142374/0/0>
- Einarsson, A. (2017). Experiencing responsive technology in a mixed work: Interactive music as embodied and situated activity. *Organised Sound*, in press.
- Einarsson, A., & Friberg, A. (2015). Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera. In *International Computer Music Conference 2015–Sept. 25-Oct. 1, 2015–CEMI*, University of North Texas, USA.
- Einarsson, A, Ziemke, T. Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies. *Frontiers in Psychology* (section: Cognitive Science), submitted to a special issue on "Beyond Embodied Cognition: Intentionality, Affordance, and Environmental Adaptation". (2017).
- Ekman, K. (2009). *The dog*. London: Sphere.
- Eliot, T.S. (1941). *The dry salvages*. London: Faber.
- Emmerson, S. (2007). *Living electronic music*. Aldershot, Hants, England: Ashgate.

- Emmerson, S. (2009). Combining the acoustic and the digital: Music for instruments and computers or prerecorded sound. In Dean, R. T. (Ed.). *The Oxford handbook of computer music*. New York: Oxford University Press. doi: 10.1093/oxfordhb/9780199792030.013.0009
- Fasciani, S., & Wyse, L. (2013). Mapping the voice for musical control. *Technical report, Arts and Creativity Lab*, National University of Singapore. Retrieved from <http://stefanofasciani.com/downloads/FascianiWyseAnclabTechReport2013.pdf>
- Finlay, L. (2009) Reflecting on reflective practice (Commissioned discussion paper). Retrieved from: <http://www.open.ac.uk/ctl-workspace/ctlcontent/documents/4bf2b48887459.pdf>
- Fregel, M. (2010). A multidimensional approach to relationships between live and non-live sound sources in mixed works. *Organised Sound*, 15(02), 96-106.
- Friberg, A., Schoonderwaldt, E., & Juslin, P. N. (2007). CUEx: An algorithm for automatic extraction of expressive tone parameters in music performance from acoustic signals. *Acta acustica united with acustica*, 93(3), 411-420.
- Frisk, H. (2008). *Improvisation, Computers, and Interaction: Rethinking Human-Computer Interaction Through Music* (Doctoral dissertation, Malmö Academy of Music, Lund University, Doctoral Studies in Fine and Performing Arts, 6).
- Frisk, H., & Östersjö, S. (2006). Negotiating the Musical Work. An empirical study on the inter-relation between composition, interpretation and performance. *Electroacoustic Music Studies Network, Beijing*. Retrieved from: http://www.ems-network.org/IMG/pdf_FriskEMSO6.pdf
- Frisk, H., & Östersjö, S. (2013). Beyond Validity. *Swedish Journal of Musicology/Svensk Tidskrift foer Musikforskning*, 95.
- Gabrielsson, A. (2001). Emotions in strong experiences with music. In Juslin, P. N. & Sloboda, J. A. (Eds). *Handbook of music and emotion: theory, research, and applications*, (pp. 431-449). Oxford: Oxford University Press.
- Gallese, V. (2003). The manifold nature of interpersonal relations: the quest for a common mechanism. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 358(1431), 517-528.
- Garnett, G. E. (2001). The aesthetics of interactive computer music. *Computer Music Journal*, 25(1), 21-33.
- Gaver, W. (1991). "Technology Affordances." CHI '91: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching Through Technology*, New Orleans, LA, 79-84.
- Geeves, A., & Sutton, J. (2014). Embodied cognition, perception, and performance in music. *Empirical Musicology Review*, 9(3-4), 247-253.
- Gibson, E. J. (1963). Perceptual learning. *Annual review of psychology*, 14(1), 29-56.
- Gibson, J. J. (1982). Notes on affordances. In: Reed, E., & Jones, R. (Eds.), *Reasons for realism: selected essays of James J. Gibson*. Hillsdale, NJ: LEA Publishers.
- Gibson, J.J. (1986). *The ecological approach to visual perception*. Hillsdale, NJ.: Lawrence Erlbaum Associates.
- Goehr, L. (2007). *The imaginary museum of musical works: an essay in the philosophy of music*. (Rev. ed.) Oxford: Oxford University Press.
- Goldberg, R. (2000). *Laurie Anderson*. London: Thames & Hudson.

- Haraway, D. (1988). Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist studies*, 14(3), 575-599.
- Hayden, S., & Windsor, L. (2007). collaboration and the composer: case studies from the end of the 20th century. *Tempo*, 61(240), 28-39.
- Heshusius, L. (1994). Freeing ourselves from objectivity: Managing subjectivity or turning toward a participatory mode of consciousness?. *Educational researcher*, 23(3), 15-22.
- Hirose, N. (2002). An ecological approach to embodiment and cognition. *Cognitive Systems Research*, 3(3), 289-299.
- Holmes, P., & Holmes, C. (2013). The performer's experience: A case for using qualitative (phenomenological) methodologies in music performance research. *Musicae Scientiae*, 17(1), 72-85.
- Howell, K.E. (2013). *An introduction to the philosophy of methodology*. Los Angeles: SAGE.
- Hultberg, T. & Bock, C. (Eds.) (1994). *Fylkingen: ny musik & intermediakost : rikt illustrerad historiskrivning & diskussion för radikal & experimentell konst 1933-1993*. Stockholm: Fylkingen.
- Johnson, M. (1987). *The body in the mind: the bodily basis of meaning, imagination, and reason*. Chicago: University of Chicago Press.
- Johnson, M. (2007). *The meaning of the body: Aesthetics of human understanding*. Chicago: University of Chicago Press.
- Johnson, M. (2011). Embodied knowing through art. *The Routledge companion to research in the arts*, (pp.141-151.) Oxon: Routledge.
- Juslin, P. N., & Västfjäll, D. (2008). Emotional responses to music: The need to consider underlying mechanisms. *Behavioral and brain sciences*, 31(05), 559-575.
- Juslin, P.N. & Sloboda, J.A. (red.) (2010). *Handbook of music and emotion: theory, research, and applications*. Oxford: Oxford University Press.
- Kaufer, S., & Chemero, A. (2015). *Phenomenology: An Introduction*. Cambridge: Polity Press.
- Kojs, J. (2011). Notating Action-Based Music. *Leonardo Music Journal*, 21, 65-72.
- Kozel, S. (2007). *Closer: performance, technologies, phenomenology*. Cambridge, Mass.: MIT Press.
- Kozel, S. (2011). The virtual and the physical: A phenomenological approach to performance research. In Biggs, M., & Karlsson, H. (Eds.). *The Routledge companion to research in the arts*. (1. ed.), (pp. 204-222.) Oxon: Routledge.
- Krueger, J. (2014). Affordances and the musically extended mind. *Frontiers in psychology*, 4, 1-13.
- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought*. New York: Basic Books.
- Langer, J. & Regius, H. (2002). *Kung Kalle av Kurrekurreddutton: en resa i Efraim Långstrumps fotspår*. Stockholm: Forum.
- Lantz, A. (1993). *Intervjumetodik: den professionellt genomförda intervjun*. Lund: Studentlitteratur.
- Larkin, M., Eatough, V., & Osborn, M. (2011). Interpretative phenomenological analysis and embodied, active, situated cognition. *Theory & Psychology*, 21(3), 318-337.

- Leavy, P. (2015). *Method meets art: Arts-based research practice*. New York: Guilford Publications.
- Leman, M. (2007). *Embodied music cognition and mediation technology*. Cambridge, Mass.: MIT.
- Leman, M., & Maes, P.J. (2014). The role of embodiment in the perception of music. *Empirical Musicology Review*, 9(3-4), 236-246.
- Lewis, G. E. (2006). Improvisation and the orchestra: A composer reflects. *Contemporary Music Review*, 25(5-6), 429-434.
- Lindblom, J. (2015). *Embodied Social Cognition*. Berlin: Springer.
- Manning, P. (2013). *Electronic and computer music*. (4. ed.) Oxford: Oxford University Press.
- McNutt, E. (2003). Performing electroacoustic music: a wider view of interactivity. *Organised Sound*, 8(03), 297-304.
- Menin, D., & Schiavio, A. (2012). Rethinking musical affordances. *AVANT. Pismo Awangardy Filozoficzno-Naukowej*, 3 (2), 202-215.
- Molander, B. (1996). *Kunskap i handling* (2. omarb. uppl. ed.). Göteborg: Daidalos.
- Molander, B. (2013). Attentiveness in Musical Practice and Research. *Music + Practice*, 1(1).
- Molnar-Szakacs, I., & Overy, K. (2006). Music and mirror neurons: from motion to 'e' motion. *Social cognitive and affective neuroscience*, 1(3), 235-241.
- Morrow, S. L. (2005). Quality and trustworthiness in qualitative research in counseling psychology. *Journal of counseling psychology*, 52(2), 250.
- Morse, M. (2003). The poetics of interactivity. In Malloy, J. (Ed.). *Women, art, and technology*, (pp. 16-33). Cambridge, Mass.: MIT.
- Myatt, T. (Ed.). (2002). [Special issue on mapping]. *Organised Sound*, 7(2).
- Mäkelä, M., Nimkulrat, N., Dash, D. P., & Nsenga, F. X. (2011). On reflecting and making in artistic research. *Journal of Research Practice*, 7(1), 1.
- Oliveros, P. (1995). Acoustic and virtual space as a dynamic element of music. *Leonardo Music Journal*, 5(1), 19-22.
- Oliveros, P. (2004). Some sound observations. In Cox, C., & Warner, D. (Eds.). *Audio culture: Readings in modern music*. New York: Continuum.
- Ovidius Naso, P. (2000). *Metamorphoses: book XIII*. Cambridge: Cambridge University Press.
- Parry, Idris (1988). Kleist on Puppets. In *Speak Silence: Essays*. Manchester: Carcanet.
- Pelinski, R. (2005). Embodiment and musical experience. *Transcultural Music Review*, 9 [online]. Retrieved from: <http://www.sibetrans.com/trans/articulo/178/embodiment-and-musical-experience>. ISSN: 1697- 0101.
- Penny, J. (2011). Flutes, voices and maskenfreiheit: Traversing performative layers. *Organised Sound*, 16(02), 184-91.
- Pressing, J. (1990). Cybernetic issues in interactive performance systems. *Computer music journal*, 14(1), 12-25.

- Rambusch, J. (2011). *Mind Games Extended: Understanding gameplay as situated activity* (Doctoral dissertation, Linköping Studied in Science and Technology 1359, Linköping University Electronic Press).
- Ramstead, M. J., Veissière, S. P., & Kirmayer, L. J. (2016). Cultural affordances: scaffolding local worlds through shared intentionality and regimes of attention. *Frontiers in Psychology*, 7:1090. doi:10.3389/fpsyg.2016.01090
- Regnier, L., & Peeters, G. (2009). Singing voice detection in music track using direct vibrato detection. *IEEE, Taiwan*. Retrieved from: http://recherche.ircam.fr/anasyn/peeters/ARTICLES/Regnier_2009_ICASSP_SingingVibrato.pdf. doi:10.1109/ICASSP.2009.4959926
- Rietveld, E. & Kiverstein, J. (2014). A rich landscape of affordances. *Ecol. Psychol.* 26, 325-352. doi: 10.1080/10407413.2014.958035
- Rizzolatti, G., Camarda, R., Fogassi, L., Gentilucci, M., Luppino, G., & Matelli, M. (1988). Functional organization of inferior area 6 in the macaque monkey. *Experimental brain research*, 71(3), 491-507.
- Rosenberg, S. (2013). *Kurbits-ReBoot: svensk folksång i ny scenisk gestaltning* (Doctoral dissertation, Sibelius-Akademin folkmusikpublikationer, 2242-8054 ; 22, Sibelius Academy, Helsinki).
- Rowe, R. (1993). *Interactive music systems: machine listening and composing*. Cambridge, Mass.: MIT Press.
- Ryan, J. (1991). Some remarks on musical instrument design at STEIM. *Contemporary music review*, 6(1), 3-17.
- Sakreida K, Effnert I, Thill S, Menz M, Jirak D, Eickhoff C, Ziemke T, Eickhoff S., Borghi A & Binkofski F (2016). Affordance processing in segregated parieto-frontal dorsal stream sub-pathways. *Neuroscience & Biobehavioral Reviews*, 69, 89-112.
- Salter, C. (2010). *Entangled: technology and the transformation of performance*. Cambridge, Mass.: MIT Press.
- Sandell, S. (2013). *På insidan av tystnaden. En undersökning*. Doctoral dissertation, ArtMonitor, 36, University of Gothenburg, Gothenburg).
- Schön, D. A. (1983). *The reflective practitioner : how professionals think in action*. New York: Basic Books.
- Shapiro, L. (2007). *Embodied cognition*. New York: Routledge.
- Sharkey N & Ziemke T (2001). Mechanistic vs. Phenomenal Embodiment. *Cognitive Systems Research*, 2(4), 251-262.
- Shaw, R., Turvey, M. T., & Mace, W. (1982). Ecological psychology: The consequence of a commitment to realism. *Cognition and the symbolic processes*, 2, 159-226.
- Skaltje, M.L. (2014). *Minsta lilla liv har sin jojk*. Guovdageaidnu: DAT.
- Sloboda, J. A., & O'Neill, S. A. (2001). Emotions in everyday listening to music. In Juslin, P. N. & Sloboda, J. A. (Eds). *Music and emotion* (pp 415-429). *Handbook of music and emotion: theory, research, and applications*, (pp. 415-429). Oxford: Oxford University Press
- Small, C. (1998). *Musicking: the meanings of performing and listening*. Hanover, NH: Univ. Press of New England.

- Smith, J. A., Flowers, P., & Larkin, M. (2009). *Interpretative Phenomenological Analysis: Theory, methods and research*. London, UK: Sage.
- Smith, J., Shinebourne, P. (2012). In Cooper, H. M., Camic, P.M. (Eds.). *APA handbook of research methods in psychology*. (1st ed.) Washington, DC: American Psychological Association.
- Stahl, A., Löwgren, J., & Höök, K. (2014). Evocative balance: Designing for interactional empowerment. *International Journal of Design*, 8(1), 43-57.
- Susi, T., & Ziemke, T. (2005). On the subject of objects: Four views on object perception and tool use. *triple*, 3(2), 6-19. ISO 690
- Svensson, H., Lindblom, J., Ziemke, T. (2007). Making Sense of Embodied Cognition: Simulation Theories of Shared Neural Mechanisms for Sensorimotor and Cognitive Processes. *Body, Language and Mind, Vol. 1: Embodiment*, 241-269, Mouton de Gruyter
- Turvey, M., Shaw, R., Reed, E., and Mace, W. 1981. "Ecological laws of perceiving and acting: In reply to Fodor and Pylyshyn". *Cognition* 9, 237-304
- Unander-Scharin, C. (2014). *Extending Opera-Artist-led Explorations in Operatic Practice through Interactivity and Electronics* (Doctoral dissertation, KTH Royal Institute of Technology Stockholm).
- Vaggione, H. (2001). Some ontological remarks about music composition processes. *Computer Music Journal*, 25(1), 54-61.
- Warren, W. H. (1984). Perceiving affordances: visual guidance of stair climbing. *Journal of experimental psychology: Human perception and performance*, 10(5), 683.
- Weber-Lucks, T. (2003). Electroacoustic voices in vocal performance art-a gender issue?. *Organised Sound*, 8(01), 61-69.
- Weschler, R. (2011) In Broadhurst, S., & Machon, J. (Eds). *Performance and Technology. Practices of Virtual Embodiment and Interactivity*. Basingstoke: Palgrave Macmillan.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic bulletin & review*, 9(4), 625-636.
- Windsor, W. L., & De Bézenac, C. (2012). Music and affordances. *Musicae scientiae*, 16(1), 102-120.
- Winkler, T. (1998). *Composing interactive music: techniques and ideas using Max*. Cambridge, Mass.: MIT Press.
- Winter, J. (2016, April 15). Invisible UI: A great opportunity for great UX [Web log post]. Retrieved 2016, Dec 14, from: <https://www.usertesting.com/blog/2016/04/15/invisible-ui/>
- Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G. J. (2012). Affordances can invite behavior: Considering the relationship between affordances and agency. *New Ideas in Psychology*, 30(2), 250-58.
- Yin, R. K. (2006). Mixed methods research: Are the methods genuinely integrated or merely parallel?. *Research in the Schools*, 13(1).
- Z, P. A tool is a tool. (2003). In Malloy, J. (Ed.) *Women, art, and technology*. Cambridge, Mass.: MIT Press.
- Zentner, M., Grandjean, D., & Scherer, K. R. (2008). Emotions evoked by the sound of music: characterization, classification, and measurement. *Emotion*, 8(4), 494.
- Ziemke T (2016). The body of knowledge: On the role of the living body in grounding embodied cog-

- dition. *BioSystems*, 148, 4-11.
- Ziemke, T. (2000). *Situated Neuro-Robotics and Interactive Cognition* (Doctoral dissertation, University of Sheffield), UK.
- Ziemke, T. (2001). The Construction of 'Reality' in the Robot: Constructivist Perspectives on Situated AI and Adaptive Robotics. *Foundations of Science*, 6(1), 163-233.
- Östersjö, S. (2008). *Shut up'n'play! Negotiating the Musical Work*, (Doctoral dissertation, Lund University, Lund).

Artistic works

- Berberian, C. (1966). *Stripsody*. On *magnifiCathy (The Many Voices of Cathy Berberian)*. Wergo WER 60054. Recorded in Milan, Italy 1971.
- Berio, L. (1965). *Sequenza III*. Mainz, Germany: Wergo, 1991, 1967
- Berio, L. (composer) (1958) *Thema (Omaggio a Joyce)* performed by Cathy Berberian, Turnabout, TV 34177.
- Einarsson, A. (2008). *Let me speak*. [Video recording]. <http://www.annaeinarsson.com/#video>.
- Einarsson, A. (2012). *PS. I will be home soon!* [Score]. Svensk Musik: Stockholm
- Einarsson, A. (2015). *Metamorphoses*. [Video recording]. <http://www.annaeinarsson.com/#video>
- Einarsson, A. (2015). *One piece of a shared space*. [Video recording]. <http://www.annaeinarsson.com/#video>
- Eno, B. (1978). *Music for airports*. On Polydor 2310647.
- Manoury, P. (1993). *En Echo*. Universal/Editions Durand.
- Saariaho, K. (1996). *Lohn*. Chester Music Ltd
- Settel, Z. (1993). *Hok Pwah*. Editions
- Settel, Z. (2000). *L'enfant de glace*. Editions
- Skaltje, ML. (2015) *Jojk - Juoigan*. [Video recording]. Stockholm: Folkets Bio.
- Stockhausen, K. (1956). *Gesang der Jünglinge*. Kurten: Stockhausen Verlag.
- Westerkamp, H. (1989). *Kits Beach Soundwalk*. On *Transformations*, Empreintes DIGITALes IMED 9631, Released 1996.



Appendix

Einarsson, A., & Friberg, A. (2015). Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera. In *International Computer Music Conference 2015-Sept. 25-Oct. 1, 2015-CEMI*, University of North Texas, USA.

Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera

Anna Einarsson
KMH Royal College of Music, Stockholm
anna.einarsson@knh.se

Anders Friberg
KTH Royal Institute of Technology, Stockholm
afriberg@kth.se

ABSTRACT

Even though a vast number of tools exist for real time voice analyses, only a limited number of them focus specifically on singing voice, and even less on features seen from a perceptual viewpoint. This paper presents a first step towards a multi-feature analysis-tool of the singing voice in a composer-researcher collaboration. A new method is used for extracting the vibrato extent of a singer, which is then mapped to a sound generation module. This was applied in the chamber opera Ps. I will be home soon! The experiences of the singer performing the part with the vibrato-detection were collected qualitatively and analyzed through Interpretative Phenomenological Analyses (IPA). The results revealed some interesting mixed feelings of both comfort and uncertainty in the interactive setup.

1. INTRODUCTION

The singing voice is one of the most versatile instruments, with an abundance of different parameters for pitch, timbre, timing and speech control. Potentially this makes it ideal to use as control signal in interactive music. However, when making an overview of accessible tools to use for analyses of singing voice in real time, and to be implemented in artistic work, some tools still seem to be missing, or at least are not so readily available. These are tools that mimic the multifaceted characteristics of the singing voice from a perceptual viewpoint. Thus to make new implementations from compositional needs seem almost mandatory in a creative process.

This paper is an offspring of one such collaborative effort, where the perceptual viewpoint is put in the foreground. The first step was to elaborate on relevant features to extract. They were chosen as to be easily integrated in a musical work realised live, and to be used by singers unfamiliar in working with live electronics. We envision a multifeatured "listening unit" that was able to extract several different parameters from the singing voice.

In this work, we started with singing voice vibrato and developed an extraction method inspired by a previous model [1]. In the below described context of the chamber opera Ps! Jag kommer snart hem! [2] we then explored a beta-version of the vibrato extraction model, in relation to how it may be used as a mean for affecting subsequent electronic sounds in computer assisted composition, and how the performer experienced this part in both the cognitive and emotional realm.

2. VIBRATO AS SINGING VOICE FEATURE

Vibrato is one of the salient features that characterises the voice [3]. It is a useful feature also due to the relative ease with which singers can isolate and manipulate it. This said with the reservation that it does not apply to singers from all styles of music [4]. Depending on the tradition the singer emanates from different styles call for different vibrato utilisation, [5] but there are also individual differences; the vibrato is more or less an integral part of the singer's individual timbral identity

[6]. Thus the amount of effort as well as comfort in manipulating this parameter may differ among singers. Interesting to note is then that technology in this way can work in two ways: both by being affected by the voice and by informing the voice of its (perhaps up to this point unexplored) resources and possibilities. Having said that vibrato may be challenging to alter for the individual singer; Vibrato is not an altogether uncomplicated matter to make use of in composition either. Perceptually it is part of the affective prosody that reveals emotional states to the listener [7]. The amount of vibrato can be used as a deliberate cursor for style, or its absence a demarcation against undesired associations. Previous research on singing voice vibrato detection has for example focussed on how to distinguish singing from speaking voice, [8] or identification of singers in order to form a so-called singer ID [9] [10].

3. SOFTWARE MODULES

The different software modules are implemented in MAX/MSP and consist of three parts: The vibrato extraction, the mapping, and the sound generation modules.

3.1 VIBRATO EXTRACTION

In this module the vibrato extent (amplitude) is extracted from audio, vibrato rate omitted. The input is the monophonic audio signal from the singer. (1) In the first step pitch and sound level are extracted using the YIN module provided by IRCAM [11]. (2) A determination of a “proper” tone is done using a combination of pitch range, sound level limits, and the quality estimation factor from YIN. Only when all requirements are met, the extracted pitch is passed on for analysis (gated). (3) The pitch signal is divided in two parts. The first part is slightly low-pass filtered. The second part is median filtered using a window corresponding to one vibrato cycle assuming a vibrato rate of 6 Hz. This will cancel out any regular vibrato around this frequency. (4) The two parts are subtracted. The resulting signal will be zero when no vibrato is present. (5) Finally the absolute value of the signal is averaged using a median filter twice the length of a vibrato cycle. The resulting signal is proportional to the vibrato extent in cents.

3.2 MAPPING

The incoming vibrato control signal was divided into four intervals (0-0.2, 0.2-0.25, 0.25-0.3, 0.3-0.45) and each interval called on a different synthesizer, all run by a master clock. Smoothing was applied to the control signal calculating the median of every 5 incoming control values. Also latency was built in of 600 ms to filter out unwanted triggers.

3.3 SOUND GENERATION

The patch for synthesis consisted of four polyphonic synthesizers, each containing resonance-filters and oscillator banks, excited by noise. Tuning was set from data stored as lists. Small random variations were added to both the amplitude and sustain in order to make the resulting synthesis more dynamic.

4. USAGE IN THE CHAMBER-OPERA

The application was implemented into an artistic work that was a commission from the Malmö Opera to first author called PS. Jag kommer snart hem! (Eng. PS. I will be home soon!). It is a chamber opera for 6 chamber musicians, 4 vocalists and electronics (live performed, tape and/or interactive),

libretto by Maria Sundqvist [3]. The libretto takes the life of the famous writer Astrid Lindgren's assumed role model for Pippi Longstocking's father, Calle Pettersson, as a point of departure. The part where vibrato extraction was implemented is called *Vykort*. Its instrumentation is mezzo-soprano, tenor saxophone and live interactive electronics as a stand-alone patch.

4.1 SINGER

The part *Vykort* was sung by a mezzo-soprano that had no previous experience of working with live electronics. She was classically trained, and also a trained conductor, thus accounted for part of the musical studying during rehearsals. She seemed modestly comfortable in manipulating her vibrato.

4.2 COMPOSITIONAL CONSIDERATIONS

4.2.1 Mapping

Fels, Gadd and Mulder [12] suggest the metaphor as a model for designing a device that also would be understandable to an audience. Since metaphors are culturally shared, shared knowledge is presumed. As Simon Emmerson [13] has described in his seminal work *Living electronics*, many composers have a history of implementing models, analogies and metaphors as bases for form as well as sound material, yet varying in the need for the model to be perceived by the audience. In *Ps!* part one *Vykort*, the approach of metaphorical mapping as described by Mark Johnson [14] was applied. In short, according to the structured mapping approach, what is transferred are not the attributes but the relations between domains: the source domain and the target domain. In this work the metaphor was one of force. Density was the expression of force in the target domain, where the target was an accompanying dynamic cluster structure. Vibrato was the expression of forcefulness in the source domain, the source being the singing voice. Thus as the vocalist sang with more vibrato, the cluster included more notes and thereby became more dense. With less use of vibrato the cluster was thinning out, i.e. notes were dropped. The idea was based on Jazz Big Band composition technique. The change of clusters were controlled to take place metrically in time, so changes in cluster size were made with each new bar.

4.2.2 Vocal composition

The compositional approach was to alternate between improvisation to generate material and a well-considered carving out of the final gestalt of the melody. At the time of composing the piece the singers were not yet casted. The score did not contain directions for where or how to vary the vibrato. Rather these were degrees of freedom left for the singer to decide upon.

4.3 PROCEDURES

The application was tested during rehearsals and during the month of scheduled performances. The computer was placed with the sound engineer on a balcony so there was no tation is mezzo-soprano, tenor saxophone and live interactive electronics as a stand-alone patch. visible technology in the concert space together with the vocalist.

The composer took autobiographical notes during the process of developing the tools, and from composing the piece. The performance was also documented by audio and videotape. Later on a written semi-structured interview with the singer was conducted. The sheet contained 14 openended questions that focused on the interplay with the computer in the domains of score, responsivity from the computer, the self and the other, the singing voice, time and listening. Examples of items are:

“How was your first encounter with the score?” “Were the relationships to other fellow musicians affected and in that case, how?” How well did the responsivity work according to your experience?” The word “responsivity” was clarified on demand in relation to “interactivity”. The questions had a clear phenomenological emphasis. An advantage of the written interview was that answers would presumably be more thoroughly reflected upon.

4.4 ANALYSES OF INTERVIEWS

According with Interpretative Phenomenological Analyses (IPA) procedure, after repeated close reading the interview data was reduced and placed into categories in an iterative process between the parts and the whole. Different interpretations have been attempted in previous lectures and artist talks, where after the material again has been revisited. The result was also sent to the singer for feedback.

5. RESULT AND DISCUSSION

5.1 THE SINGER'S ACCOUNT

The encounter with a new score may be regarded as an expression for the expectations that a musician brings into a musical project. Core elements of this encounter, which interestingly also could be traced throughout the work was that it seemed exciting, challenging and uncertain. The uncertainty was of course in part due to the electronic layer being at that point yet unknown to the vocalist; the score only contained notated clusters with possible sound material for each bar, but no timbres were known. The relationship to the computer is interestingly ambiguous and paradoxical. The challenges of performing against a fixed beat are a recognised fact in the literature [15] [13]. This was also evident in this work and resulted in a sensation of being controlled by the computer. Another recurrent theme is that the relationship to the computer evolved over time, from being one denoted by reluctance to a rewarding one. The singer says: “Jag upplevde den [datorn] som mot mig till en början. Men när jag vant mig och kommit in i det så kändes det mycket spännande och som att det gav mig något extra” (In the beginning I experienced the computer as going against me. But once I got used to it and became involved it felt very exciting, and as if it provided me with something special).

In this statement both the initial excitement and the sense of challenge can be traced. Two other themes emerge dealing with the stance towards the computer. On one hand the computer is indeed experienced as a separate thing detached from the performer, with reference to the concept of the computer as the disembodied other (see for example [16] p. 168). This is well captured in the following: ”Ja, när vi gick från rep-situation till föreställning med publik upplevde jag att tempot gick ner. Jag tror att det beror på att när den nerv som har med nervositet att göra infann sig hos mig för att det blev skarpt läge, då behöll datorn sitt tempo och jag upplevde att tempot var långsamt, att det gick ner. Egentligen hade det bara med mig att göra. Det var en intressant upplevelse” (Yes, when we went from rehearsals to performing in front of an audience I experienced the tempo dropped. I believe it depends on that as the show was on, the nerve related to nervousness appeared, and the computer kept its tempo but I experienced the tempo as slow, as if it had decelerated. And still it only had to do with me. It was an interesting experience). The singer also describes how she feels uncertain and perceives the computer as unpredictable; again a theme that goes back to the expectations arisen when first encountering the score. “Jag kände mig osäker på vad som kunde komma (i form av toner och kluster) och det ställde större krav på mig som sångare” (I felt uncertain about what was to appear (regarding notes and clusters) and it put higher demands on me as a singer). She reports her listening strategies were affected with a heightened focus due to the uncertainty. On the other hand there is a strong feeling of connectedness and a sense of cohesion. For instance when she says the following: [Datorn] “Inte en förlängning av min identitet men som att vi blev mer utav ”ett”. Och att den gav

mig trygghet”. Och: “Jag var en del i ett sammanhang på ett starkare sätt än vid andra tillfällen. Dvs jag kände mig mindre ensam och mindre ”utsatt”” ([The computer] Not as an extension of my identity but as if we became more “one”. And that it provided me with comfort. Or: I was part of a context much more strongly than at other occasions. I.e. I felt less alone and less “exposed”). So the computer was a source of both comfort and uncertainty. Also the response was experienced as slow. This underlines an experience of the computer as separated, but also relates to the theme of being controlled by the computer.

5.2 TECHNICAL ACCOUNT

The application worked flawless during the whole month of performances and technical staff that did not have any knowledge in MAX/MSP managed its turning off and on. The vibrato extraction worked well and was robust after introducing the extra delays as described above.

6. CONCLUDING REMARKS

The unpredictability in the relationship to the computer the singer reports in the interview demands a closer inspection. First, it may be due to an arbitrary choice of scale in the mapping. In voice research the range of a classical singer’s vibrato extent is on average about +- 70 cent around the intended note [1]. Yet, as an integrated principle in use in a piece, which scaling should be used between in this case the extracted vibrato extent and the synthesis control? Is it linear? This also relates to the discussion regarding the extent to which a singer actually can vary the span of the vibrato [5]. Second, it may relate to the preconceptions of the singer. What formal training she or he has had and what musical culture he or she stems from heavily influences how the music is perceived and what one needs to be in control of in the moment. In music that has elements of improvisation, to not know how things will sound or have them different each time is part of the presuppositions for performing. The two-sided experience of the computer is an interesting finding since in part it combines two different strands of thinking about the relationship to the computer in mixed works, i.e. the computer as separated from or the computer as a prolongation of the musician. In the current case it seems to provide comfort and uncertainty, detachment and cohesion simultaneously. Or it may be that it is a story told from the perspective of otherness, where the separation is a condition for feeling the sense of unity as reported. Furthermore the singer reported that the response from the application was experienced as slow: Here there was a negotiation between the compositional desire to have a stable shift of chords with each new bar and the performers need to have a more direct response. A different structure in the synthesis would have made the response more flexible and possibly more satisfactory. We can conclude that vibrato detection is a powerful tool to use. What sounds are to be affected by the vibrato detection and even more importantly how they are affected in the time domain is yet an object of further inquiries. Preliminary results from an on-going project hints at the possibility of the structure of the sound and the length of the response to be important elements for determining how the relationship to the response is perceived.

Copyright: © 2015 Anna Einarsson et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License 3.0Unported, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

7. REFERENCES

- [1] Friberg, A., et al. (2007). "CUEX: An algorithm for automatic extraction of expressive tone parameters in music performance from acoustic signals." *Acta acustica united with acustica*, 93(3): 411-420.
- [2] Einarsson, A., Sundqvist, M. (2012) *Ps. Jag kommer snart hem!*, Svensk Musik, Stockholm.
- [3] Prame, E. (1997). Vibrato extent and intonation in professional Western lyric singing. *Journal of the Acoustical Society of America*, 102(1), 616-621.
- [4] Sundberg, J. (1994). Acoustic and psychoacoustic aspects of vocal vibrato, Speech Transmission Laboratory. *Quarterly Progress and Status Reports*, vol. 35, no. 2-3, pp. 045-068, 1994.
- [5] Zangger Borch, D. (2008). *Sång inom populärmusikgenrer: konstnärliga, fysiologiska och pedagogiska aspekter*. Diss. Luleå Univ., 2008 Piteå.
- [6] Mitchell, H. F., Kenny, D. T. (2010; 2009). Change in vibrato rate and extent during tertiary training in classical singing students. *Journal of Voice*, 24(4), 427-434. doi:10.1016/j.jvoice.2008.12.003
- [7] Peretz, I. (2010). Towards a neurobiology of musical emotions. In Juslin, Patrik N. & Sloboda, John A. (Eds.), *Handbook of music and emotion: theory, research, and applications*, Oxford University Press, Oxford, 2010.
- [8] Regnier, L. and G. Peeters (2009). Singing voice detection in music tracks using direct voice vibrato detection. Acoustics, Speech and Signal Processing, 2009. ICASSP 2009. *IEEE International Conference on, IEEE*.
- [9] Nwe, T. L., Li, H. (2007). Exploring vibrato-motivated acoustic features for singer identification. *IEEE Transactions on Audio, Speech, and Language Processing*, 15(2), 519-530. doi:10.1109/TASL.2006.876756
- [10] Bartsch, M.A., Wakefield, G.H.: Singing Voice Identification Using Spectral Envelope Estimation. *IEEE Transactions, Speech and Audio Processing*, 12, 100-109 (2004)
- [11] de Cheveigné, A., & Kawahara, H. (2002). YIN, a fundamental frequency estimator for speech and music. *The Journal of the Acoustical Society of America*, 111(4), 1917-1930. doi:10.1121/1.1458024
- [12] Fels, S., et al. (2002). "Mapping transparency through metaphor: towards more expressive musical instruments." *Organised Sound* 7(2): 109-126.
- [13] Emmerson, S. (2007). *Living electronic music*, Ashgate Publishing Company.
- [14] Johnson, M. (1987). *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason*, University Press.
- [15] McNutt, E. (2003). Performing electroacoustic music: a wider view of interactivity. *Organised Sound* 8(03): 297-304.
- [16] Emmerson, S., *Combining the acoustic and the digital: Music for instruments and computers or prerecorded sound*. The Oxford handbook of computer music ed. 2009: Oxford University Press.

Einarsson, A. (2015). 'We Can Work It Out - Calibration as Artistic Method', *Ruuku*, 4 (19/03/2015) <https://www.researchcatalogue.net/view/142373/142374/0/0>

We Can Work It Out - Calibration As Artistic Method by Anna Einarsson

Getting a commission is like being a hired assassin: you agree on a target, you receive some money and you do not meet again until the dark and sordid deed has been performed.

In 2010 I received a commission to compose a chamber opera for MalmöOperaverkstad, an opera company in the southern part of Sweden. I envisioned a work integrating different forms of electronics together with traditional instruments, for over the last few years this was the timbral palate I had come to establish in my practice. At the time of the commission I also commenced a PhD in singing voice and interactive electronics at the Royal Academy of Music in Stockholm. Therefore I decided to implement interactive electronics using vocal analysis in some part of the work.

The idea for the work emerged after reading the book *Kung Kalle av Kurrekurreduddön*, where the presumed historical role model of Pippi Longstocking's father Efraim was portrayed (Langer & Regius, 2002). The story was fascinatingly multifaceted, the themes of longing and loneliness universal, and the connection with one of the most beloved fairy tale characters in Sweden was appealing, yet at the same time challenging; most Swedes have a relationship to Pippi Longstocking. For the opera company, this was a way of approaching Pippi as part of their series of Astrid Lindgren characters in children's operas. In addition to working with a mix of acoustic instruments and electronics, and having the above-mentioned book as a point of departure, I wanted to work by negotiating the performance space and the great divide between audience and stage. During the last few years, bringing in everyday sounds and synthetic electronic sounds as music material had expanded my compositional palette. I wanted this for me personally attractive state - the expansion of listening and attention - also to influence the performance situation. This approach had an antecedent in for example a work I initiated called *Ljudspår* (2008) where I performed with tram sounds live on the old tramway to Djurgården in Stockholm together with two fellow composers. *Ljudspår* was a concert-in-motion, and *Ps! I will be home soon!* opened for an exploration of the possibilities of an audience-in-motion, the division between seated passive audience and standing active performers feeling inhibitory.

Returning to the initial quote, a comment made by a renowned fellow composer regarding the commissioning procedure, the scenario is unfortunately a quite common way to go about the commissioning of new works. But is it necessarily the only course of action?

Visual artist and researcher Paul Carter (2009) - albeit from another art discipline - similarly brings awareness to problems that may arise when a commissioner does not acknowledge the value of a collaborative process. He identifies three conditions common in a fruitful collaborative situation: the forming situation, the discursive momentum and the necessity of design, conditions to which I will return later in the exposition. Turning the tables, Hayden and Windsor (2007, p. 29) make the claim that composers are poorly prepared (or motivated) to engage in committed collaborations, and they quote Nash in an article from the 1950's saying that from a composer's point of view, "the most ideal form of collaboration for a composer be with a dead artist"! Nevertheless they emphasise a need for exploring new ways of proceeding when commissioning music, and this constitutes the backdrop for the discussion to follow.

Together with the artistic director of Malmö Operaverkstad Maria Sundqvist, a series of workshops with different topics for each occasion was decided upon. The overall aim was to explore different themes related to the narrative and the musical content of the work-in-becoming *PS. Jag kommer snart hem!* (*PS. I will be home soon!*) (Einarsson & Sundqvist, 2012). In the following, benefits and challenges of the workshop structure as a method towards a new work of music drama are presented through the use of thematic examples. The process is tentatively summoned up in the final section as a multi-layered calibration towards the new work.

PS. I WILL BE HOME SOON!

ON THE WORK

PS. I will be home soon! is a musical composition with a written score, fixed time between events and performing musicians and artists; thus it is not a music-theatre with a script nor an installation where one can enter or leave at will. The fact that the work was housed inside an opera company further emphasises its situation in a music discourse.

Elektrikal was the neologism I entitled the work-to-be, suggesting the intersection of different musical styles in my compositional language. Also it hints at the discursive field (Barrett, 2009, p. 137) within which the work takes place: in the intersection of writing opera and writing popular music, highlighting issues of combining electronics with acoustic instruments in the realm of the mixed work (Emmerson, 2009).

The parts included are: *Vykort* (Postcards), *Vrakgods* (Wreckage), *Skeppsbrott* (Shipwreck), *Big Charley* and *Kompass* (Compass).

Table 1. Instrumentation.

Vykort	Mezzo-soprano, tenor saxophone and live interactive electronics.
Vrakgods	Assembled physical sound objects and objects rigged with motion detectors for the audience to interact with by touching, lifting, opening, shaking etc. Tape part creating the environment for the other sound events to take place in.
Skeppsbrott	Tape electronics, live electronics, all four singers (2 soprano, 1, mezzo, 1 baritone) and all six instrumentalists (DB, vlc, vl, el. git, bar. sax, live el.).
Big Charley	Live electronics, violin, 2 sopranos.
Kompass	Live interactive electronics, violin.

The narrative in *PS. I will be home soon!* is non-linear. The parts can be assembled in different ways to provide different meanings. Thus, focus is on the individual experience. In the piece the audience is divided into two groups, each group guided by an actor and following the piece clockwise and counterclockwise. There were no chairs so the audience was free to move about or sit down as they wished, scenography allowing (for a sketch on the audience's trail - see Image 12 below[1]). The piece opens with the two actors telling the tale of Calle Pettersson's shipwreck.

The interactive technology implemented was a motion-tracking system in the scene *Kompassen*, voice analysis in the scene *Vykort*, and found objects reacting to touch, elevation etc. in the scene *Vrakgods*. The analysis tools for voice and motion capture were developed in collaboration with Dr Anders Friberg, researcher at the Royal Technical University in Stockholm. (The voice implementation is further described in Einarsson & Friberg, 2015, In press).

ON INTERACTIVITY

The discourse regarding how to define and demarcate interactivity is ongoing. Many authors have stat-

ed that interactivity is a concept too all-encompassing (Morse, 2003; Kim & Siefert, 2007; Drummond, 2009; Paine, 2002), and different definitions flourish within different domains, without any clear consensus. The concept interactivity assumes interplay between two parties different in nature. Therefore, some authors prefer the term responsivity, since it also allows for a technology not always working flawlessly, yet bringing about interesting artistic results (Morse, 2003; Kozel, 2007). “The most significant distinctions to be made between a poetics of interactivity and one of responsivity relate to the nature of action and the construction of subject” (Kozel, 2007, p. 187). I am inclined to denote my work as responsive, to impact rather than control, yet when collaborating with musicians I have found that such wording calls for much more explanation. I will not go further into this taxonomy discourse in this paper, but conclude that there is a need for defining interactivity in a less polarized manner, allowing for the same flexibility as technology does to also influence how we conceptualise, and instead leaning on how performers perceive the interplay. Preliminary results from my continuous work in a project called *Metamorfoser (Metamorphoses)* (Einarsson, 2015) suggest that a unique feature of technology is its capacity to be experienced as both intra- and inter-, and this will be further elucidated in forthcoming publications.

WORKSHOPS

Participants and Procedures

Three workshops were held: two of them before the reception of the libretto/start of composing and one of them during the phase of composing. The current theme and aim for each workshop formed the basis for the choice of participants. The topics for each workshop were actively discussed and finally decided upon by the artistic director Maria Sundqvist, then planned and led by MalmöOperaverkstad. Each workshop was documented by videotape.

This collaborative artistic work in the making was studied through an approach of direct and participatory observations, as well as formal and informal discussions intersecting throughout the workshops.

Workshop 1:

September 10th and 11th 2010. Participants: the composer, the librettist, the scenographer Leif Andersson and the drama pedagogue Lars Fembro together with invited children from the culture school and some additional adults associated with the MalmöOpera.

Aim: to explore the narrative through different group exercises led by Lars and an arts teacher from a local school.

How: improvisation of scenes made up with our bodies as material for living statues, creation of collages, discussions and much more.

Workshop 2:

November 4th and 5th 2010. Participants: the composer, the librettist, the scenographer, musicians, opera-singers and two film-pedagogues.

Aim: to explore musical interactivity, design of the room and of movement. Video-projection through blue screen technique was also explored.

How: improvisation with words, with music, with live-electronics, and experiences of creating drama improvisation with the blue screen technique.

Workshop 3:

March 31st and April 1st 2011. Participants: the composer, the librettist, the scenographer, 6 opera singers, one live-electronic musician, one pianist and one conductor. Some additional observers: staff from Malmöopera.

Aim: to explore staging, movement and musical excerpts with live electronics.

How: different placements of singers performing different actions, different movements through the room, different singer approaches towards the audience, different placements of an audience.

Study visits.

Two study visits were also part of the process: one where the composer and the scenographer visited a Malmö art exhibition and experienced sculptures by the artist Pascale Marthine Tayous; one where the librettist, the scenographer and the composer visited the Ethnographical museum in Stockholm and had a private showing of the malangan carvings that originated from the area where Kalle Pettersson lived.

A NOTE ON CONCEPTS

Before the process with workshops is further described, a distinction needs to be made between rehearsal and workshop. In the realm of a workshop, techniques and ideas can be explored without having the final result in focus. Through the workshops a piece of the process is bracketed out that – eventually – will lead to a goal, yet for the moment during the workshop, the goal is set aside. Still, there is no fixed point in space where the concept of workshop ends and the concept of rehearsal commences. Elements will be overlapping, as learning does not happen as isolated events of sudden change, but as slow and gradual accommodation.

OUTCOME OF WORKSHOPS

Following below is a synthesis of experiences from the workshop process, with examples given for each claim.

1. To Establish a Common Frame of Reference and Platform for Dialogue

A musical drama is at its very nature interdisciplinary. One of the benefits of arranging workshops in a very early stage of the collaborative process – even before any music or text is notated – is that one thereby forms a shared basis of references, experiences from which a dialogue may stem. I would say much of what it means to establish a dialogue is contained in listening and sharing work-related experiences.

Example 1.1. In one workshop the procedure was as follows: A rough summary of the book was presented to the participants, accompanied by a slide show with authentic images from this historical period of time. A critical discussion followed with the content as point of departure: What stood out in today's context? What elements from the account lingered? Participants then anonymously wrote down their chosen key concepts, and the artistic director assembled the notes. These key concepts guided further inquiry, not least what scenes should be picked out for the final work. It is difficult to say at what point that decision was made. During coffee breaks or during exercises the dialogue was kept moving, everybody being very much engaged in the process. The scenes were agreed on when the librettist sat down to fill the scenes with content. Later on in the workshop, they playfully improvised possible scenes from the story with their bodies, music and drawn images as material; some participants watched while others performed the scenes. Again critical discussions followed. For example one scene where the natives met with the stranded Calle Pettersson was very elucidating (see Image 4). We had many thoughts on how this encounter from the story should take place, or whether it should take place at all, with the awareness of trying to avoid the largest pitfalls of exoticism. Performing this scene, yet in a playful manner, made it clear that it felt kind of awkward and should not be included. This exemplifies the worth of actually performing an idea. Through this process, where others mirrored the material and filtered out what they found to be core elements, we all gained experiences

to take into account when moulding the essence of the story to be told. The shipwreck was one such cornerstone; in the final piece the shipwreck was staged as the middle scene. To leave one's children behind was yet another; the work came to picture abandoned children on two continents talking and having fantasies of their long gone father. These were archetypes of the story - the backbone - that through this shared process, and not through a priori theoretical decisions, became our mutual common ground in the work to come. The collages, the result of one exercise, became mood boards for the librettist and the scenographer to draw inspiration from (examples: Image 2 & 3). The idea of a "warm" zone and a "cold" zone was distilled and found its way into choice of the scenography's colours and the visual presentation of a libretto delivered by the librettist to me, the composer. Through this they also became concepts I related to in an early phase of composing, not however in an allegorical way, but rather as words to improvise from and reflect upon, written down on a large piece of paper pinned above the piano.

Example 1.2. The condition I aimed for in the piece was one of different states and snapshots, a notion Maria picked-up from conversations on the form of the narrative and the role of the audience, and in particular, she said, from me performing my music together with two fellow musicians in one of the workshops (improvisations and songs from the CD *Archipelago*). This exemplifies how the act of me singing informed her writing the libretto, without us ever explicitly discussing the matter until long after the work with Ps! was over. So when she later wrote the libretto, she integrated this approach of a non-linear narrative with pieces open for assembly by the audience. Such a narrative as well as having an audience moving about, acting at and reacting upon the concert space and its performers as further described below, shares a common feature; it is to renounce part of the control over the final result, over the meaning-making shaped by the narration and the physical actions in the performance space. Again, it was nothing we explicitly discussed, but part of the shared experience during workshops.

Example 1.3. As part of my preconception I had the works of Pippilotti Rist, in particular *Tyngdkraft, var min vän (Gravity, be my friend)* from 2007. Among other things, this work addresses issues of audience perspective taking, one lies down together with complete strangers to experience the work projected on the ceiling. Through one of the study visits we could form a shared point of reference in regards to this topic. Namely, in the Malmöart gallery, statues of Pascale Marthine Tayous were exhibited. We the visitors were able to ascend a built platform and watch the exhibition from above (see Image 9). The sensation of this shift in perspective was simple yet strong. The experience became an important piece of inspiration for the part *Sjörapporten*, lingering with the scenographer and me for quite some time after and how an elevation could be constructed was thoroughly discussed. Even though the inspiration was not realised as elevation in the final work, the idea of enabling audience perspective-taking was a powerful shared reference remaining in the music (see about spatialisation under Calibration/within the work) as well as in the scenography (see Image 8).

2. To Experience Unorthodox Phenomena

The workshops served as an important platform for evaluating, experiencing and giving way to unorthodox phenomena. One of the over-arching ideas of mine for Ps! was to examine how the audience could be made more actively participant without assigning compositional choices to the audience (common for example in some works by means of mobile phones). The use of interactivity in the performance was in part motivated by this wish to encourage a more active audience, and thereby the choice became an integrated part of the whole.

Example 2.1. Early on in the process I envisioned the audience led through different scenes in the opera by one of the singers performing. This idea, stemming from a wish to negotiate the stage room,

was tested during one workshop with a male opera singer as “guide” and the remaining workshop participants as audience (approximately 4-5 persons were being led, me being one). As it turned out, the situation with the singer at the same time singing and guiding felt too theatrical. It appeared as too much of a gesture - a rather comical one - and the musical content got somewhat lost along the way. Quite instantly I made the decision that for this work in the making, this was not the way to continue. There is a difficulty in walking and guiding a crowd; it easily becomes actuating, which was not at all the sought for expression. Or perhaps it was the combination of the sung expression and the bodily gestural expression that became overly explicit?

In the final performances, instead of singers there were two actors in the role of sea pilots that guided the audience through the work. Rather than being impelled by a musical need, this was more of a practical solution to instil some movement into the crowd without giving verbal instructions, and a director’s choice. The actors showed the way without speaking, and used flashlights to signal that one scene was over and it was time to move to the next in an adjacent room. The idea attempted at the workshop, having the performer move together with the audience, was transformed into a violin-player, whom I assigned the role of guiding the audience between two of the five scenes. Interestingly enough this did not have the same overly explicit outcome as singers guiding. Somehow the theatrical aspect disappeared in the absence of language, or even so, in the absence of the singing voice.

Example 2.2. During one workshop, opera singers were trying out interactive software presented to them, on this occasion software from collaborations between composer Mattias Sköld and me. This gave the artistic crew an opportunity to witness live interplay with technology similar to what I would eventually be using for Ps!. In the final work, in the scene *Vrakgods (Wreckage)* (between *Vykort (Postcards)* and *Skeppsbrott (Shipwreck)*), the audience is left to explore the room and the objects it contains. The objects eliciting sound when interacted with were chosen in collaboration with the artistic team: A doll spoke when lifted; a door squeaked when opened; coins could be counted in a coffer, and so forth. This, I propose, would not have been so smoothly worked out without the process of workshops, in different ways communicating the role of interactivity in the work. Furthermore I suggest that an awareness of everyday sound as compositional material and sound as carrier of the narrative had emerged.

Example 2.3. During rehearsals director Ragna Weisteen was brought in and she had some ideas about adding sound to the existing composition. She had not gained the same common frame of reference as the rest of us had through workshops. The artistic leader could then, drawing upon the experiences from workshops of how sound was used as compositional material and integrated into the coherent whole of the work, more easily communicate how this would be an alteration to the composed piece, and turn the suggestion down when the issue came up.

Example 2.4. One technique we did not bring into the final work was the green screen film technique explored in one of the workshops. It was fun to use, but a costly technique and it did not add to the core narrative or musical elements pertinent to Ps! something we all agreed upon when discussing matters.

3. To Define the Playfield and Identify Challenges

When is a challenge challenging enough? In today’s contemporary music scene there is a gap between the environment established during musicians’ formal training in conservatories and the aesthetic impulses and demands of professional music life. This is brought forward by Caroline Wilkins (2011) in her dissertation *The Instrument in Space: The Embodiment of Music in the Machine Age*. It is far from given, she pinpoints, that a musician has experiences of performing with live-electronics or alternative playing techniques. In this regard a workshop may serve the purpose of circling in on the playing field, i.e. defining the frames within which a musician/ensemble/institution may be challenged.

Example 3.1. A general observation from the elaborations during workshops was the difficulties with keeping to a fixed beat, i.e. a rhythmical sequence with static pulse. This fact is well acknowledged in the literature in respect to electronics and acoustic instruments. Some musicians experience staying aligned with a fixed pulse as restrictive, as expressivity many times is tightly connected to moving freely in the time domain (Emmerson, 2007; McNutt 2003). Despite these observations I chose to integrate such parts, but expected difficulties due to this. During the process of casting this awareness was nevertheless valuable; it enabled the crew to highlight the need for musical openmindedness and look for a more diverse musical background in the singers.

Example 3.1. A general observation from the elaborations during workshops was the difficulties with keeping to a fixed beat, i.e. a rhythmical sequence with static pulse. This fact is well acknowledged in the literature in respect to electronics and acoustic instruments. Some musicians experience staying aligned with a fixed pulse as restrictive, as expressivity many times is tightly connected to moving freely in the time domain (Emmerson, 2007; McNutt 2003). Despite these observations I chose to integrate such parts, but expected difficulties due to this. During the process of casting this awareness was nevertheless valuable; it enabled the crew to highlight the need for musical openmindedness and look for a more diverse musical background in the singers.

Example 3.2. To work with a project requiring an assembly of much technical equipment such as multiple sound systems, and to find different sorts of technical solutions, for instance building temporary soundproof walls dividing the concert space (see Image 11), may indeed pose challenges to an institution. The economical challenge is obvious, but the challenge may also be in terms of know-how. On the one hand, these are issues technical staff deals with on daily basis. Nevertheless, since technical staff attended workshops, the opportunity was provided to be better prepared in terms of making an inventory of necessary soft and hard resources. Awareness arose from the workshop experiences among the technicians that the work to come would demand advanced programming to control sound and light. Following this, they asked for working hours to deepen their knowledge in designated software. Similarly, director Ragna Weisteen was chosen due to her experiences working with site-specific theatre, and again it was through the workshop process the need for this particular competence was identified.

All in all, the workshop process enabled an anchoring of the work within the receiving institution in such a way that its ingredients did not become a surprise on the day of delivery, something known to jeopardize the staging of new commissions. The same goes for the artistic crew as for the technical staff; most of the challenges the work encompassed were already known beforehand.

CALIBRATION

The above described workshop method may be integrated into a larger over-arching concept of calibration. In different ways the examples given have illustrated this process of *calibration towards the work*, involving the artistic team (composer included) and the receiving institution. In addition to calibration towards the work, calibration may also be housed as a principle within the final work, functioning almost like an amplifier of core elements, directed at the relationship towards the audience. At the end of this section thoughts on this will be introduced in brief.

Calibration is a notion I use for the harmonisation process where pre-compositional ideas and concepts are explored: tested, rejected or refined, as well as sanctioned. When I say ideas and concepts, I encompass the sharing of an experience related to the work to be. This emphasises an important facet of calibration, namely that the embodied knowledge brought along into the workshops and study visits by each participant is made part of the process through acts involving reflection, action, sensing and decision-making. This entails that calibration is not only a means to an end but part of an ongoing

development of existing embodied knowledge, transformed through the material and the shared experiences in the workshop-process. A vital part of this embodied way of knowing stems from feelings, approaching or estranging material and other beings, human or non-human. As Mark Johnson puts it, “[...] we must recognize the role of the body, especially sensori-motor processes and our emotions and feelings, in our capacity for understanding and knowing” (Johnson, 2010, p. 145).

With calibration the aim is not to level out the authorship of the composer, but to allow for a more dynamic stance, less concerned with guarding ideas in their embryonic stage –something which indeed demands a certain amount of bravery - and with more reflective input from participants in the workshop. Issues arising during workshops that directly or indirectly have impact on the music are left for the composer to decide upon, with the artistic director having the final say in the case of differences in opinions between parties in the collaboration. Hayden and Windsor (2007) define three different collaborative positions for the composer: one end being the approach of the directive composer, which simply put resembles the traditional way to proceed on a commission; in the middle the interactive composer, the approach closest to the approach contained within calibration; and the other end the collaborative composer, where it can not be made clear who has contributed with what towards the new work. The interactive composer’s approach is where “the composer is involved more directly in negotiation with musicians and/or technicians [than the directive composer’s approach]. The process is more interactive, discursive and reflective, with more input from collaborators than in the directive category, but ultimately, the composer is still the author” (2007, p.33).

My concept of calibration bears some resemblance to what Carter describes as a “discursive momentum” (Carter, 2009, p. 22). A discursive momentum results from a situation he calls “the forming situation”, which he proposes could be a commission. The discursive momentum is according to Carter what “provides an interest impelling the invention” (ibid, p. 22), invention pointing towards a new work. Though as I read Carter, the discursive momentum he refers to is a much looser condition than calibration; more of a state (he also refers to Sigmund Freud’s description of the state prior to dreaming), and as Carter describes it, an “anything-goes mode” (ibid) of invention, where usual logic is suspended.

Carter has a key concept denoted “material thinking”, where it is the handling of material in practice that provides a way of knowing the world. Carter mainly puts emphasis on a process that “issues from, and folds back into, a social relation” (ibid, p. 19). Barbara Bolt (2009, p.30) differentiates her understanding of Carter’s concept of material thinking to “material productivity”, with the necessity of relations being between the material and the artist, not merely the social relations, talking about one’s practice. I would say that this is an important aspect of the concept of calibration; talking only does not suffice. Nevertheless neither do the social relations simply form background to the relation between material and artist. Together the two kinds of relations serve as equally important and intertwined constituents of calibration.

There are examples in the literature describing artistic processes similar to the workshop-process I am presenting here. In the account of the intermedia work *The Flood*, Hannan (2009) describes what resembles the formation of a common frame of reference (see Example 1.1) through an intense discussion of concepts, visiting possible sites for the play and watching video documentation. Yet, they never stage or practically attempt any ideas, and it is difficult to tell what the true impact of this week of “intense collaboration” actually provided. Did it alter or further develop individual contributions? The description of the process unfortunately remains on a much too superficial level and the collaboration seems mostly to concern sharing verbal information, thus seeming not to include the sharing of embodied knowledge, at least not from what is brought forward in his writing.

To reconnect with Bolt (2009), it is not the talking but the making that is at stake, it is the dialogue mediated through the material specific for each art discipline that brings a shift in perspectives and a potential to transform knowledge, as in the case of *PS. I will be home soon!*: vocalising, performing or moving about in the concert space and experiencing, adjusting and trying anew. And with the word

perspective in a corporeal sense of knowing the world in mind, I am arriving at the point where I wanted to end up; namely what I am suggesting is that what is calibrated is a bodily rooted attention, forming a kind of joint attention towards the work in the making.

Calibration Within the Final Work

Having elaborated on my use of the notion calibration, I will also briefly outline what calibration within the work could purport. In Ps! there was a sort of calibration also taking place within the final work, in relation to the particular use of interactive technology.

In one of the five scenes of PS. I will be home soon! described in the section Unorthodox phenomena (Example 2.2), the audience themselves were invited to interact with objects eliciting sound when acted upon. Moreover the spatialisation of sounds in the space was arranged in order to invite aural exploration, providing the listener with a different mix of sound depending on where they positioned themselves in the concert space. Taken together these experiences were thought to resonate with, and enhance, the apprehension of the interactivity between performers and sounding electronics encompassed in the work; perhaps even facilitating the formation of inferred relationships between musicians and electronics, even where there were no such composed relationships at hand (composed in terms of cause and effect), by directing the attention towards certain elements (i.e. relationships) in the work.

CONCLUDING REMARKS

In this exposition, I have shown how advantages of a workshop-process towards a new work include: a) establishing a common frame of reference and platform for dialogue; b) introducing and experiencing unorthodox phenomena in the situation at hand; c) defining the playing field in regard to potential challenges. Hence it is a process that lays the foundation for oscillation between reflection and practice, exploring, experiencing and evaluating. I have argued that the workshop-process can be accounted for in a larger concept of calibration, which may be applied in at least two different layers: calibration towards the work and calibration within the work.

The concept has also been applied in a just recently finished work, *Metamorphoses* (Einarsson, 2015), and preliminary findings from these experiences emphasise that working in this vein brings about a particular work-specific embodied way of knowing that facilitates the collaborators' apprehension for example of the technologies at hand and the artistic intentions of the composer.

Importantly, this is not to say that there is but one way to experience a work of music; rather this idea should be seen as related to the concept of subject position, where a frame for possible interpretations is assumed (Clarke, 2005). This concept, originally from film theory, is part of musicologist Eric Clarke's effort to place an ecological approach to the perception of musical meaning. The almost infinite plurality of ways an individual is shaped by his or her preconceptions when listening is limited by characteristics of the musical work.

A prerequisite for a creative and explorative stance during workshops is - of course - a secure working environment, which may emerge in the encounter between participants of a workshop, through adherence to the task at hand, and openness toward the development of the on-going process. Elaborating on the notion of being secure, it is very important that the work at this stage is allowed to be inclusive and explorative rather than questioning and instrumental, but sad to say, many times being uncertain is equated with unknowing (Molander, 1996).

Furthermore, Vera John-Steiner in her book *Creative Collaboration* brings forward cognitive and emotional aspects of collaborations among artists and scientists and she describes how: "[I] integrative collaboration requires a prolonged period of committed activity, and thrives on dialogue, risk taking and a shared vision to transform existing knowledge, thought styles or artistic approaches into new visions" (John-Steiner, 2000, p. 203). Ideally, this is what a workshop-method would provide grounds

for.

The claim that composers would be less suited for collaboration needs to be responded to. Hayden and Windsor (2007) do not go further into any underlying mechanisms, but mention the (self-) stereotype of the composer as solitary genius. They refer to Donald Schön who notes that “professions (music included) tend to build a repertoire of technical knowledge which are only questionable by individuals from within that profession” [...] resulting in defensive and controlling behaviour rather than a focus on mutually beneficial goals” (Schön in Hayden & Windsor, 2007, p. 30). Turning to John-Steiner, she underlines how productive collaboration demands “sustained time and effort” as well as “the shaping of a shared language, the pleasures and risks of honest dialogue, and the search for a common ground” (John-Steiner, p. 204). The risk-taking, according to her, includes both intellectual and emotional risks. Indeed this unveils a possible conflict that needs bridging, and I believe a keystone is articulating the roles of the participants when deciding upon the workshop-structure.

Yet another clarification is at hand; the situation accounted for here is where a commission has already been made. I want to emphasise that I am not advocating workshop as a competition in disguise. A workshop method is by no means a quick fix and as Hayden and Windsor (2007, p.37) warn, collaboration may be an ideology that by itself does not warrant a good outcome. “However strongly the collaborative model is valued, it can only operate when all parties are prepared to enter into collaboration”. Neither is the message that an author must decline his or her artistic intention in order to attract a broader category of visitors.

In conclusion, the calibrations in *PS. I will be home soon!* took place in the context of the making of a musical drama. This may not immediately translate into other contexts, but my hope for the future is that this may inspire others, and nurture a discussion about the conditions for commissioning new music as well as what practical tools are needed for framing this process. There is much yet to explore in order to deepen the knowledge about how different parts couple in the endeavours towards new artistic works.

Acknowledgements

I wish to express my gratitude towards MalmöOpera for permission to use the images, to all participants in workshops and performances, and to the artistic team at MalmöOperaverkstad for a valuable collaboration. The full final work can be accessed through MalmöOperas channel at youtube.

REFERENCES

- Barrett, E. (2009). Foucault’s “What is an author”: Towards a critical discourse of practice as research. In Barrett, E., & Bolt, B. *Practice as research: Approaches to creative arts enquiry*, (pp. 135-146). London: I B Tauris.
- Bolt, B. (2009). The Magic is In Handling. In Barrett, E., & Bolt, B. *Practice as research: Approaches to creative arts enquiry*, (pp. 26-34). London: I B Tauris.
- Carter, P. (2009). Interest: The Ethics of Invention. In Barrett, E., & Bolt, B. *Practice as research: Approaches to creative arts enquiry*, (pp. 15-25). London: I B Tauris.
- Clarke, E. F. (2005). *Ways of listening: An ecological approach to the perception of musical meaning*. Oxford University Press.
- Drummond, J. (2009). Understanding interactive systems. *Organised Sound*, 14(02), 124-133.
- Einarsson, A. (2007) *Archipelago* by Anagram. AEM003. www.annaearnsson.com

- Einarsson, A., Petersson, M., Sköld, M. (2008). *Ljudspår*. A concert-in- motion in collaboration with Stockholms Spårvägssällskap (Stockholm Old Tram Society).
- Einarsson, A., Sundqvist, M. (2012). *Ps. Jag kommer snart hem!*. Stockholm: Svensk Musik
- Einarsson, A. (2015). *Metamorfoser*. Unpublished score
- Einarsson, A, Friberg, A. (2015). Using singing voice vibrato detection as control parameter in a chamber opera. *In press*.
- Ek, C. (2012). Skapandet av ett nytt verk. Unpublished print from MalmöOpera.
- Emmerson, S. (2007). *Living electronic music*. Ashgate publishing, Ltd.
- Hannan, M. (2006). Intermedia collaboration for the flood. *Contemporary Music Review*, 25(4), 327-339. doi:10.1080/07494460600760999
- Hayden, S., & Windsor, L. (2007). Collaboration and the Composer: Case Studies from the End of the 20th Century. *Tempo*, 61(240), 28-39. doi: 10.2307/4500495
- Johnson, M. (2010). Embodied knowing through art. In Biggs, M., Karlsson, H. (Eds.), *The Routledge companion to research in the arts* (pp. 141-151). Routledge, New York, 2010
- John-Steiner, V. (2000). *Creative collaboration*. Oxford; New York: Oxford University Press.
- Kim, J. H., & Seifert, U. (2007). *Embodiment and agency: Towards an aesthetics of interactive performativity*. Paper presented at the Proceedings of the 4th Sound and Music Computing Conference (SMC'07).
- Kozel, S. (2007). *Closer: performance, technologies, phenomenology*: MIT Press Massachusetts & London.
- Langer, J. & Regius, H. (2002). *Kung Kalle av Kurrekurreduktion: en resa i Efraim Långstrumps fotspår*. Stockholm: Forum.
- Morse, M. (2003). The poetics of interactivity. In Malloy, J. (2003). *Women, art, and technology* (pp.17-33). Cambridge, Mass; London: MIT.
- McNutt, E. (2003). Performing electroacoustic music: a wider view of interactivity. *Organised Sound*, 8 (3), 297-304. doi:10.1017/S135577180300027X
- Molander, B. (1996). *Kunskap i handling*. (2nd Ed.) Göteborg: Daidalos.
- Paine, G. (2002). Interactivity, where to from here? *Organised Sound*, 7(3), 295-304.
- Rist, P. (2007). *Tyngdkraft, var min vän*. Exhibition at Magasin III, Stockholm, <http://www.magasin3.com/konstverk/tyngdkraft-var-min-van/>
- Tayou, P. M., (2010). *Always all ways -Omnes viae MalmöDucunt*, Exhibition at MalmöArt Gallery, <http://www.pascalemarthinetayou.com>
- Wilkins, C. (2011). *The Instrument in Space: The Embodiment of Music in the Machine Age*. Retrieved from <http://bura.brunel.ac.uk/bitstream/2438/6438/6/FulltextThesis.pdf>

[1 Images are omitted in this version of the article. Please consult original article at <https://www.researchcatalogue.net/view/142373/142374> for images and sound examples.

Einarsson, A. Experiencing responsive technology in a mixed work: Interactive music as embodied and situated activity. *Organised Sound*, in press.

Experiencing Responsive Technology in a Mixed Work: Interactive music as embodied and situated activity

by Anna Einarsson

Royal College of Music, Box 277 11, 11591 Stockholm, Sweden
annaenarssonmusic@gmail.com

How is performing with responsive technology in a mixed work experienced by performers, and how may the notion of embodied cognition further our understanding of this interaction? These questions are addressed here analysing accounts from singers performing the author's mixed work *Metamorphoses* (2015). Combining semi-structured interviews and inspiration from Interpretative Phenomenological Analysis, questions concerning the 'self' when listening, singing, moving and relating to fellow musicians, as well as the relationship towards the computer, are explored. The results include a notion of the computer as neither separated nor detached but both, and highlight the importance of the situation, including not only the here and now but also social and cultural dimensions. The discussion emphasises the role of sensorimotor interaction and bodily experience in human meaning-making.

1. INTRODUCTION

In a way, we are all experts at different forms of interaction, with both our physical and our social environment. From the moment we are born, we evolve cognitively and emotionally throughout life in relation to other beings, both human and non-human. Perhaps due to this 'expertise', the ubiquity of relatedness, or the hegemonic scientific paradigm, it is easy to downplay the value of collecting idiographic accounts of experiencing performance interplay mediated or assisted by computer technology. There is a constantly growing body of research in the music community on interactivity, and descriptive approaches are commonly used. However, phenomenological accounts of what performing with interactive music systems actually feels like, where an affective dimension also is included, are still relatively rare.

A few examples: Elizabeth McNutt (2003) describes being 'trapped between the bar lines' when performing with interactive technology. Jean Penny (2011) emphasises the disembodiment of performing with live electronics, and Franziska Schroeder (2006) asserts the instrument as an extension of the self. Luciani, Florens, Courroussé and Castet (2009) encompass felt experience, discussing the 'ergotic gesture-sound' with emphasis on tangibility of interfaces. However, their work is based on laboratory environment, thus lacking ecological validity.

Schroeder and Rebelo emphasise the body not as object, but as flux (2009: 136), which is similar to my approach. Furthermore in my work I strive for a seamless – cohesive – unity between singing and sound synthesis, although this does not mean per se that the relationship always will be experienced as seamless. Discontinuities, like Schroeder and Rebelo (2009) argue for, as well as resistance, may still appear experientially for the performer. My approach is also similar to that of Johnston, Candy and Edmonds (2008), to devise no extra control unit apart from the live input.

There is a fine line between exploration/discovery and repeatability in the kind of responsiveness a system exhibits (e.g. Mulder 1994; Paine 2002; Drummond 2009). Is it a matter of surrendering control

that is at stake? Or is control pivotal for interactivity? The notion of control is indeed disputed. The community of music scholars seems to be divided in two: there are those arguing for a move beyond control (Broadhurst 2006; Frisk 2008; Johnston et al. 2008; Paine 2009) at the same time as there are others defending it as one cornerstone for interactivity (Drummond 2009; Eigenfeldt 2011).

Moreover, there is a plethora of approaches towards mapping: neural networks, linear, behavioural objects, metaphor and 'control mapping' to mention but a few. Many times direct mapping is considered not to provide enough exploratory qualities in interactive systems (Paine 2002; Drummond 2009). Mapping through metaphor is said to be particularly suited for enabling embodied knowing (Antle, Corness and Droumeva 2009), and is an approach applied in one of my previous works *PS. I will be home soon!* (Einarsson and Friberg 2015) and by Essl and O'Modhrain (2006), even though the latter, although discussing metaphor as weak sensorimotor integration, never make reference to Lakoff and Johnson (1999) or Johnson's (2008) seminal work on the matter.

Musicologist Eric Clarke (2005) presents an ecological approach to the perception of musical meaning, drawing upon the work of James J. Gibson. Unfortunately, he only spends a handful of pages discussing listening-when-playing, that is, the performer's perspective. There he hints at the particularities of the performance situation, where the separation between the object (the music) and the subject (the musician) tends to blur: 'In playing music, the object really is within the control of the subject, because perception and action – held apart for listeners in concert culture – are in dynamic relation with one another' (ibid.: 150–1). According to Clarke, the type of instrument performed plays a role in determining how the particular relationship between action and perception is expressed in the particular situation. As I will be suggesting, in singing this conflation is taken to the extreme.

2. AIM AND METHOD

When the computer is conceptualised in the discourse of mixed works, that is, works where an acoustic sound source and an electronic sound source are used in combination, it is usually considered as either an extension of the musician's instrument or a separate entity, an 'other'. Simon Emmerson, for example, writes in *The Oxford Handbook of Computer Music*: 'How does the instrumentalist respond – literally and musically – to the disembodied "other" (even when it is a mirror image)? It is the duality that is the focus here' (Emmerson 2009: 168).

Now what do the accounts from singers performing a mixed work reveal? How do they conceptualise the computer? And how can their accounts be understood when situated in a framework of radical embodied cognition and ecological psychology (Clarke 2005; Chemero 2009)? Interactivity provides an opportunity for noting aspects of performing music through 'an event that bring [sic] corporeal and cognitive awareness' (Morse 2003: 18). In the following, it is the experiences of the 'self' and the listening, singing and relating to fellow musicians mediated by the computer technology as well as the relationship towards the computer as such that are collected and highlighted. Through singing when standing, walking and even in elevation, emphasis is put on how embodied activity would influence this experience.

The investigation is a continuation of composing and working with the chamber opera *PS. I will be home soon!* (Einarsson 2015; Einarsson and Friberg 2015) and takes place in the work *Metamorphoses*, a responsive work for four laptops and four vocalists, where singing voice features affect the subsequent sounding electronics. The word 'responsive' is used to denote a work facilitating an exploration of different ways of conceptualising the computer, less occupied with control and more concerned with different ways of responding (Kozel 2007: 21). Data is collected with semi-structured interviews and analysed with the method of Interpretative Phenomenological Analysis (IPA) as a touchstone. In brief, IPA is intended not only to generate descriptions but also to add a hermeneutic layer. Holmes and Holmes write: 'phenomenological analysis and interpretation can reveal an idiographic relationship between the subjective conscious awareness and the cognitive landscape of the individual' (2010: 74),

and they recommend the choice of IPA when doing explorative research on music performance experiences (ibid.: 80). IPA was also chosen due to the focus of lived experience and how performers try to make sense of their experiences, with an emphasis on a particular context (i.e. *Metamorphoses*) as well as its proximity to embodied cognitive approaches (Smith, Flowers and Larkin 2009: 198–200).

3. EMBODIED COGNITION

Embodied cognition, sometimes referred to as ‘second-generation cognitive science’ (e.g. Shapiro 2007), is a vast and diverse field of research. It has grown out of a reaction against the traditional computational model of cognition, according to which human cognition is considered to work as a computer program and where cognition is primarily seen as an abstract manipulation of (meaningless) symbols (internal representations), and where the body is superfluous (Shapiro 2007; Johnson 2008; Lindblom 2015).

Roughly speaking, two branches can be said to exist within embodied cognition. One is embraced more by the Artificial Intelligence (AI) community and Rodney Brooks, where a robot is embodied due to having a body and is situated since it exists in the world (Shapiro 2007: 139), an approach also denoted mechanistic embodiment (Sharkey and Ziemke 2001). The other branch, building upon Gibson ecological psychology which is also the one I adhere to in the following, arrives in radical embodied cognitive science pairing Gibson’s ecological psychology with dynamic system theory (Chemero 2009; Käufer and Chemero 2015) and has the living body as a cornerstone, phenomenal embodiment (Sharkey and Ziemke 2001).

There is a growing body of interdisciplinary research in support of a radical view of embodied cognition where sensory-motor processes play a vital role. Groundbreaking research on mirror neurons, Antonio Damasio’s and Joseph Ledoux’s research on emotion and, of late, new findings on embodied social cognition and embodied simulations (see Lindblom 2015) seem very convincing and in extension also provide interesting perspectives on performance practices in mixed work with computer technology.

According to embodied cognitive science, the mind is not independent from the world (Johnson 2008). The subject/object division is considered an abstraction (ibid.), and interacting with computer technology is very different from the idea of an external manipulation of a tool or an object but instead a coupled activity. Meaning in interactions between organism and environment arises from movement, emotions, and metaphor, all of which are firmly rooted in bodily experience (ibid.).

Furthermore, it is through repeated firing of neurons – ‘neurons that fire together wire together’ – that learning is made possible. This repeated stimulation, which results in adaptation largely due to brain plasticity, is in ecological terms referred to as perceptual learning (Clarke 2005: 22–4) and part of the coupling between organism and environment to which ecological psychology has paid considerable attention.

Finally, a few words on the relationship between the capacity of an organism and features in the environment, so-called affordances. The concept is so watered down from its original sense that it has almost lost its meaning altogether (Torenvliet 2003; Susi and Ziemke 2005). In the following, affordance will be used as denoting action possibilities in the environment, that is, a direct relationship between organism and environment (Chemero 2009). As Käufer and Chemero (2015) point out, Gibson’s affordances have a peculiar ontological status for they are neither a property of the organism nor the environment, but relational. There may be sequential affordances, where we perceive one to then perceive the whole (Gaver 1991). This makes sense in terms of computer programs realised during performance. One action may in turn open up a range of additional action possibilities once the response is provoked. The microphone is, on the other hand, another story, since there is not really anything about the microphone that suggests ‘singing-into’ affordances. This displays a cultural dimension, possibly encompassed in what Gibson would call ‘second-hand knowledge’ (Gibson in Rambusch and Susi

2008). That culture is part of what we perceive is acknowledged by Clarke (2005), but not something Gibson paid particular attention to. What humans use as guiding principles to select between affordances is still to be uncovered, but one interesting suggestion about the agency is the concept ‘invites’ (Withagen, de Poel, Araújo and Pepping 2012). Also perceptual learning may assist in differentiating between information pointing towards affordances in the organism’s environment. According to Gaver (1991), perception of affordances may be ‘highlighted’ by aspects such as experience, culture, social setting and intention, yet this constitutes a departure from Gibson’s original claim that perception is direct. Subsequent research also confirms how social knowledge impacts what we perceive in many different ways (see Lindblom 2015).

Affordances do not cause us to act; they are opportunities for action. Neither are they about appearance only of a device or object, which is a common confusion in the matter (Rambusch and Susi 2008).

4. THE WORK *METAMORPHOSES*

The work *Metamorphoses* is a responsive work for four laptops and four singers. Jörgen Dahlqvist (Teatr Weimar) wrote the text, drawing upon the lives of four characters whose lives have been transformed in one way or another. The piece consists of three successive parts, where the first part containing the sections ‘the small legs’ and ‘I was there’ is dominated by granular synthesis with different add-ons, the second part a poly-synthesiser sensitive to incoming pitch and the third part containing the section ‘holds up, stop’ has a build from the IRCAM object psychoirtrist as its major component. The way technology is implemented is further described below.

4.1. TECHNICAL DESCRIPTION

4.1.1. Singing voice feature analyses

The feature analysis applied in the work was a translation of Anders Friberg’s application for Pure Data (PD), the cue-extractor (Friberg, Schoonerwaldt and Juslin 2007) to Max/MSP. The extracted features are amplitude, pitch (yin- from IRCAM), mean duration, tones, articulation, soundlevel (SL), attack, spectral slope and onset.

4.1.2. Mapping

Inspiration for mapping was drawn from the approach multiple-layered mapping as described by Hunt, Wanderley and Paradis (2010). On a conceptual level it is a one-to-one mapping. However, as the authors of the article acknowledge, many low-level parameters have been cross-coupled. In this piece there are three layers: Performance features > Perceptual feature > Sound synthesis.

4.1.3. Sound synthesis

The main sound synthesis engines were as follows. Part one executed granular synthesis by the rogs-object from IRCAM. Part two consisted of a poly- synthesiser/sampler tuned by preset values stored in a table. Part three was a combination of different forms of synthesis: mosaicking- and psychoirtrist- by IRCAM and comb filters.

4.2. SINGERS

The participating singers all had a solid background in jazz and improvisation, and some to moderate experience of singing contemporary music. The singers had little to no prior experience with performing with live electronics. The author and composer of the work also participated as a singer.

4.3. DATA COLLECTION

Two major data collections were made. On the first occasion the singers were first asked to write down their experiences from the day, to facilitate recall and avoid regression to mean. Second, an hour-long open structured interview with all three singers took place. During the whole day testing was recorded and the resultant discussions taking place while testing were also transcribed.

For the second data collection, an interview schedule was constructed to cover areas of interest. It drew on the earlier work with chamber opera *PS. I will be home soon!* and writings of Simon Emmerson. Separate interviews were conducted; each interview lasted about one hour. They were recorded and later transcribed verbatim.

4.4. DATA ANALYSIS

The analysis phase followed the following stages.

Five superordinate themes were identified from the process of repeated reading, where each of the 4th (and final) interview transcriptions were juxtaposed finding psychological conceptualisations at slightly higher levels: (1) singing, body and emotion; (2) listening and seeing; (3) relating and interplaying; (4) the process towards the work; (5) the score. This article focuses on the themes (1)–(3) presented in the subordinate themes:

- The computer as extension or separated
- The computer as a fickle playmate
- Body and gesture
- Participation and uncertainty: influence by culture
- An expanded sphere
- A sense of whole
- Listening in dynamic dialogue with the situation at hand
- Experiencing in an altered bodily awareness
- Looking for a response
- The character of the response
- Situational factors.

It might be worth noting that, just as IPA is a method with emphasis on interpretation, interpretations drawn are informed by the interviewer as a participating vocalist in the work and collaboration towards the work through workshops and rehearsals. On the one hand, this threefold role of interviewer/composer/co-performer could be considered problematic. On the other hand, this facilitated a shared cultural understanding, something someone from the ‘outside’ can hardly acquire.

5. RESULTS

The singers’ accounts will be discussed from three main points of departure: first, conceptualisation of the computer; second, experiences mediated or moderated by the computer when singing, listening and relating; and third, possible mechanisms behind these experiences such as the characteristics of the response, the effect of the response and the impact of the dynamics between performer and environment during performance.

5.1. CONCEPTUALISATION OF THE COMPUTER

5.1.1. The computer as extension or separated

What denotes the interplay with the responsive technology in *Metamorphoses*? Seemingly there is a shift in the experience throughout the work between the computer as an extension of the singer's instrument and the computer as a separate entity. Speaking in a very tentative and almost mysterious way, the word 'spirit' is suggested, and singer one arrives at depicting the computer as follows: 'Perhaps more spirit than extension, but a bit of an extension as well.' Singer two displays a similar ambiguity: 'I don't see this as something outside of myself, even though it is.' The singers provide examples from the work where either one dominates. The section referred to as 'stannar upp, stanna (holds up, stop)' serves as an example of an extension of a singer's voice. The application mainly active in the section is a build on psychoirtrist- from IRCAM. It anticipates the singing voice feature vibrato, its presence or absence, which affects the transposition of the electronics. Pressed voice, derived from the quality parameter in yin- together with amplitude, also affects the electronics, altering its frequency.

The section 'jag var där' ('I was there') is referred to as an example of the computer as separated. One singer visualises someone residing inside the loudspeaker: 'One almost visualises someone living inside the speaker.' In this section there was a combination of comb-filtered granular synthesis and feedback delay. The singing voice features pitch and duration evoked the responsiveness. Pitch alone affected timbre by controlling interpolation between two different settings for a spectral filter, and in combination[1] with amplitude it affected the number of grains in the response.

Experimenting with the singers adjusting the length of the granular response in the section 'dom små benen' ('the small legs') during one of the workshops, it was also notable how, depending on the length of the response, singers experienced the live electronics as separated or extended, although there was no pivotal point in common for everyone. The degree to which it is possible to anticipate the behaviour of the computer also influences whether it is perceived as separated or extended, as well as how quickly the computer response follows the sung input. Moreover, all these parameters act in concert with other situational cues, such as the balance in sound level between voice and live electronics, proximity of loudspeakers and positioning of fellow musicians.

Drawing upon the majority of the singers' interviews, the distinction between extension and separation indeed seems permeable, or at least they do not act in opposition, but rather as a complementary principle, almost like yin and yang: 'Also because it plays with you, and lives its own life and such. So it is easy to form oneself around it. And it forms itself around me.' What is left is a web of relations high in complexity where everyone has their own 'extended arm': 'It becomes somehow more because everyone has an extended arm, everyone has another dimension or whatever you call it. So it becomes like a richer soundscape.'

5.1.2. The computer as a fickle playmate

One singer discusses the great number of preconceptions she has towards the computer. She makes use of the computer as a tool for writing scores quite a lot, and the frustration that gets stirred up by a malfunctioning computer program is an association close at hand for her. She prefers talking about the computer as a fickle person, and she is more prone to address the computer as separated from her. She primarily assigns this inclination to the ability to – as she put it – have the computer as a playmate.

5.1.3. The body and the gesture

It is almost as if the physical presence or absence of another body – musician or computer – is of less importance. The prime concern is the musical gesture. Is it playful? Is it imitative? The imitative quality in the electronics brings out a sensation of being connected. Singer two:

[1] Multiple linear regression.

Some musicians or some contexts, one feels that one is not playing together; so it is this I mean, that I feel like I am playing together with the electronics, and therefore we are together, in some way. And then I do not feel that it is a separate layer. And since it also imitates the sounds one makes oneself, and like that, then it becomes easy to feel a connection with it.

This issue is brought up by Marc Leman, that ‘mimicking may enforce liking and social bonding’ (Leman 2008: 144–5). Perhaps some degree of imitation may be a good thing if a composer wishes to enhance the feeling of connectedness with the computer technology.

5.2. EXPERIENCES OF LISTENING, SINGING, RELATING

5.2.1. Participation and uncertainty: influence by culture

Different aesthetics and compositional approaches give birth to different responses on the part of the computer, which will naturally elicit different experiences in the singer when performing the mixed work. Quite contrary to the idea that it makes no difference whether the relations between electronics and singer are real or inferred, a singer with previous experience of performing with fixed media emphasises the shift in the sense of participation when working with responsiveness: ‘I have never before worked with any sorts of effects or such on my singing, apart from working with NN, but then it was that it – sort of – worked with me. More than that, I was like not really part of it.’

She then contrasts that experience with the work at present, where there is an exploratory approach and an element of waywardness in the relationship towards the computer, something she returns to throughout the collaboration as something valuable: ‘one sees that the singer sings and generates a electronic sound, and perhaps next time something else results. So, since it’s not really totally set, that there are differences in the electronics part creates a certain ... insecurity ... which one is totally used to if one is used to improvisation.’

This latter pinpoints how culture constitutes part of the bricolage we perceive, and as Eric Clarke writes, ‘Culture and ideology are just as material (in the concreteness of the practices that embody them) as are the instrument and human body that generate this performance, and, as perceptual sources, they are just as much a part of the total environment’ (Clarke 2005: 61).

5.2.2. An expanded sphere

When the response from each one of the singers consists of both the sounding voice and the computer response, this renders the voice alone less significant. The singers describe in slightly different ways an experience of a sort of branching out, of experiencing having an expanded sphere, which impacts singing as well as listening. As for singing, the unusual and slightly awkward experience of being responsible for sound not chosen by the singer herself (the electronic sounds) was brought up. In sharp contrast with the high degree of control exerted by singers and the very intimate and corporeal relationship towards the voice production, the computer technology was suddenly part of their vocal sphere.

5.2.3. A sense of a whole

Emphasis is given to the sense of a whole when listening: ‘One is more “one”, a mass, instead of different musicians’, ‘I feel that my role is different, that when the sounds I choose to make are supposed to be a part of the whole ... um ... that is supposed to be mixed together, instead of running off somewhere.’

A sense of distance is expressed, even though everyone was positioned very close in a semi-circle when performing in concert. She continues picturing an almost contemplative listening when describing how 'the ears sink outwards'.

5.2.4. Listening in dynamic dialogue with the situation at hand

The experience of listening to a whole is echoed in the second singer, but a whole containing multiple layers. Directing her attention is a cornerstone, with inclusion and exclusion of different aspects of the performance situation, such as 'listening' and 'un-listening'. There is also a listening for what is not yet there, for the music's potential and the composer's intention. 'listens ... according to what you think that you want the direction of the music to take'. There is no one way of listening, she exemplifies, but a listening in dialogue with the situation: 'one always listens differently, in almost all one's concerts. That is, in all contexts where one takes part.' Since the situation encompassing responsive technology comprises many layers, there is an oscillating movement between the singer's own expanded sphere, the others' expanded spheres and the resultant whole:

I am always listening to what the electronics are doing. And try to play with it. So I am listening, trying to analyse it, and we have done that together too, and you have sometimes also told us what the different things do. So I play with it as if it was a musician. So, so it is a way of listening, while I am at the same time listening to what I am doing, because that also becomes a part of it then: what one does oneself and what one can do with the electronics is one thing, and then what you are doing and what you do with the electronics is another, so all this becomes a whole that is a listening.

Throughout the work she is assertive to possible affordances in all these different layers mentioned. Technically there are different parameters for analyses and synthesis in different sections of *Metamorphoses*, so the computer will respond differently at different moments in time, as the sounding environment changes. Not only does this impact the musical action throughout the work; even more so, it changes its meaning dynamically, since affordances in an ecological perspective are tightly connected to meaning-making. The computer responsiveness may give birth to different sets of meaning for different singers at the same time-event, but also quickly or dynamically change how singers make sense of the computer and their interplay when performing.

5.3. A LOOK AT POSSIBLE MECHANISMS

5.3.1. Looking for a response

During the process of working with *Metamorphoses*, especially during the first two workshops, the singers tended to fall into a pattern of looking for a computer response. Why is this so? For one it may be just a novelty effect, which would go away over time. There is a notion that comprehension of the relationship towards the computer evolves over time: 'that one gets a better understanding of how we communicate [over time]'. Listening strategies may also develop as time goes by. In the following the singer describes how she attends to the response: 'One is used to singing in one's own body, to be totally present in what comes out. One makes a sound to hear the reaction, that which NN spoke of earlier.' The same singer also comments that the relationship towards the device takes time to grow into: 'It takes some time for them to grow together into music-making. It can take quite some time.' Another way to look at it is as a bringing something forward, putting it on display in a 'look what I

found' sense. The actual meeting is then not with technology but with each other through technology. Something is being uncovered for a fellow musician or an audience, [2] real or imaginary. Yet in the first workshop, one account was how the looking for a response happened at the expense of the relationship towards the fellow musicians.

Voc 1: It is quite easy to not think musically, at least for my part. It feels like [brr, brrr, helloooo].

All: [Laughs]

Interviewer: Ok?

Voc 2: To not think musically?

Voc 1: No but, it doesn't feel as if we have made music together. I am more interested in, if, how ... It's more on my part, if one can get past it.

Interviewer: (Laugh) ... if one can get past it?

Voc 3: I think so!

Voc 1: One must be able to. There has to be some discipline. But it's fun to play too.

Then, quite contrary to meeting each other through technology, the relationships are isolated islands, singers separated from each other. [3]

But maybe the question should be put differently? Perhaps the looking for a response in the mixed work is a necessity? For what would be the case otherwise? The texture would be extremely dense and the function of the electronic sounds as a partner in dialogue and impulse-giver would almost disappear. The live electronics would solely be assigned the task of background. So, tentatively speaking, maybe this aspect of looking for a response in the computer technology is mandatory, but in interplay with all the material and people contained in the situation. This puts high demands of flexibility on the performer, but would harmonise with the idea of something developing over time.

5.3.2. The character of the response

The character of the response shapes what is sung, it constitutes a situation for improvisation and interplay. The granular synthesis structure is commented on in the following:

And it is rather dense, I was thinking. Or at least somewhat dense. And what, what was nice were the rests ... But it wasn't anything negative, so ... not the way I thought of it, per se. That causes one to relate to it. In order to take it in and understand it you need to be quiet. A bit.

In the above application the electronic sounds follow the length of the sung input. The response elicits a way of singing where there is space for the computer response. Following this, the character of the response impacts the improvisation to become more fragmented than it otherwise would have been with having the score only. As a consequence, there is a layer in the work that is rather implicit and brought forward only when the work is performed:

For example, this 'springande springa' (sings) and it's like that, and then reactions stem from that. And then I know that this way, that there came a funny sound when I made the 'r's or how it was like so I went on,

[2] The violinist in *PS. I will be home soon!* spoke of the same thing, how she wanted to show the sounds to the audience. Through her path across the floor where the motion detector tracked her movements (in the part of the work that is called *Kompass*) she achieved this research, this display.

[3] This experience was also felt by one of the singers in *PS. I will be home soon!* She described how she experienced her co-musicians as more individual in the context involving responsive computer technology.

then it generates more 'r' from me to see what will happen with it. So of course it affects.

5.3.3. The situational factors

The particularities of the situation are not negligible. The responsive system encompasses four computers and four vocalists, which brings on a completely different situation from a solo singer performing with responsive electronics in an acoustic ensemble. Somehow it normalises the situation and also impacts listening. In addition it contributes to a sense of communion. Not least if the shared situation also comprises elements of challenge as in the concert performance, where triggering was a delicate action performed, preferably in synchronisation, at predetermined locations notated in the score. Another factor mentioned is the presence of the composer, resulting in a clearly felt relation to the composer's intention in the technology.

5.3.4. Experiencing in an altered bodily awareness

To reiterate, affordance is a relation between the capacities of the individual and features of the environment (Chemero 2009). Then how is the experience if the capacity is restrained, as when singing in elevation? The assumption was it would be drastically altered, but as it turns out, the answer is both yes and no. The impact on the performance aspect of the voice production is almost none. The learned component of voice production in professional singers is profound; and all singers agreed it is such a strong corporeal practice. And at the same time, being a practice so firmly rooted in the body, would not an alteration of the bodily awareness leave any imprint? Well, the audience fades from the awareness, or at least there is a sense of distance in my experience. The others' bodies are of less importance. They can no longer be used for visual cues, nor be experienced kinaesthetically; they are just too far away and/or too restrained. When singing in the harness uplifted in the ceiling, the channel for interplay is focused to the singing voice, the sung gestures. Listening is accentuated; that is where the interplay with the others occurs. It wanders in between the different layers of the sounding - the others' emotional expression, the cues and responses from the electronics from each and every one, hearing one's own voice somewhat from a distance, but also meanwhile a heightened awareness towards the bodily sensation and the feelings that rise and fall with the situation: tense, relaxed, active, passive.

6. DISCUSSION

What happens when the electronic layer is added to the acoustic layer in the mixed work? There is a shift in attention - of course - since something is being added. And the question emerges among the singers as to which one of the sounding tails is their response as a consequence of the web of interrelations being expanded.

What happens though is not as simple as to say that A has been added. There is a change in impulse-giving, which in turn affects how the singers perform. Certain applications provide certain responses, generating a push in a particular direction. For example, the implementation of the object psycho-trist- from IRCAM was very responsive to [v]- and [f]-sounds, as also was suggested in the score. When the singers experimented with inviting new sounds into the improvisation, the general comment was that there was a pull back to these [v]- and [f]-sounds, which elicit the strongest response. Maybe it is similar to empathic confirmation (validation) inside a dialogue (Rogers 1975). What brings out resonance in the listener is elaborated on, what is un-echoed is dropped (Miller and Rollnick 2012); hence a flow or an unspoken direction is set out.

But what about this change in the sounding situation, in what way does this differ from, for example, overhearing the sound of a truck being parked with the engine still on outside the house when per-

forming? Maybe the difference lies in the pre-composed rule system where a relation between what is sung and what the subsequent electronics do is decided beforehand. Talking about attention, the performer may decide to encompass the truck in her field of attention and thereby establish a relationship, that is, direct her attention. Nevertheless this will form a static relationship in the sense that no matter how the performer sings, it will have no effect on the sounding electronics. It remains detached. The computer on the other hand is capable of assuming different roles. It may assume the role of the 'truck' having a process completely separated from the performer, at an instant switch to denote the opening of a new section and form a sort of way mark, then mould into an extension of the performer's musical expression by some preconceived parameter. Thus the computer is characterised by its versatility.

Turning to the performers' interplay with the computer, one recurring line of thought throughout the accounts of experiences from the work *Metamorphoses* is the importance of the situation; the computer is assigned different roles and ascribed different sets of meaning depending on what sounds it is generating. What was possible in one situation is no longer a possible course of action in the next, and this interplay is constantly evolving and reshaping the situation. As previously discussed, affordance is tied with meaning-making, which may help explaining the changes experienced of the computer being on the one hand an extension and on the other a separate entity. It is not only the computer that transforms but also the person in interplay with the computer. It is not only the situation and the computer, or the performer's way of singing, but also the two intertwined that reach into and transform the performer's experience of self. Herein also lies the core of direct perception as described by Chemero (2009). The object in the situation is neither separate nor an extension, but both.

Parallel to the work's momentary processes is the more overarching notion of perceptual learning, as described in section 3. As the singer studies the work, participates in workshops and learns the principles for interacting with the computer, a transformation is also taking place in her, especially in such a process as *Metamorphoses*, lasting for more than a year. This transformative potential sheds some new light onto the process towards a work, bringing some clarity, but also adding yet another layer of complexity to the interplay. The performer's ability is not static but highly dynamic. [4] Johnston et al. (2008) write that the single biggest factor differentiating various modes of interaction with a virtual instrument in their study is the issue of control. These findings serve as an important reminder that perceived control is not static and set once and for all.

According to Clarke (2005), culture is part of what we perceive. For one of the singers, the computer (in particular the Mac computer), constitutes part of her office working environment, and pertinent to this its 'working-partner' qualities become a salient aspect of the environment to her. In relation to listening, the formal training a musician has is yet another cultural component. What are the individual's listening habits? In *Metamorphoses* there was the notion of attending to a whole, much more than on other occasions.

Furthermore working with jazz singers, the experience of insecurity about what to expect from the computer response was totally natural. [5]

In the beginning of the article it was suggested how the conflation between perception and action is taken to the extreme in the practice of singing. Drawing upon my experience, this is due in part to the very mechanism of singing, where the experience simultaneously is of the sounding reaching the eardrum, vibrations through the skull and muscular sensations in the larynx, and the experience of the full bodily state as described by Damasio (2003). One vocalist in *Metamorphoses* describes this confusion, or conflation, expressing a sensation of constituting one mass, dissolution of the subject,

[4] This shift in experience was also encountered in *PS. I will be home soon!* by the author. One singer described herself shifting from experiencing the computer as indeed separated towards a position of feeling as if she became more 'one' with the computer at the end of the performances, which lasted for about a month (Einarsson and Friberg 2015).

[5] In the collaboration with a classically trained vocalist in the work *PS. I will be home soon!* (Einarsson and Friberg 2015), the situation was reversed; she regarded the element of uncertainty as inherently negative.

depicting the metaphor of being a body moving as a school of fish. Singers describe both being and having their voice. So even towards their own voices there is a relationship that is at the same time extended and separated.

During the performance, the affordances appear in several layers simultaneously – in the staged setting as well as in the sounding (music) setting. There are interesting indications of an amplification of the sung expression when these are pulling in the same direction, which may be understood in relation to intermodality, how senses inform each other.

According to Paine (2002), a detailed treatment of the nature of the relationship, that is, mapping, is crucial to perceiving a correlation between the quality of the input and the quality of the output for those who engage with the interactive sound system. Indeed Paine has a point, but there is also a need to emphasise the small word ‘quality’, because the issue is not only what connections are devised but also how they behave will decide how the relationship is experienced. Affordances alone do not aid embodiment, as proposed by Paine (2009), at least not affordances in the Gibsonian sense, because they do not reveal anything about what actions are chosen from multiple opportunities or how the action chosen is carried out.

Composer James Andean (2011) has attempted to apply the ideas of Gibson to listening to electroacoustic music with the idea that the physical body has precedence over other sources of information on the musical scene. He describes a scenario where the listener first scans the situation for humans and then proceeds to ‘reading’ the situation in a particular order. This order of events is not supported by any empirical findings in the article and rather bares traces of a hierarchical processing of information, something a more radical interpreter, like Chemero (2009), would hardly agree on. Perceiving and experiencing is the same according to Chemero (2009), and there are no representations or cognitive calculations to mediate what is perceived. Turning to experiences from *Metamorphoses*, would sounds generated by a physical visible body/the performer have precedence in the way Andean suggests? The experiences suggest otherwise. The physical body is of less importance, at least for the performers. The attention wanders between voices and electronic responses. Speaking in ecological terms, what causes shifts in attention is rather changes in affordances. Marc Leman makes the claim that we always listen for what is causing the sound and, if anything, human beings in the mixed work are a given. If anything, attention is drawn to ambiguities (Windsor 2000). The structure of the sounds, their behaviours, qualities and placement are all important facets to consider when trying to determine what causes the singer’s readiness to act and shift of attention.

7. CONCLUSION

To summarise, the practice of singing is an embodied activity, in which body and mind are not separated but conjugated. Embodiment is a vehicle for being situated, and, as I have shown, using theories from ecological psychology and radical embodied cognition, the coupled interplay with the situation as it unfolds through a musical work is of great importance. When the computer technology is incorporated forming the mixed work, as in *Metamorphoses*, it constitutes part of both the embodied practice of singing and the situation.

Despite the limited number of participants and observations, the described accounts from singers may nevertheless help in raising questions and deepen our understanding of the relationship towards computer technology in a mixed work, and perhaps to some extent be extrapolated to how technology is related to everyday life. This may also lay foundations for future compositional tools and/or performance practices.

REFERENCES

- Andean, J. 2011. Ecological Psychology and the Electroacoustic Concert Context. *Organised Sound* 16(2): 125–33.
- Antle, A. N., Corness, G. and Droumeva, M. 2009. What the Body Knows: Exploring the Benefits of Embodied Metaphors in Hybrid Physical Digital Environments. *Interacting with Computers* 21(1): 66–75.
- Broadhurst, S. 2006. Digital Practices: An Aesthetic and Neuroesthetic Approach to Virtuality and Embodiment. *Performance Research* 11(4): 137–47.
- Chemero, A. 2009. *Radical Embodied Cognitive Science*. Cambridge, MA: MIT Press.
- Clarke, E. F. 2005. *Ways of Listening: An Ecological Approach to the Perception of Musical Meaning*. Oxford: Oxford University Press.
- Damasio, A. R. 2003. *Looking for Spinoza: Joy, Sorrow and the Feeling Brain*. London: Heinemann.
- Drummond, J. 2009. Understanding Interactive Systems. *Organised Sound* 14(2): 124–33.
- Eigenfeldt, A. 2011. Real-time Composition as Performance Ecosystem. *Organised Sound* 16(2): 145–53.
- Einarsson, A. 2015. We Can Work It Out – Calibration as Artistic Method. *Ruukku*, 4. www.researchcatalogue.net/view/142373/142374 (accessed 14 September 2017).
- Einarsson, A. and Friberg, A. 2015. Using Singing Voice Vibrato as a Control Parameter in a Chamber Opera. *Proceedings of ICMC 2015*. Texas, 25 September–1 October.
- Emmerson, S. 2009. Combining the Acoustic and the Digital: Music for Instruments and Computers or Pre-recorded Sound. In R. T. Dean (ed.) *The Oxford Handbook of Computer Music*. Oxford: Oxford University Press.
- Essl, G. and O’Modhrain, S. 2006. An Enactive Approach to the Design of New Tangible Musical Instruments. *Organised Sound* 11(3): 285–96.
- Friberg, A., Schoonderwaldt, E. and Juslin P. N. 2007. CUEx: An Algorithm for Automatic Extraction of Expressive Tone Parameters in Music Performance from Acoustic Signals. *Acta Acustica United with Acustica*, 93(3): 411–20.
- Frisk, H. 2008. *Improvisation, Computers, and Interaction: Rethinking Human-Computer Interaction Through Music*. Doctoral dissertation, Lund University.
- Gaver, W. 1991. Technology Affordances. CHI ’91: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching Through Technology*. New Orleans, LA, 28 April–2 May.
- Holmes, P. and Holmes, C. 2013. The Performer’s Experience: A Case for Using Qualitative (Phenomenological) Methodologies in music Performance Research. *Musicae Scientiae* 17(1): 72–85.
- Hunt, A., Wanderley, M. M. and Paradis, M. 2003. The Importance of Parameter Mapping in Electronic Instrument Design. *Journal of New Music Research* 32(4): 429–40.
- Johnson, M. 2008. *The Meaning of the Body: Aesthetics of Human Understanding*. Chicago: University of Chicago Press.
- Johnston, A., Candy, L. and Edmonds, E. 2008. Designing and Evaluating Virtual Musical Instruments:

- Facilitating Conversational User Interaction. *Design Studies* 29(6): 556–71.
- Käuffer, S. and Chemero, A. 2015. *Phenomenology: An Introduction*. Chichester: John Wiley.
- Kozel, S. 2007. *Closer: Performance, Technologies, Phenomenology*. Cambridge, MA: MIT Press.
- Lakoff, G. and Johnson, M. 1999. *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. New York: Basic Books.
- Leman, M. 2008. *Embodied Music Cognition and Mediation Technology*. Cambridge, MA: MIT Press.
- Lindblom, J. 2015. *Embodied Social Cognition*. Berlin: Springer.
- Luciani, A., Florens, J. L., Couroussé, D. and Castet, J. 2009. Ergotic Sounds: A New Way to Improve Playability, Believability and Presence of Virtual Musical Instruments. *Journal of New Music Research* 38(3): 309–23.
- McNutt, E. 2003. Performing Electroacoustic Music: A Wider View of Interactivity. *Organised Sound* 8(3): 297–304.
- Miller, W. R. and Rollnick, S. 2012. *Motivational Interviewing: Helping People Change*. New York: Guilford Press.
- Morse, M. 2003. The Poetics of Interactivity. In J. Malloy (ed.) *Women, Art, and Technology*. Cambridge, MA: MIT Press.
- Mulder, A. 1994, August. Virtual Musical Instruments: Accessing the Sound Synthesis Universe as a Performer. *Proceedings of the First Brazilian Symposium on Computer Music*. Minas Gerais, Brazil, 2–4 August.
- Paine, G. 2002. Interactivity: Where to From Here? *Organised Sound* 7(3): 295–304.
- Paine, G. 2009. Towards Unified Design Guidelines for New Interfaces for Musical Expression. *Organised Sound* 14(2): 142–55.
- Penny, J. 2011. Flutes, Voices and Maskenfreiheit: Traversing Performative Layers. *Organised Sound* 16(2): 184–91.
- Rambusch, J. and Susi, T. 2008. The Challenge of Managing Affordances in Computer Game Play. *Human IT* 9(3): 83–109.
- Rogers, C. R. 1975. Empathic: An Unappreciated Way of Being. *The Counseling Psychologist* 5(2): 2–10.
- Schroeder, F. 2006. The Voice as Transcursive Inscraper: The Relation of Body and Instrument Understood through the Workings of a Machine. *Contemporary Music Review* 25(1–2): 131–8.
- Schroeder, F. and Rebelo, P. 2009. The Pontydian Performance: The Performative Layer. *Organised Sound* 14(2): 134–41.
- Shapiro, L. 2007. *Embodied Cognition*. Abingdon: Routledge.
- Sharkey, N. E. and Ziemke, T. 2001. Mechanistic Versus Phenomenal Embodiment. *Cognitive Systems Research* 2(4): 251–62.
- Smith, J. A., Flowers, P. and Larkin, M. 2009. *Interpretative Phenomenological Analysis: Theory, Method and Research*. London: Sage.
- Susi, T. and Ziemke, T. 2005. On the Subject of Objects: Four Views on Object Perception and Tool Use.

Triple C: Cognition, Communication, Co-operation, 3(2): 6-19.

Torenvliet, G. 2003. We Can't Afford It! The Devaluation of a Usability Term. *Interactions* X(4, July/August): 12-17.

Wilson, M. 2002. Six views of embodied cognition, *Psychonomic Bulletin and Review*, 9 (4): 625-636.

Windsor, L. 2000. Through and Around the Acousmatic: The Interpretation of Electroacoustic Sounds. In S. Emmerson (ed.) *Music, Electronic Media and Culture*. London: Ashgate.

Withagen, R., de Poel, H. J., Araújo, D. and Pepping, G. J. 2012. Affordances can Invite Behavior: Reconsidering the Relationship between Affordances and Agency. *New Ideas in Psychology*, 30(2): 250-8.

Einarsson, A, Ziemke, T. (2017) Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies. *Frontiers in Psychology* (section: Cognitive Science), submitted to a special issue on “*Beyond Embodied Cognition: Intentionality, Affordance, and Environmental Adaptation*”.

Exploring the multi-layered affordances of composing and performing interactive music with responsive technologies

Anna Einarsson¹, Tom Ziemke^{2,3}

¹Dept. of Composition, Conducting & Music Theory, Royal College of Music, Stockholm, Sweden

²Cognition & Interaction Lab, Human-Centered Systems Division, Dept. of Computer & Information Science, Linköping University, Linköping, Sweden

³Interaction Lab, School of Informatics, University of Skövde, Skövde, Sweden

Correspondence:

Tom Ziemke, tom.ziemke@his.se

Keywords: affordances, cultural affordances, embodied activity, embodied cognition, composition, interactive music, responsive technology, situated activity.

ABSTRACT

The question motivating the work presented here, starting from a view of music as embodied and situated activity, is how can we account for the complexity of interactive music performance situations. These are situations in which human performers interact with responsive technologies, such as sensor-driven technology or sound synthesis affected by analysis of the performed sound signal. This requires investigating in detail the underlying mechanisms, but also providing a more holistic approach that does not lose track of the complex whole constituted by the interactions and relationships of composers, performers, audience, technologies, etc. The concept of affordances has frequently been invoked in musical research, which has seen a ‘*bodily turn*’ in recent years, similar to the development of the embodied cognition approach in the cognitive sciences. We therefore begin by broadly delineating its usage in the cognitive sciences in general, and in music research in particular. We argue that what is still missing in the discourse on musical affordances is an encompassing theoretical framework incorporating the sociocultural dimensions that are fundamental to the situatedness and embodiment of interactive music performance and composition. We further argue that the *cultural affordances* framework, proposed by Rietveld and Kiverstein (2014) and recently articulated further by Ramstead and colleagues (2016) in this journal, although not previously applied to music, constitutes a promising starting point. It captures and elucidates this complex web of relationships in terms of shared landscapes and individual fields of affordances. We illustrate this with examples foremost from the first author’s artistic work as composer and performer of interactive music. This sheds new light on musical composition as a process of construction – and embodied mental simulation – of situations, guiding the performers’ and audience’s attention in shifting fields of affordances. More generally, we believe that

the theoretical perspectives and concrete examples discussed in this paper help to elucidate how situations – and with them affordances – are dynamically constructed through the interactions of various mechanisms as people engage in embodied and situated activity.

1. INTRODUCTION

Given that this paper deals with music, but is submitted to a cognitive science/psychology journal, we assume that the majority of readers are cognitive scientists, and only a minority of readers are familiar with music theory. The first question that comes to mind for the average cognitive scientist, who is to some degree familiar with JJ Gibson's (1979) notion of *affordances*, might be whether music really has affordances in the first place. After all, Gibson was mainly concerned with the sense of vision and the affordances of concrete physical objects. These were affordances conveyed by the optical array and perceived by agents being far from stationary, but moving about interacting with those objects, such as the *sit-ability* of chairs or the *grasp-ability* of cups. Nonetheless, hearing also deals with concrete objects, since sound carries information about a source. We are always in search for what is causing the sound, learning about environmental occurrences (Windsor, 2000; Gaver, 1993). As Jonas (1966/2001) writes, hearing is related to event and not to existence. Half a century later, Gibson's *ecological psychology* is still highly influential, not least in research on *embodied cognition* (e.g. Varela et al. 1991; Chemero, 2009; Shapiro, 2011), and, although widely debated, the concept of affordance is still very much used (e.g. Thill et al 2012; Sakreida et al 2016) and new conceptual frameworks are continuously being developed (e.g. Rietveld & Kiverstein, 2014; Ramstead et al 2016; Davis & Chouinard, 2017).

In musical research, perhaps contrary to what one may assume, discussing the affordances of music is nothing new. It is in accord with the more over-arching *bodily turn* of musicology and related fields since the beginning of the 21st century (Pelinski, 2005). There is in fact a growing body of support for music as embodied and situated activity *Performing and interacting with musical instruments*, for example, is widely recognized as an embodied phenomenon (e.g. Leman, 2007; Windsor & Bézenac, 2012). Furthermore, Eric Clarke (2005), among others, has discussed the role of embodiment in the experience of music, particularly *listening*, and there also is support for an activation of the human mirror neuron system when *experiencing music* (Molnar-Szakacs & Ovary, 2006). The concept of affordance has been used in music by a number of authors in recent years (e.g. Clarke, 2005; Kreuger, 2011; 2014; Leman, 2007; Menin & Shavio, 2012; Windsor, 1995; 2000; Windsor & Bézenac, 2012; Einarsson, in press). It offers unique ways of describing the reciprocal relationship between performer/composer and musical structures, but also, as we will see, towards the performance situation as a whole, in all its complexity. Windsor and de Bézenac (2012), for example, have argued that “the concept of affordances helps to conceptualise the mutual relationships that exist between listeners and sounding objects and events, between performers and their instruments, and between musicians in a manner quite foreign to more cognitive structural approaches to music psychology” (2012, p. 103). This reciprocity being a topic of great research interest is emphasised also by Geeves and Sutton (2014). However, current interpretations of the concept of affordances in musical research vary very significantly among each other. Most of them also deviate significantly from the Gibsonian notion of affordances, which is not always acknowledged by the authors (as will be discussed in detail in the next section). As Davis and Chouinard (2017) state in their discussion of the general use of the affordance concept, the challenge for researchers is to delineate their usage of the concept and adopt this in ways displaying both relational, material and dynamic dimensions. We agree with them that the mechanisms of affordances operate within a situation, whose aspects interact and thus affect the efficacy of affordances, a notion highly applicable to music.

Over the last decade questions of *aliveness* and *embodiment*, in the light of advancements in technology (i.e. increased computer processing speed enabling interactivity between agents and computer system(s) to be staged and performed live in real time), have been a major concern in artistic fields such as *performance studies* (Barret & Bolt, 2013; Broadhurst & Machon, 2011), *dance* (Kozel, 2007), and *music* (Emmerson, 2007; Peters, Eckel & Dorschel, 2012). In the field of music, an interesting special case, in our opinion, is music whose composition and performance is aided by computer technology in real time (running time), i.e. *live electronic music*. We are particularly interested in interactive music utilising responsive technologies, such as sensor-driven technology or, as the major focus in this article, computer sound synthesis affected by computer analysis of an acoustically performed sound signal. For example, features of a sung input (e.g. vibrato) are analysed by the computer, and the subsequent electronic sounding (e.g. a chord) is dependent on the amount of vibrato. In musical works of this kind, a notion of interacting with “a disembodied other” (Emmerson, 2010) (i.e. computer technology), brings questions of embodiment and music to the heart of the discussion. We believe that the notion of affordances – in the broadened sense of *cultural affordances* discussed in this paper – can play a central role in such endeavours.

Hence, the aim of this paper is threefold: Firstly, to expand on the notion of affordances as it has been used in musical research previously, by clarifying the diversity of interpretations of the concept, but also the limitations of its present use. Secondly, to suggest an application of the notion of *cultural affordances* – originally proposed by Rietveld and Kiverstein (2014) and recently further elaborated by Ramstead et al (2016) in this journal – to interactive music, where the performers, the audience, and the composer shape, experience and perform music with and through individual yet overlapping, and dynamically varying, fields of affordances. This will be illustrated with examples from the first author’s artistic work as composer and performer of *mixed works*, where a combination of acoustic sound sources (singers) and digital sound sources (responsive computer technologies) perform together live. Last, but not least, the focus of this paper is on musical performers’ and composers’ skill and embodied affective appraisal in dynamic relationship with the environment, situated inside a sociocultural practice. In our opinion, this contributes to bridging the conceptual gaps between the seemingly disembodied work of the composer, the concrete embodied activity of musical performers, their interaction with more or less ‘invisible’ technologies, and the – according to some – highly abstract social and cultural practices that they are part of.

2. ON AFFORDANCES

In order to contextualise the discussion, without any attempt to provide a complete historical account here¹, we will recapitulate some relevant notions of the concept of affordances in psychology/cognitive science in general and elucidate its use in music research in particular.

2.1. AFFORDANCES IN THE COGNITIVE SCIENCES

2.1.1. The reciprocity between organism and environment

Most of James J. Gibson’s *ecological psychology* and his theory of perception were formulated in the late 1960s and -70s, i.e. long before embodiment had become a popular topic in the cognitive sciences. His work was a reaction against a mechanistic worldview and a move away from seeing cognitive processing as causation. First and foremost his work was concerned with visual perception, such as his

1 More complete historical accounts of the notion of affordances have recently been provided by, for example, Dotov et al. (2012) and Osiurak et al. (2017).

influential theory of the visual field and the *optical array* (Gibson, 1979/1986).

Gibson introduced the notion of *affordances* for what he viewed as action opportunities for humans, or other animals, in their environment. In Gibson's original sense these have a peculiar ontological status: they are neither a property of the environment alone, nor a feature of the animal alone, but rather a property of both, i.e. emerging from the animal's interaction with its environment. In Gibson's own words:

[...] an affordance is neither an objective property nor a subjective property; or it is both if you like. An affordance cuts across the dichotomy of subjective-objective and helps us to understand its inadequacy. It is equally a fact of the environment and a fact of behavior. It is both physical and psychical, yet neither. An affordance points both ways, to the environment and to the observer (Gibson, 1979/1986, p. 129).

Hence, a key aspect of affordances is that they are not just physical properties, but have to be considered relative to the animal. This reciprocity between organism and environment is fundamental to the Gibsonian notion of affordances. Affordances are specified by the pick-up of invariant information from the ambient light, the so-called *optical array*, whilst the animal – its body, legs, hands and mouth – is *coperceived* (Gibson, 1979/1986, p. 141). Thus, information does not equal affordances – information only points towards affordances. Furthermore, affordances, according to Gibson, are permanent and stable. They do not change relative to the organism's varying internal states, such as needs or motives. He writes: "Something that looks good today may look bad tomorrow but what it actually offers the observer will be the same" (Gibson, 1982, p. 410). This is, of course, not uncontroversial, because it means that, for example, a particular staircase is either – in principle – 'climbable' for you or it is not, but its 'climb-ability' does not vary over time just because some days you might be, for example, too tired or too drunk to actually climb it. So, to Gibson it is a reciprocal concept between organism and environment, but it is binary and relies on properties, which do not change according to changing needs. At this point, you might ask if affordances are opportunities for behaviour, why do we not act on every possibility? What about social and cultural influences? And what about affordances not so readily available? These are issues we will come back to in the following.

As often is noted, Gibson's writings are sometimes ambiguous, some would say incomplete, and his theories have been a target of substantial criticism (e.g. Fodor & Pylyshyn, 1981). Nevertheless, his theories have undoubtedly spurred lots of interesting research and debate in the field. There are different interpretations and reformulations of Gibson's original theory, some of which have focussed more on the agent, some more on the object, and others have attempted to stay close to Gibson's original relational concept encompassing both agent and object.

2.1.2. From dispositional properties to relational abilities

Turvey, Shaw and Mace took up the challenge of developing Gibson's ideas into a more philosophically sound and empirically tractable theory through a number of papers (e.g. Turvey et al., 1981). For them it was dispositional properties in the object and in the organism that enable action. They introduced the concept of *effectivities* (Shaw et al., 1982), complimentary to affordances, and intended to specify an animal's means for action, i.e. a combination of the function of its tissues and organs relative to the environment, to realize a specific affordance in a given situation. That means, the dispositional affordance and the effectivity complement one another. Hence, their theory relies on ecological laws, which

are not universal but relate to a niche.

In particular this latter aspect has been one of the major criticisms formulated by Chemero (2006; 2009). Although he recognises Turvey, Shaw and Mace's contributions to the development of Gibson's ecological theory, his point is that they have turned the theory into having too little information available for direct perception, ruling out direct perception of *individuals* and perception of things partly determined by *convention*. "If information depends on laws", he writes, "there is also no information about individual people available for perception. So although a human infant might have information available about humans, she has none about her mother" (Chemero, 2009). Moreover, ecological laws may structure the way that, for example, light is reflected off of an aluminium can, but according to Chemero they cannot account for instances where, for example, there has been a mix up in the factory between milk and soda, or someone has played a practical joke. Conventions build upon public agreement and are easily violated, he states.

Chemero's (2009) own take on modernizing Gibson, is – in a nutshell – to combine Gibson's theory with dynamic systems theory (also employing situational semantics in order to avoid natural laws and instead allowing for constraints connecting situations, which may be cultural or conventional). This is part of the formulation of what he refers to as *radical embodied cognitive science*. He argues that affordances are *relations* in a similar sense as one entity is taller than another. He also makes an important distinction between *feature* and *property*. While perceiving a feature is a matter of perceiving that *the situation as a whole has a certain feature*, perceiving a property, on the other hand, presupposes much more previous knowledge than perceiving features. Perceiving affordances, according to Chemero, is placing features. Secondly, Chemero argues, that instead of talking about an individual's capacities in terms of body scales, we should consider how an individual's ability is more relational. Dispositions never fail, but abilities may, thus allowing us to account for occasions when performance does not meet up with for example biological expectations (or where musical performances fail!). For example, one day somebody might simply be too tired to walk the steep stairs. Affordances and abilities, according to Chemero, causally interact and are causally dependent. That means, what Chemero refers to as *affordance 2.0* is a relation between the abilities of the individual and features of the environment.

2.1.3. Affordances as aspects of a sociocultural environment

Rietveld and Kiverstein (2014) propose a significantly broader application of affordances than Chemero. They emphasise how the exercise of abilities happens in a *context*, and that we as humans participate in *sociocultural practices*. Their two key concerns are: (1) the notion of a *form of life*, denoting human patterned behaviour, i.e. "normative behaviours and customs of our communities" (ibid, p. 328), a concept borrowed from Wittgenstein, and (2) the influence of normativity on our engagement with affordances. Instead of features they prefer speaking of *aspects of an environment*, since "in the human case the material environment has been sculpted by our sociocultural practices into a sociomaterial environment (ibid, p. 335). Accordingly, they suggest the following definition: "Affordances are relations between aspects of a material environment and abilities available in a form of life" (ibid, p. 335). This is very much in line with Chemero's (2009) argument that "the situation as a whole supports (perhaps demands) a certain kind of action" (cf. 2.1). In other words, this view enables us to consider the reciprocity between human and environment as conveyed by learned behaviours under the influence of social niches and conventions.

To Rietveld and Kiverstein, affordances are both relational and a resource (ibid, p. 327). They are relational in that they depend on the material environment and the abilities in the form of life. At the same time, they are resources in the way opportunities for action rely on how we create, for example,

tools for our projects and concerns, and engage with changing aspects of the material situation. In their reading of Gibson, instead of affordances, they give primacy to the ecological niche for a kind of animal with a certain form of life. Accordingly, they introduce the notion of a *landscape of affordances*, meaning affordances available in an ecological *niche*. As Bruineberg and Rietveld (2014) put it: “In our human form of life, these are related to the whole spectrum of abilities available in our socio-cultural practices”. Furthermore, some affordances that “stand out more than others” to the individual (cf. Withagen et al, 2012), and which are relevant to a particular individual in a particular situation, are denoted as a *field of affordances* (Bruineberg & Rietveld, 2014). Sensitivity to a situation, to the landscape of affordances, is achieved through abilities or skills. These are in turn generally acquired through training and experience in sociocultural practices.

But, recapitulating the question in 2.1.2, how come we do not act on every affordance available in our field? According to Rietveld and Kiverstein, this is due to an agent’s drive to achieve an *optimal grip* on the situation, a striving for improvement of the situation. The concept of optimal grip stems from philosopher Merleau-Ponty, intending to capture how living systems are always simultaneously “in a state of relative equilibrium and in a state of disequilibrium” (Merleau-Ponty in Kiverstein and Rietveld, 2015). Improving optimal grip entails a bodily action readiness: “In many real-life situations multiple states of action readiness interact in generating action tendencies and action” (ibid, p. 342). Ramstead et al (2016) exemplify the concept of optimal grip nicely with the image of a boxer who orients towards the punching bag so as to afford a suitable variety of possible strikes. Optimal grip helps explaining the way some affordances in the field, through interaction with affective appraisal and attention, cause action readiness and become solicitations to the individual.

Lastly, Rietveld and Kiverstein (2014) also introduce the concept of *skilled intentionality*, i.e. “the individual’s selective openness and responsiveness to a rich landscape of affordances” (Kiverstein & Rietveld, 2015) in overlapping cycles of action-perception. This ability is developed over the years as part of an increasing sensitivity to discriminate between situations. In other words, skilled intentionality is a tendency to act towards an optimal grip on a field of affordances (Bruineberg & Rietveld, 2014).

2.1.6. Cultural affordances

Ramstead et al (2016), in their discussion of *cultural affordances*, building on Rietveld and Kiverstein (2014) and Kiverstein and Rietveld (2015), among others, have recently raised the question how culture and context interact with human biology to shape cognition, behaviour and experience. They distinguish between two kinds of cultural affordances: *natural affordances*, which are possibilities for action, dependent on an agents’ exploiting reliable correlations in its environment with its set of abilities (similar to Chemero’s affordance 2.0) and *conventional affordances*, which depend on a shared set of expectations, norms and conventions. Important to note, there is a continuum of affordances between those that depend on reliable correlation (natural affordances) to those that depend on shared sets of expectations (conventional affordances). This view of affordances as gradual is also in accordance with Davis and Chouinard’s recent (2017) characterization of affordances, as determined by and depending on a number of, in practice not easily discernable, situational cues. According to Ramstead et al. (2016), it is important to note that culture underpins *both* natural and conventional affordances. Herein also lies their definition of culture. In their own words: “Human biology is cultural biology; culture has roots in human biological capacities. The affordances with which human beings engage are cultural affordances”. Even more so, in their view, both kinds of affordances may be socially constructed. Hence, according to their theory, an affordance may be changed either by altering aspects of the material environment or the organism’s form of life. Thus affordances may be shaped and vary in relation to enculturation, social influence, and skill, which is highly relevant to our discussion on musical practice.

Ramstead et al. (ibid) also adopt the concepts of a *landscape of affordances* (cf. previous section), which for them is relatively static and constituted by the totality of affordances available to a population in a given environment. They also use the notion of a *field of affordances*, which for them is the subset of “affordances in the landscape with which the organism, as an autonomous individual agent, dynamically copes and intelligently adapts”, i.e. “those affordances that actually engage the individual organism because they are salient at a given time, as a function of the interests, concerns, and states of the organism”. They argue, similar to Rietveld and Kiverstein (2014) that an organism does not encounter affordances one by one, but “as an ensemble of affordances, with which it dynamically copes and which it evaluates, often implicitly and automatically, for relevance”. These affordances are themselves entangled in various ways and appear as nested, depending on each other, hiding, enabling or revealing other possibilities for action. Certain affordances, in this view, are also highly influenced by joint intentionality, social and cultural normativity and shared expectations (implicit and explicit), co-determining the landscape of affordances. The field of affordances is “experienced as ‘solicitations,’ in that they solicit (further) affective appraisal and thereby prompt patterns of ‘action readiness,’ that is, act as perceptual and affective prompts for the organism to act on the affordance”. This idea of affective appraisal causing readiness to act (cf. Lowe & Ziemke, 2013) is again highly relevant to a performer or composer’s practice. Indeed, this means they depart from Gibson in a number of ways, including their argument that the individual experiences affordances as *solicitations*.

One of the assumptions the theoretical framework of conventional affordances rests upon is the dependence on shared expectations, or as they put it, how behavior is influenced by expectations about others’ expectations. Accordingly, the presence of others affects the salience of affordances, due to human conventions. Also culturally shared expectations are embodied at various levels (brain networks, artifacts, constructed environments).

In effect, Ramstead et al (2016) suggest a *predictive processing* model, emphasizing how the generative model does not need to entail semantic content. Generative models are embodied at different levels, may it be neurally in the brain or in terms of behavioural patterns. Here attention plays a key role in guiding action perception, affecting the acquisition of culturally specific sets of expectation.

2.2 AFFORDANCES IN MUSIC RESEARCH

How then do affordances in music work? Despite – or maybe due to – the extensive usage of the concept in music theory and related fields in recent years (e.g. Clarke, 2005; Kreuger, 2011; 2014; Leman, 2007; Menin & Shiovio, 2012; Windsor, 1995; 2000; Windsor & Bézenac, 2012; Einarsson, 2017, in press), interpretations and applications vary significantly. One thing most music scholars do seem to agree on though is that music *affords* movement (e.g. Clarke, 2005; Windsor & Bézenac, 2012), although some focus mostly on aspects of synchronisation or *entrainment* (e.g. Leman, 2007; Kreuger, 2014), where entrainment, in Leman and Maes’s definition (2014, p. 239), stands for “pre-reflective adaptation of human movement to music”.

To begin with, Clarke (2005), who primarily addresses the listener’s point of view, accounts for culture as being a vital part of what we perceive. He writes on culture: “once a tradition or convention is established and is embodied in widespread and relatively permanent objects and practices, it becomes as much a part of the environment as any other feature” (ibid). In his view, music, carrying invariant structures, can reveal almost any source in a situation: instrument, medium, social functions in which they participate, emotional states, bodily actions, and spaces. Moreover, according to Clarke, affordances change in accordance with an organism’s changing needs. He acknowledges that there are

social constraints that make some affordances less likely, for instance a violin that affords burning, but does not elaborate on these aspects.

To Windsor and Bézenac (2012), in line with Clarke, affordances are not fixed. Their view on culture follows Sanders (1997), entailing a stance according to which direct perception of affordances both may and should be applied in complex cultural contexts (Windsor & Bézenac, 2012) – again, in line with Clarke. However, unlike Clarke, Windsor and Bézenac’s approach resembles Reed’s adaptation of Gibson (cf. Withagen et al, 2012), according to which affordances exert a selective pressure on the behaviour of individuals. Windsor et al. also adopt from Shaw et al (1982) the concept of *effectivities* (cf. section 2.1.2.).

Moreover, they acknowledge the relevance of other people and social/material context to human behaviour, which they illustrate with the example of jazz musicians “going with” or “going against” what other musicians’ actions afford. It is, however, not clear what the underlying mechanisms are. It is also somewhat contradictory how these affordances, on the one hand, can “determine the characteristics” of a particular music, while at the same time it is emphasised “that while the pianist’s actions afford particular behaviours, they do not *demand* such behaviours” (ibid). Finally, a more controversial stance of theirs is that music affords semiotic acts, and the production of particular signs, for example through verbal or textual action (ibid, p.114). All in all, Windsor and Bézenac make a substantial contribution to the discussion of different ways of applying direct perception and affordances to music, and do include music-making to a larger degree than Clarke. Still, we lack the full picture, and the concept remains far from being well defined.

The focus of Kreuger (2014), another influential voice, on the other hand, is on emotion regulation. His view is one of *distributed cognition* (Hutchins, 1995), according to which music is for off-loading emotional responses. He equates affordances with the concept of *invites* (Withagen et al, 2012), but in a manner rather different from what Withagen et al intended (ibid). He assigns a demand character to the concept of affordance, discussing them from a perspective of “the way that we often experience music as affectively irresistible” (Kreuger, 2014, p. 2), and draws upon the notion of *entrainment* (see section 2.2). Music, according to Kreuger, is part of a distributed system where “musical affordances provide resources and feedback that loop back onto us and in so doing, enhance the functional complexity of various motor, attentional, and regulative capacities responsible for generating and sustaining emotional experience” (ibid). Kreuger focuses on the listener’s point of view, and although he is more detailed than Clarke (2005) or Windsor and Bézenac (2012) regarding the theoretical underpinnings of this position – drawing upon, amongst other things, *the extended mind hypothesis* (Clark & Chalmers, 1998) – his focus is rather narrowly set on solicitations of different emotional experiences. Hence, his theory is difficult to apply to a performance situation as a sole theory. He only touches slightly upon any social dimension in terms of *affective synchrony*, albeit not particularly in relation to affordances, and culture is addressed only as a consequence of discussing the many contexts in which music can be utilised.

Menin and Schiavio (2012), finally, delimit, but also reinterpret the concept of affordances as dealing with *intentional* relationships between musical subjects and objects exclusively, a relationship grounded in how the motor possibilities of the subject’s body can interact with the environment. Therefore they reject the idea of inferential relationships – such as, for example, a movie trailer ‘affording’ going to the cinema – as being affordances. They draw a parallel to the work of Delalande (in ibid, p. 210) on children’s exploratory behaviour towards musical objects, concluding how embodiment (and the discovery of musical affordances as intentional acts) arises from sensory-motor modalities of interaction

with an object. Thus their stance relies on relationships that have emerged during early childhood discoveries such as plunging, hitting and scratching. Accordingly, they propose “an embodied approach that radically diverges from the standard accounts, considering musical objects as entities constituted within the intentional motor-based relation that defines a musical context” (ibid, p. 211). It is not at all clear, however, how – and to what degree (if any) – they consider cultural or social aspects to influence or be part of the embodiment musical theory they describe.

2.3 WHERE DO WE GO FROM HERE?

To summarize, in most music theorists’ interpretations of affordances, cultural aspects are inevitably included, while the degree to which social aspects are incorporated varies to a large extent. What is still missing in the field of music research, in our opinion, is a more encompassing theoretical framework incorporating the sociocultural dimensions that are fundamental to the situatedness and embodiment of music performance, providing a detailed account of the underlying mechanisms, but also providing a more holistic approach that does not lose track of the complex whole constituted by the interaction of composers, performers, audience, technologies, etc. We believe that Ramstead et al.’s (2016) *cultural affordances* framework, as discussed in the previous subsection, although not previously applied to music, constitutes a promising starting point for capturing and elucidating this complex web of relationships. We will therefore in the next section illustrate this with examples foremost from the first author’s artistic works as composer and performer of *mixed works*, where a combination of acoustic sound sources (singer(s)) and digital sound sources (responsive computer technologies) perform together live (cf. Figure 1).

Figure 1: An illustration of the performance piece *Metamorphoses* (2015), a mixed work composed and co-performed by the first author (Einarsson, in press; see also <https://vimeo.com/153345880> for a Vimeo video).

3. AFFORDANCES IN INTERACTIVE MUSIC

The mechanisms of affordances in music operate within a situation whose aspects interact and thus affect the efficacy of affordances. Hence, affordances and situation are inevitably intertwined. However, for the sake of analysis, we will attempt to address in the following different parameters as if they were separable. Importantly though, by discussing affordances in terms of aspects of a situation, as Rietveld and Kiverstein (2014) proposed, this enables us to address affordances as graded instead of binary, which is much more applicable to the reciprocal dynamics that are crucial to music performance in general, and interactive music in particular.

3.1. THE LANDSCAPE AND FIELDS OF AFFORDANCES

What then constitutes the shared landscape of affordances in an interactive music work of which a performer is part? The landscape (cf. section 2.1.6.) is the totality of available affordances in a niche, associated with a form of life, so for most cases it is the action possibilities offered by the audience, the concert space, the reciprocal relationship towards sounds generated by the computer technology and possibly other participating performers. As the framework suggests (cf. section 2.1.6.), there are cultural affordances of both *natural* kind and *conventional* kind. An example of the former is a chair on stage that affords sitting, and in the latter case a microphone that affords singing into. In an interactive performance work, such as the first author’s *Metamorphoses* (Einarsson, 2017, in press; cf. Figure 1), the situation holding the landscape is very complex; the music composition is realised only when the com-

puter technology is interacted with, and stage directions are added to the performance, e.g. physical actions such as walking, sitting, standing, and singing elevated in the air in harnesses.,. Affordances appear, just as Rietveld and Kiverstein (2014) state, as nested and as an ensemble, where situation and affordances are inevitably intertwined.

Fields of affordances, on the other hand, (cf. section 2.1.6.), are at the level of the individual. What will stand out for the individual performer, thus constitute their field of affordances, is dependent on the performer's concerns, needs and abilities. These are in turn under the influence of enculturation, patterned practices, directed attention and shared expectations. Altogether this will colour the performer's detection of possibilities for action nested in the interplay with the computer, other performers, the audience and the performance space. Again, there typically are cultural affordances of both natural kind and conventional kind. An example of the former is the act of turning towards a sound suddenly projected from a specific loudspeaker.

The latter, conventional affordances, may be exemplified with a musical structure containing short sampled sounds lasting for 20-100 milliseconds or so, (i.e. granular synthesis) implemented at one location in the work *Metamorphoses*. The structure invites a sort of mimicking, which the score also devises. This electronic response is dependent on the length of the sung input (alongside additional parameters), and elicits a way of singing where space is left for the computer response. Following this,



the character of the response impacts the improvisation towards becoming more fragmented and the denser the response gets, it brings about more pause on part of the singers. Thus there is a potential to reshaping the affordance gradually towards a background texture, increasing the likeliness of soliciting contrasting musical gesture like silence (Einarsson, 2017, in press). Singing itself is an interesting sub-case, for singing words evoke emotions, and these in turn will impact appraisal of the affordance field.

In some instances this distinction between natural and conventional may be less clear-cut, which at the same time illustrates how natural and conventional affordances are poles on a continuum rather than two distinct categories. For example, an interesting study by Berg et al (2016) reveals how a classically trained pianist adjusts his playing in relation to the room acoustics. The study was based in a modern concert hall where ceiling height could be altered, and there were also listeners present. The larger the concert hall the longer the reverberation time, and the slower the tempo the pianist performed at became. Interestingly, there was also a heightened focus on details in the interpretation when the reverberation was shorter. So, modifications to the material environment, and the impact this had on the sociocultural situation (as constituted by for example performance practice, the character of the music and listener's expectations), influenced the pianist's behaviour.

3.3. STRIVING FOR OPTIMAL GRIP

One challenge that arises in artistic practice is, in comparison to many other activities we as humans engage in, the goal, or optimum, is not very clearly defined. Perhaps the goal, to a performer or composer, can be put as ways of being and engaging with/in music. As T.S Eliot famously stated: "You are the music, while the music lasts". On the other hand, as Bruineberg and Rietveld (2014) write, "the skilled individual does not necessarily have an explicit goal in mind, but rather is solicited by the environment in such a way as to improve her grip on the situation". Striving toward *optimal grip* is thus according to them equivalent to "having an action readiness for dealing adequately with an affordance" (ibid). Our suggested "goal" in terms of ways of being in music, is constrained by the demands of the situation, its physical, social and cultural prerequisites. One prerequisite may simply be the artistic work to be performed or composed. There may also be inner constraints derived from the motivations behind engaging in music, in particular emotionally laden ones.

The ways for improving grip, as a performer, may therefore be a tending towards having the full palate of artistic expression made available, in relation to the situational demands. The performer may optimize feedback monitoring, placement of equipment, positioning in relation to the audience and/or fellow musicians, controlling muscular tension/level of anxiety in order to perform at his or her best, minimize possible distractions, rehearse, acknowledge and adapt to present room acoustics - just to mention some. The performer may also learn new behaviours, cf. modifying affordances by changing the form of life. For example, in the work *PS. I will be home soon* by the first author (Einarsson & Friberg, 2015), performers reported that they had to find new listening strategies in order to achieve a satisfactory interaction with the computer. Many aspects applicable to the performer's situation may also be applied to the composer's situation. In addition, the composer can be said to have a goal set in terms of a directedness - let us call it an affective bearing towards which the artistic course for the work is set. An affective appraisal is always present when acting. So the *skilled intentionality* (cf. section 2.1.5), i.e. striving for optimal grip, in this case, speaking from the first author's experience, is reflected in having concrete tools readily available for composition (computer, instruments, synthesisers etc.), but also in terms of having access to the desired bodily state (as Damasio denotes it), pertaining feelings and cognitive processes in accordance with the idea for the work. The composer, similar to what composer Horacio Vaggione (2001) describes, attempts to using his/her own body as a template when shaping and listening to the work in progress, making use of embodied simulation in order to work with expectations and directing the attention of as well performers as audience as the work proceeds. Affect, attention and affordances interact to sculpt a field of affordances, as Ramstead et al (2016) put it. These aspects of *skilled intentionality* may be seen as ways of unveiling *embodied expectations in the landscape of affordances*, (i.e. shared expectations embodied in material culture, social niches and patterned cultural practices, enabling the landscape of affordances), by hands-on testing and experiencing sounds

and computer responses when composing.

3.4. ATTENTION AND JOINT ATTENTION

As Ramstead et al (2016) point out, constructed human environments, which we suggest a musical work may be likened with, work with soliciting certain expectations and directing attention. Attention impacts the ways the performer engages with the field of affordance. How a performer is attentive is shaped over the course of development, as part of an enculturation, thus ways of relating to computer responses in an interactive piece of music is part of a larger picture, where preconceptions in terms of ways of being attentive are part of how the performer attends to the music. Since parameters for analysis and synthesis not seldom change dynamically throughout the piece, many affordances are highly dynamic.

Drawing upon interviews with singers from two different musical works, it is possible to compare a classically trained vocalists' conceptualisation of the computer (Einarsson & Friberg, 2015) with jazz vocalists' preconceptions of the computer (Einarsson, 2017, in press). These differences in sociocultural situation between singers identifying with different genres, i.e. different fields of affordances, show how waywardness in the relationship towards the computer may cause uncertainty in some singers, but the appraisal of uncertainty and subsequent course of action may vary very much due to what formal training (enculturation and skill) they have and what connotations the computer brings along (the object). Uncertainty was experienced as inherently negative by the classically trained vocalist, while to the jazz singers it was at the heart of the practice and to a large degree indispensable (Einarsson & Friberg, 2015; Einarsson, 2017, in press).

The singer's accounts in the work *Metamorphoses* (ibid) also reveal expectations, such as listening out for what is not already there, in other words, listening out for where the piece of music is heading trying to anticipate the computer's (re-) action, or trying to "un-listen" what some singers or computers are performing in order to execute difficult passages. This directly relates to the agent's selective engagement with the field of affordance, as modulated by directed attention.

According to Ramstead et al (2016), joint and shared attention mark out some affordances as more salient, and this we suggest is part of how the composer works, i.e. by guiding the attention of both performers and audience. Particularly with interactive works, the first author's research brings forward performers' experiences of putting the relationship towards the computer on display for the audience or for fellow musicians (Einarsson, 2017, in press) in a "look what I found" sense. For example, the violinist in *PS. I will be home soon!* (Einarsson, 2012), performing in a motion-tracking system, described how she wanted to show the sounds to the audience. Through her path across the floor, where the motion detector tracked her movements, she achieved this display. Simply put, in one moment, the audience afforded the action of putting on display, and the electronic sounding afforded exploration and movement, yet these affordances can be assumed to interact, similar to what is suggested by Ramstead et al. (2016), which also would be interesting grounds for continuous study. This also applies to a mechanism only briefly touched upon by Ramstead et al (ibid), a description of how joint attention, usually only applied to dyadic relationships, may be projected to larger groups. The first author's research suggests that the musical work containing interactive technology may constitute one such case of expanded joint attention, where computer technology is part of the field of affordance holding an ensemble of nested affordances.

3.5. SOCIOCULTURAL DIMENSIONS

Recurring in this discussion, the musical performance situation is indeed a *sociocultural environment*, but as previously noted in section 2.2, this is surprisingly often not addressed when discussing affordances in music. For instance, this entails that fellow musicians influence available affordances by directing attention to certain aspects of the landscape, making some behavioural responses more likely due to expectations based on formal training and experience than others.

Already Gibson spoke of information, of secondary knowledge, as a way of accessing some affordances, and by emphasizing similar sociocultural dimensions, as Rietveld and Kiverstein (2014) and later Ramstead et al (2016) do, the theory makes much more sense in the field of music. For example, in an interactive musical work, for a performer to have some of the background information, such as knowing the composer's intentions with the relationships between materials, contributes to the sense of a whole and the discovery of affordances, i.e. how to choose between actions (Einarsson, 2017, in press).

One mechanism at work, affecting the fields of affordances for all parties involved (performers, audience, composer), is *sociocultural normativity*. This includes, but is by no means restricted to, (1) cultural artifacts such as the score, enculturation in terms of the singer's formal training, the ease with which certain actions are preferred over others – i.e. the ability of the performer, the participating institution (s), or (2) social influence such as the presence and proximity of the audience, the presence and proximity of other musicians, composer and technicians/staff, even social identity in terms of members of a social group not present at the moment. In interactive works it is apparent how emotions as well as culture and social relations are part of the interplay between performer and computer technology. Returning to the notion of experiencing waywardness in the relationship towards the computer, the situatedness, the enculturation and social influence, impact how this is experienced. With four singers in *Metamorphoses*, all having the same sort of “fickle playmate”, creates, according to the singers' accounts (Einarsson, 2017, in press), a sense of a shared handling of the situation (social influence).

One kind of computer response commented on by the singers performing *Metamorphoses* (ibid) was imitation, a driving force that enforces social liking (Leman, 2007). Engaging with certain responses offers a give and take of imitative gestures between singer and computer. Many of the affordances in the responsive work are thus nested, or of give-and-take character, and taking the musical lead in one direction opens up an array of action possibilities in the next step.

3.6. THE ROLE OF THE COMPOSER

Given what has been discussed so far, the role of the composer is then to shape dynamical fields of affordances accounting for their possible interactions, based on a shared landscape of affordance (cf. subject position in film theory (see Clarke, 2005), shaping a shared frame of reference for interpretation, but here with an emphasis also on action – among other things). Within this larger landscape of affordances and the musical performance situation with all its parties and multiple layers, there are clusters and overlaps: the singers' somewhat permeable and overlapping fields of affordances, and the listeners' fields of affordances. Considering this – consciously or unconsciously – is part of the composer's practice. Even when composing, we suggest composers create their field of affordances to operate within, relying on mechanisms of predictive processing and embodied simulation. Quiet inner listening brings about action cues, and extracts of musical passages or certain sounds projected over loudspeakers in the studio also suggest musical action in an embodied manner. Anticipating and forming relationships, as well as playing with expectations, is many times at the core of the composer's practice.

This is in line with Ramstead et al.'s statement: "The everyday phenomenology of affordances is one of possibilities for action and their variations; in other words, of *expecting* certain nested action possibilities and prescriptions for action" (Ramstead et al, 2016, p. 13, our emphasis).

An interesting example of working with the field of affordances is the audiovisual performance work *One piece of a shared space* (2015), where sung vowel sounds had an impact on the localisation of sound in the concert space (i.e. spatialisation). The singer experienced the relationship towards the live electronics as quite ephemeral, and looking through the lens of the cultural affordances framework some interesting issues arise. A response in the domain of location does not first and foremost solicit an action of vocalising. Rather the suggested action is to turn towards the sound, to approach and examine (a natural affordance). The concert space where this particular piece was rehearsed did not allow for very much movement, thus restricting the field, but when this kind of action was added as a kind of stage direction, to turn towards the sound (a guidance in the field of affordances), it did become more meaningful to watch and also made more sense to the performer. As a continuation, one could hypothesise that this kind of affordance would be better highlighted in an environment allowing for more exploration (changing the 'form of life' by manipulating the environment, and/or behaviour), or, a situation where the system was also susceptible for movement, i.e. the performer's movement was also taken into account for analyses, in addition to the sung input (changing the form of life by manipulating the material).

Hence, pertinent to our discussion of music performance is a dynamic between shared landscape and individual fields of affordances, and we suggest that considering this dynamic is at the heart of the music composer's practice. We are, however, not saying that compositional practice is devoid of rationalisations or structured approaches, but rather – following Damasio (1994), Johnson (2007) and Ziemke (2016) – that embodiment is fundamental to every aspect of human life and meaning-making.

4. DISCUSSION AND CONCLUSION

One of the driving forces behind this research has been the question how we can begin to account for the complexity of interactive music performance situations and analyze details without losing track of the whole. We have argued that what is still missing in the discourse on musical affordances is an encompassing theoretical framework incorporating the sociocultural dimensions that are fundamental to the situatedness and embodiment of interactive music performance. This would be facilitating a detailed account of the underlying mechanisms, but also providing a more holistic approach that does not lose track of the complex whole constituted by the interaction of composers, performers, audience, technologies, etc. We believe that Ramstead et al.'s *cultural affordances* framework, drawing upon the work by Rietveld and Kiverstein (2014), although not previously applied to music, constitutes a promising starting point for capturing and elucidating this complex web of relationships. Furthermore, by providing insights into the underlying mechanisms, it also facilitates new ways of considering the process towards new musical works as well as the performance situation as such. We hope to have illustrated this in this paper, at least to some degree, with examples from the first author's artistic work as composer and performer of *mixed works*, where a combination of acoustic sound sources (singers) and digital sound sources (responsive computer technologies) perform together live.

To begin with, Ramstead et al (2016) put forward, echoing Rietveld and Kiverstein (2014), that an ecological niche equals a landscape of affordances. "The total ensemble of available affordances for a population in a given environment. This landscape corresponds to what evolutionary theorists in biology and anthropology call a 'niche'" (Ramstead et al, 2016, p. 3). We then learn how a niche: "

[...] in the case of humans, the social world [is]—associated with (and partly constituted by) a form of life” (ibid, p. 5). We also learn that: “Different human communities, societies, and cultures, with sometimes strikingly different styles of engagement with the material and social world, constitute different forms of life.”

Hence, the consequence of what they are saying is, different forms of life entail different landscapes of affordances. Furthermore they describe how there is also a strong influence on available affordances in a niche from “local ontologies”, i.e. collective expectations, installed through specific ways of doing joint activities in domain-specific material-discursive environments (patterned practices). They write: “[...] these ontologies codetermine the exact affordances that are available in a given niche, for they prescribe certain ways of being, thinking perceiving and acting in context that are situationally appropriate” (ibid, p 14). So, local ontologies also influence affordances available in a niche, i.e. the landscape.

In our analysis, we have seen the need for a way to describe these arenas of a landscape of affordances where local ontologies derived from social niches and cultural practices have shaped a community as part of a landscape. Reading Ramstead et al (2016) closely, they also seem to be grasping for this level of analysis:

“Our claim here is that cultural affordances (especially conventional ones) form a coordinated affordance landscape, which is enabled by sets of embodied expectations that are shared by a given community or culture. Social niches and cultural practices generally involve not isolated, individual affordances or expectations but *local landscapes* that give rise to and depend on shared expectations. We submit that these shared expectations—implemented in the predictive hierarchies, embodied in material culture, and enacted in patterned practices—contribute to the constitution of the landscape of affordances that characterizes a given community or culture” (Ibid, p.14 our emphasis).

Kiverstein and Rietveld (2015) write: “The human landscape of affordances is one that is tightly interwoven with both material aspects and social and cultural practices *local to different regions of this landscape*” (ibid, p. 712 our emphasis).

We interpret this as a common reaching for an intermediate level between landscape and field, a “local landscape” in the words of Ramstead et al, or a “region of the landscape” in the words of Kiverstein and Rietveld (2015). In a similar vein, Kiverstein and Rietveld (ibid) touch upon how a landscape of affordances relies on possibilities for action available in a particular form of life, because of the patterned and coordinated activities in which members of this form of life are able to partake in. We see a need for this level constituted by clustered fields, *an arena of affordances*, for example when discussing performers identifying with different genres, stemming from different sociocultural background, i.e. different formal training, different repertoire knowledge, different ideals and expectations, and familiarity with different institutions and patterned practices associated with these. These differences are distinct and relatively stable, although not as distinct we would claim as to call them different forms of life, i.e. different landscapes. We therefore advocate an addition to the framework in terms of an intermediate level, an arena of affordances, meaning clustered fields of affordances determined by shared local ontologies and social and cultural practices, as part of the landscape of affordances.

Hence, what this paper contributes to the understanding of music as embodied and situated activity, we believe, is the presentation and illustration of a theoretical framework centered on affordances, yet a broader notion of affordances than previously discussed in the musical context. We argue that this is more suitable for capturing the social and cultural aspects that are central to musical performances, while also not losing track of their embodied nature. In our opinion, the crucial departure from the original Gibsonian notion of affordances, and many later variations and interpretations thereof, lies in the position that it is the *situation as whole that has affordances*. This also sheds new light, as discussed in detail in the previous section, on musical composition as a process of construction – and embodied mental simulation – of situations, guiding the performers' and audience's attention in shifting fields of affordances.

Finally, what this paper contributes to the research topic “*Beyond Embodied Cognition*”, is an illustration – using the case of interactive music – of how seemingly highly abstract, disembodied and unsituated activities, such as the composition of musical works, can in fact be strongly grounded in concrete embodied and situated activity. Hence, the contribution to the cognitive sciences in general, beyond the specific application to interactive music, lies in the formulation, discussion and illustration of a significantly broader notion of affordances as *aspects of situations*, building on the recent work of Rietveld and Kiverstein (2014) and later Ramstead et al. (2016) on cultural affordances. The distinction between a population's relatively static landscape of affordances and individuals' dynamically varying fields of affordances, is also in line with recent work on the neural and cognitive mechanisms underlying affordances, which indicates that affordance perception is less direct, more context- and goal-dependent than Gibson thought 40–50 years ago (Thill et al., 2012), and that there are separate brain pathways for stable and variable affordances (Sakreida et al. 2016). The question of what exactly constitutes a situation is of course not trivial – that discussion goes back to at least Dewey (1938) and Russell (1939), and is beyond the scope of this paper. However, we believe that the theoretical perspectives and concrete examples discussed in this paper help to elucidate how situations – and with them affordances – are dynamically constructed through the interactions of biological, contextual, social and cultural mechanisms as embodied and situated activity unfolds.

5. CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

6. AUTHOR CONTRIBUTIONS

The work reported here is part of AE's doctoral research, for which TZ has been the main supervisor. Accordingly, most of the text has been written by AE, and much of the material comes from her artistic work as well as her doctoral dissertation. TZ has contributed to framing the discussion from a cognitive science perspective.

7. FUNDING

AE was funded in part by the Swedish National Artistic Research School (*Konstnärliga forskarskolan*). TZ's research is supported in part by the Knowledge Foundation, Stockholm, under the AIR grant (SIDUS grant agreement no. 20140220) and in part by ELLIIT, the Excellence Center at Linköping-Lund in Information Technology.

8. ACKNOWLEDGMENTS

The authors would like to thank Per Mårtensson, Royal College of Music, Stockholm, for many comments on the first author's doctoral dissertation drafts, which have indirectly also contributed to this paper.

9. REFERENCES

- Barrett, E., & Bolt, B. (2013). *Carnal knowledge: towards a 'new materialism' through the arts*. Ib tauris.
- Berg, J., Jullander, S., Sundkvist, P., & Kjekshus, H. (2016, May). The Influence of Room Acoustics on Musical Performance and Interpretation—A Pilot Study. In *Audio Engineering Society Convention 140*. Audio Engineering Society.
- Broadhurst, S., & Machon, J. (2011). Performance and Technology. *Practices of Virtual Embodiment and Interactivity*. New York.
- Bruineberg, J., & Rietveld, E. (2014). Self-organization, free energy minimization, and optimal grip on a field of affordances. *Frontiers in Human Neuroscience*, 8.
- Chemero, A. (2006). Information and direct perception: A new approach. In: P. Farias and J. Queiroz (Eds.), *Advanced Issues in Cognitive Science and Semiotics* (pp. 55-72). Aachen: Shaker Verlag.
- Chemero, A. (2009). *Radical embodied cognitive science*. Cambridge, Mass.: MIT Press.
- Clark, A., & Chalmers, D. (1998). The extended mind. *analysis*, 58(1), 7-19.
- Clarke, E.F. (2005). *Ways of listening: an ecological approach to the perception of musical meaning*. New York, N.Y.: Oxford University Press.
- Damasio, A. R. (1994). *Descartes' error: emotion, reason and the human brain*. London: Picador.
- Davis, J. L., & Chouinard, J. B. (2017). Theorizing Affordances: From Request to Refuse. *Bulletin of Science, Technology & Society*, 0270467617714944.
- Dewey, H. (1938). *Logic: The Theory of Inquiry*. Holt, Rinehart and Winston, New York.
- Dotov, D. G., Nie, L., & De Wit, M. M. (2012). Understanding affordances: history and contemporary development of Gibson's central concept. *Avant: the Journal of the Philosophical-Interdisciplinary Vanguard*.
- Einarsson, A. (2012). *PS. I will be home soon!* [Score]. Svensk Musik: Stockholm
- Einarsson, A. (2015). *Metamorphoses*. [Video recording]. <http://www.annaearsson.com/#video>
- Einarsson, A. (2015). *One piece of a shared space*. [Video recording]. Retrieved from <http://www.annaearsson.com/#video>.
- Einarsson, A., & Friberg, A. (2015). Using Singing Voice Vibrato as a Control Parameter in a Chamber Oper. In *ICMC 2015-Sept. 25-Oct. 1, 2015-CEMI, University of North Texas, USA*.
- Einarsson, A. (2017). Experiencing responsive technology in a mixed work: Interactive music as embodied and situated activity. *Organised Sound*, in press.
- Emmerson, S. (2007). *Living electronic music*. Aldershot, Hants, England: Ashgate.
- Frisk, H., & Östersjö, S. (2006). Negotiating the Musical Work: An empirical study. In *ICMC*.

- Fodor, J. A., & Pylyshyn, Z. W. (1981). How direct is visual perception? Some reflections on Gibson's "ecological approach". *Cognition*, 9(2), 139-196.
- Gaver, W. W. (1991). Technology affordances. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 79-84). ACM.
- Gaver, W.W. 1993a. "How do we hear in the world? Explorations of ecological acoustics". *Ecological Psychology*, 5, 4, pp. 285-313.
- Geeves, A., & Sutton, J. (2014). Embodied cognition, perception, and performance in music. *Empirical Musicology Review*, 9(3-4), 247-253.
- Gibson, J.J. (1982). Reasons for realism. In Reed, E., & Jones, R. (Eds.), *Selected Essays of James J. Gibson*. Hillsdale, NJ: LEA Publishers.
- Gibson, J.J. (1986). *The ecological approach to visual perception*. Hillsdale, N.J.: Lawrence Erlbaum Associates.
- Hutchins, E. (1995). *Cognition in the Wild*. Cambridge, MA: MIT press.
- Johnson, M. (2007). *The Meaning of the Body: Aesthetics of Human Understanding*. University of Chicago Press, 2007.
- Jonas, H. (2001 [1966]). *The Phenomenon of Life. Toward a Philosophical Biology*. Place, IL: Northwestern University Press. And especially 'the nobility of sight'.
- Kaufer, S., & Chemero, A. (2015). *Phenomenology: an introduction*. John Wiley & Sons.
- Kiverstein, J., & Rietveld, E. (2015). The primacy of skilled intentionality: on Hutto & Satne's the natural origins of content. *Philosophia*, 43(3), 701-721.
- Kozel, S. (2007). *Closer: performance, technologies, phenomenology*. MIT Press.
- Krueger, J. (2014). Affordances and the musically extended mind. *Frontiers in psychology*, 4, 1003.
- Krueger, J. W. (2011). Doing things with music. *Phenomenology and the Cognitive Sciences*, 10(1), 1-22.
- Leman, M. (2007). *Embodied music cognition and mediation technology*. Cambridge, Mass.: MIT.
- Leman, M., Maes, P.J. (2014). The role of embodiment in the perception of music. *Empirical Musicology Review*, 9(3-4), 236-246.
- Lowe, R., & Ziemke, T. (2011). The feeling of action tendencies: On the emotional regulation of goal-directed behavior. *Frontiers in Psychology*, 2:346, doi: 10.3389/fpsyg.2011.00346.
- Menin, D., & Schiavio, A. (2012). Rethinking musical affordances. *AVANT. Pismo Awangardy Filozoficzno-Naukowej*, (2), 202-215.
- Molnar-Szakacs, I., & Overy, K. (2006). Music and mirror neurons: from motion to 'e' motion. *Social cognitive and affective neuroscience*, 1(3), 235-241.
- Osiurak, F., Rossetti, Y. & Badetse, A. (2017). What is an affordance? 40 years later. *Neuroscience & Biobehavioral Reviews*, 77, 403-417.
- Pelinski, R. (2005). Embodiment and musical experience. *Trans. Revista Transcultural de Música*, (9), 0.
- Peters, D., Eckel, G., & Dorschel, A. (Eds.). (2012). *Bodily expression in electronic music: perspectives on reclaiming performativity*. Routledge.

- Ramstead, M. J., Veissière, S. P., & Kirmayer, L. J. (2016). Cultural affordances: scaffolding local worlds through shared intentionality and regimes of attention. *Frontiers in Psychology*, 7:1090. doi:10.3389/fpsyg.2016.01090.
- Rietveld, E. & Kiverstein, J. (2014). A rich landscape of affordances. *Ecol. Psychol.* 26, 325-352. doi: 10.1080/10407413.2014.958035
- Russell, B. 1939. Dewey's New Logic. In: *The Philosophy of John Dewey*, ed. P. A. Schilpp, 1:137-156. Evanston, Ill., and Chicago: Northwestern University Press.
- Sakreida, K., Efnert, I., Thill, S., Menz, M., Jirak, D., Eickhoff, C., Ziemke, T., Eickhoff, S., Borghi, A., & Binkofski, F. (2016). Affordance processing in segregated parieto-frontal dorsal stream sub-pathways. *Neuroscience & Biobehavioral Reviews*, 69, 89-112.
- Sanders, J. T. (1997). An ontology of affordances. *Ecological Psychology*, 9(1), 97-112.
- Shapiro, L. (2011). *Embodied Cognition*. New York: Routledge Press.
- Shaw, R., Turvey, M. T., & Mace, W. (1982). Ecological psychology: The consequence of a commitment to realism. *Cognition and the symbolic processes*, 2, 159-226.
- Small, C. (1998). *Musicking: the meanings of performing and listening*. Hanover, NH: Univ. Press of New England.
- Thill, S., Caligiore, D., Borghi, AM., Ziemke, T., & Baldassarre, G. (2013). Theories and computational models of affordance and mirror systems: an integrative review. *Neuroscience & Biobehavioral Reviews*. 37(3), 491-521. doi: 10.1016/j.neubiorev.2013.01.012.
- Turvey, M., Shaw, R., Reed, E., and Mace, W. 1981. "Ecological laws of perceiving and acting: In reply to Fodor and Pylyshyn". *Cognition* 9: 237-304.
- Vaggione, H. (2001). Some ontological remarks about music composition processes. *Computer Music Journal*, 25(1), 54-61.
- Varela, F.J., Thompson, E. & Rosch, E. (1991). *The embodied mind: cognitive science and human experience*. Cambridge: MIT Press.
- Warren, W. H. (1984). Perceiving affordances: visual guidance of stair climbing. *Journal of experimental psychology: Human perception and performance*, 10(5), 683.
- Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625-636.
- Windsor, L. (2000). Through and around the acousmatic: the interpretation of electroacoustic sounds. In Emmerson, S (Ed.), *Music, electronic media and culture*. Routledge.
- Windsor, W. L. (1995). *A perceptual approach to the description and analysis of acousmatic music* (Doctoral dissertation, City University London).
- Windsor, W. L., & De Bézenac, C. (2012). Music and affordances. *Musicae scientiae*, 16(1), 102-120.
- Withagen, R., de Poel, H. J., Araújo, D., & Pepping, G. J. (2012). Affordances can invite behavior: Reconsidering the relationship between affordances and agency. *New Ideas in Psychology*, 30(2), 250-258.
- Ziemke, T. (2016). The body of knowledge: On the role of the living body in grounding embodied cognition. *BioSystems*, 148, 4-11.



Anna Einarsson (1978) is a Swedish performer and composer. She began her career as a vocalist at the age of 13, performing her own songs at local clubs and venues. She received her formal training as vocalist and composer at the Royal College of Music in Stockholm and at de Montford University in Leicester, England. Her artistic contributions span from works for orchestra, choir, and opera to jazz. She has released six albums with her own music.



LUND
UNIVERSITY

KMH
Royal College
of Music
Stockholm