

Karette Stensæth (Ed.)

Music, Health,
Technology and Design



**Norges
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Music, Health, Technology and Design

Karette Stensæth (Ed.)

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Contents

Foreword <i>Natasha Barrett</i>	<i>i</i>
Editor's foreword	<i>vii</i>
Designing four generations of 'Musicking Tangibles' <i>Birgitta Cappelen and Anders-Petter Andersson</i>	<i>1</i>
Vocal and tangible interaction in RHYME <i>Anders-Petter Andersson and Birgitta Cappelen</i>	<i>21</i>
An interactive technology for health: New possibilities for the field of music and health and for music therapy? A case study of two children with disabilities playing with 'ORFI' <i>Karette Stensæth and Even Ruud</i>	<i>39</i>
Potentials and challenges in interactive and musical collaborations involving children with disparate disabilities A comparison study of how Petronella, with Down syndrome, and Dylan, with autism, interact with the musical and interactive tangible 'WAVE' <i>Karette Stensæth</i>	<i>67</i>
'Come sing, dance and relax with me!' Exploring interactive 'health musicking' between a girl with disabilities and her family playing with 'REFLECT' (A case study) <i>Karette Stensæth</i>	<i>97</i>
'FIELD AND AGENT': Health and characteristic dualities in the co-creative, interactive and musical tangibles in the RHYME project <i>Ingelill Eide</i>	<i>119</i>
Health affordances of the RHYME artefacts <i>Even Ruud</i>	<i>141</i>

PARTICIPATION: A combined perspective on the concept from the fields of informatics and music and health	157
<i>Karette Stensæth, Harald Holone, and Jo Herstad</i>	
From experimental music technology to clinical tool	187
<i>Alexander Refsum Jensenius</i>	
Technology and clinical improvisation – from production and playback to analysis and interpretation	209
<i>Jaakko Erkkilä, Esa Ala-Ruona, and Olivier Lartillot</i>	
Using electronic and digital technologies in music therapy: the implications of gender and age for therapists and the people with whom they work	227
<i>Wendy L. Magee</i>	
Author information	243

Foreword

Natasha Barrett

Introduction

Technology has, over the past decades, yielded new ways to creatively explore sound and music, to interact with computers and to engage in social interaction. The change from analogue (device-determined) to digital (program-determined) created a major shift in the interaction paradigm, touching all areas of everyday life. Likewise, the analysis of, and critical reflection on, the use of digital music technology has advanced at a similar pace, feeding into developers' methodologies. It is hardly surprising that professionals and users across different fields are excited to explore that which materialises when they bring together their skills. The anthology 'Music, Health, Technology and Design.' collects articles from a set of international research projects but the most from the national interdisciplinary RHYME project where professionals, children, parents and caregivers have collaborated. In this project they have investigated what interactive sound and media technologies, that integrate hearing, sight, touch and physicality, can bestow upon the health and wellbeing of children with severe disabilities and developmental disorders.

When considering the articles as a collection, a number of universal threads can be traced: affordance, transparency, collaboration, appropriation and design needs in terms of system, interaction and relevance. The essence of these threads is discussed in the following.

Affordance

Evaluating RHYME's qualitative research projects, with absolute criteria, is far from easy. As an analysis tool, many of the articles draw on the idea of 'affordance', from Gibson's ecological theory, as a means to map the appropriateness of the interactive objects within their complex settings. In Gibson's theory, rather than regarding perception as a constructive process, affordance emphasises the structure of the environment itself, where users take in already structured perceptual information. In RHYME's context, affordance is used to analyse the significance of the artefacts, their attributes and the abilities of the participants, mapping the health benefits afforded by the integration of technologies and interactive frameworks. Eide broadens this analysis tool to encompass concepts of field and agent, contrasting

what the interactive objects provide against what they do. She proposes that this approach facilitates an easier analysis of the relationships between the physical environment in which the interaction takes place and the participants in the interaction.

Many features of this highly structured environment can be considered as 'natural' and 'familiar' – gravity, light, colour, texture, the coupling of sound with vibration – creating the feeling of safety to a newcomer in the system. Yet as we will see below, affordances are yielded by what may initially appear the less familiar territory of technological interaction. When affordances are mediated through an embodied participation in the world, technologies are characterised by more than functionality alone. To illustrate via an abstraction, we can draw on Bachelard's description of 'felicitous' objects or places. He explains why humans can be emotionally moved by felicitous objects and places, which in turn can be said to reverberate atmospheres in ways that capture human imagination. They attract us because they have become topographies of our intimate being. As such, they 'speak a language' that enters in resonance with felt human aspirations (Bachelard 1964, ix).

Transparency

In our current age, technology is transparent. Mobile, wireless, miniature computers serve our media needs and contextualise us in a network of interactive potential without our needing to know anything about the complexity of their design. The success of ubiquitous technology involves, amongst other things, an integration of hardware, software, content and applicability. 'Wirelessness', miniaturisation and affordability are all important contributors in terms of hardware, bringing with them sensations of movement, change and proximity into a technology rich landscape of experience. In RHYME, success of the CCTs (co-creative tangibles) is likewise by virtue of these elements.

In developing a structure, system and content, serving tangible interaction and responding to societal challenges and individuals' needs, collaboration and design iteration are essential. To give an example, one of the many developments resulting from this approach involved moving the sound source closer to the place of interaction: transparent and technically realisable through the miniaturisation of affordable technology. An individual working alone may easily overlook how this simple semblance to both acoustic instruments and living objects that can enrich the tangible experience.

Appropriation

Collaborative design invariably involves the appropriation of ideas, aesthetics and technologies from other disciplines. Jensenius' paper presents a good example. His work involved designing a set of video-based visualisation techniques for the analysis of music-related body motion. Initially intended for the study of music and dance performances, the tools were appropriated for laboratory experiments on ADHD and clinical studies of CP. What was it that promoted this transfer of technology from music and dance to medicine? Simplicity, accessibility and flexibility are key, and as Jensenius says, "...a lot of the motion-capture solutions... are either too advanced or targeted at specific applications". Unlike expensive, fixed installation motion-capture systems requiring specialised user knowledge, Jensenius' video system utilises a normal laptop computer, cheap video technology and straightforward image processing. No specialised skills are needed to produce a time-based motion information visualisation. This representation, which we can view as the neutral object in Nattiez's semiological tripartition (Nattiez, 1990), is then available for analysis by professionals with specialised medical knowledge. Collaboration is key in appropriation: lacking a priori knowledge, the neutral object does not function without input from the expertise of the clinicians.

System, Interaction and Relevance

As a tangible object, ORFI is described as both instrument and toy, containing bend sensors that generate light, sound and image. The technology is straightforward. The challenge is in implementing an appropriate interactive system and content. Andersson points out that although direct response gives clear feedback, such methods are less good for users with strong disabilities: if you are unable to accurately press a button, then you will be unable to interact with the system despite its apparent simplicity. In interviews it became apparent that to avoid leaving the child in isolation the CCTs should 'afford' action. Considering these needs, it is clear that content, system and response structure are central considerations for many of the authors. A simple action may result in an immediate and clearly correlated response, or the response may be dislocated, implying a holistic view to the behavioural interaction between user and system. Andersson and Cappelen note that they structure ORFI's software and musical compositions using three layers: sound nodes, compositional rules and narrative structure. They explain their aim to be a balance between absolute cause-effect and playful, or surprising responses from the CCTs. The authors suggest that the narrative structure may also create

expectations, not all of which will be satisfied, occasioning further intervention in turn. Here we enter a symbolic level involving time and memory, where interaction does not need to be directly connected to real-time audio. Symbolic approaches to computer-aided composition, music representation and musical interaction have been established practice for decades, and could be a wealthy source of appropriation when further exploring symbolic level possibilities in a music and health context.

Interviews with family members stress the importance of 'having things at home that inspire them to interact and have fun together'. One of the many challenges discussed through the articles is how a CCT may function, on simultaneous levels, for co-creators of different ages and abilities to mutually interact. Whether concerned with one-way interaction, such as mimicry, or two-way processes, where both sides influence the next action, by designing a layered meta-structure users can 'create' without need for refined techniques, yet explore in greater depth as their interactive skills develop. Realising a layered meta-structure appealing to simultaneous users of different interests, needs and abilities is a challenge. From my own experience as a composer of interactive sound installations and music performances, I observe that people inevitably find the interactive experience stimulating in ways appropriate to their personal interests, understanding and curiosity, where system and content are key. Putting technology to one side and considering content provides a starting point. For a somewhat amusing example I can reflect on my own childhood and experience as mother. Certain cartoons that were funny for me as a child are still hilarious to me as an adult. Simple comedy, appealing to a child, is combined with fast associations and connotations creating jokes appealing to teenagers and adults. Child and parent can watch the same show and both truly laugh!

The needs of a child and their family may change from moment to moment as well as develop over shorter and longer time-spans. CCTs cannot continuously be removed from the environment for redesign and reprogramming. If we look to the future, they need to adapt to these changing circumstances without the need for professional assistance. Interactive technologies are however tending to integrate intelligent emergent systems that learn through interaction and dynamically develop over time. Already, sophisticated social robots with cameras for eyes can study an infant over periods of time to detect signs of autism spectrum disorders, as well as be an educational tool and companion. Other robots are designed specifically to help children with autism learn how to coordinate their attention with other people and objects in their environment. We can easily speculate how the possibilities offered by intelligent emergent systems will further the advancement

of interactive tools within health related contexts. In the two-way interaction between child and digital agents, the system learns through doing, tailoring its behaviour specifically to each child's changing needs. In terms of sound and music it is here important to remember that the direct connection between touch and acoustic resonance is not necessarily a linear process: vibration and sound are logically entwined in terms of tactile and auditory perception, yet when sound changes its *behaviour* through time, it takes on characteristics of an intelligent companion. Meaningful information extracted from audio signals, which in computer music is termed 'machine listening', can be used as input for the emergent system.

The subjects in the RHYME project each present unique needs. Are there universal concepts to guide the design process? The authors continuously return to this, and other questions, through analysis, interviews and discussions.

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Editor's foreword

Typical for today's information society is our use of interactive and digital media. In almost any situation, whether we are on the bus, on the street, in the café, or at home, we have a digital device of some sort close at hand. It is generally easy to pick up and fascinating to use, and with simply the touch of a fingertip on the screen, we can connect, chat, and otherwise interact with friends, family, or anyone at all. If we want to lock out the physical world around us, we can plug in our ear-phones, close our eyes, and listen to music from our self-made playlists. Who could have imagined such possibilities even ten to fifteen years ago?

Clinical psychologist Sherry Turkle says that our digital era, and especially our social networks, changes not only what we do but also who we are. In her book *Alone Together*, she argues that technology appeals to us most where we are most vulnerable in terms of our need to belong, and to feel part of something bigger. However, she continues, because digital media create an illusion of companionship without the actual presence (and demands) of it, they in fact offer only a new form of isolation. While this may be true, if we cannot go backward, we might as well look ahead. How can technology become a means of inclusion instead? How can we develop and design technology that hinders the spread of digitally enabled isolation and instead fosters new ways of participating in the digital society for everyone, including those who are illiterate, handicapped, or simply unwilling or unable to adapt to the digital world? In the context of the interactive and musical potentials that are built into this kind of media, it is also relevant to ask another question: How can we develop the technology to improve health and well-being through musical-technological means for all of us?

The present volume, which is the eighth anthology published in this Series by the Centre for Music and Health at the Norwegian Academy of Music, presents a compilation of articles that explore the many intersections among music, health, technology, and design. These studies all engage with the use, development, and design of interactive and digital media for the potential health benefit of users with some kind of physical or mental needs. They also share a notion of health in a prophylactic and preventive sense, as something that can be maintained continuously through meaningful and life-fulfilling activities, both by oneself and with others and with technological media.

The book is divided into two parts. The first and larger part includes articles deriving from the on-going Norwegian multidisciplinary qualitative research project called RHYME. The second part includes articles from a selection of

well-known international researchers in the field of music, technology, and health. I will begin this introduction by presenting the RHYME project.

The Research Council of Norway finances the RHYME project through the VERDIKT program for a research period that extends from 2010 through 2015. The project is still in its final test rounds as this book is being published. The research team embodies collaboration among the fields of interaction design, tangible interaction, industrial design, universal design, and music and health, with individuals from the Department of Design, Oslo School of Architecture and Design, the Department of Informatics, University of Oslo, and the Centre for Music and Health, Norwegian Academy of Music. In essence, the RHYME project explores ways in which families that include people with or without disabilities might experience the act of creating something together through the use of things whose design integrates interactive information technology. The project fosters a new treatment paradigm based on collaborative and interactive net-based musical 'smart things' with multimedia capabilities, situated within a broad perspective on health. These things, which are tangible and evoke both pillows and toys, are called 'co-creative tangibles' (CCTs). At the outset, the overall agenda of the RHYME project was to develop three generations of prototypes focused on different communication situations:

- 1) A tangible multimedia solution to facilitate communication, collaboration and co-creation between two people that would focus on the tangible, visual and auditive qualities of the multimodal user interface and especially the ways in which it might be designed to motivate collaboration over an extended period.
- 2) A tangible mobile multimedia solution for communication, collaboration and co-creation in social networks that would focus on the social-networking aspects of a mobile user interface and services and especially the ways in which it be designed to motivate multiple individuals to play and collaborate in the same physical space over an extended period.
- 3) Tangible distributed communication, collaboration and co-creation that would focus on the qualities of distributed multimodal user interfaces and the ways in which design might be made to motivate multiple individuals to play and collaborate over an extended period while separated in time and/or space.

Through processes based upon action research, a large amount of data from the test periods, including video clips, logs, interviews, and questionnaires, has been gathered in RHYME. Based on these sources of information, new prototypes of CCTs were developed. The reader can learn about the project on the project's web site at www.rhyme.no created by Birgitta Cappelen.

Birgitta Cappelen is also the designer of the musical and interactive tangibles, and together with Anders-Petter Andersson, the sound designer, they describe the design process and the development of the four generations of the CCTs in this anthology's first article. Based on their experiences they suggest their notion, 'Musicking Tangibles', to be both an approach in RHYME and a novel perspective. According to them, the concept of Musicking Tangibles combines a humanistic, resource and empowerment oriented health approach with an aesthetic and culture based design approach towards music technology. This way Musicking Tangibles creates an arena where there is no right or wrong actions.

During the RHYME experiments it was evident that the possibilities to explore their voice through the microphone was of special interest for the children with disabilities. In their next article, Anders-Petter Andersson and Birgitta Cappelen describe the various vocal and tangible interactions in RHYME. They refer to music therapy theories and combine these with knowledge from multi-sensory stimulation. They also adopt vocal composition and improvisation techniques from music therapy, with the goal to inform their own design practices in the field of Interaction Design, Assistive Technologies, Musicology and Interactive Sound Design.

Even Ruud and I, as the editor, represent the Centre for Music and Health at the Norwegian Academy of Music in the RHYME project.¹ Together with Ingelill Eide, we contributed articles that discuss the following music- and health-oriented question: How do the participating children and/or their family members and close others relate to and interact with interactive and musical CCTs, and in what ways might their interaction become potentially health promoting for them? This question goes to the heart of the RHYME project in attempting to ascertain whether the CCTs can motivate participants to engage in active play and co-creation. As stated in RHYME's project description, the vision is that the CCTs, by expanding the possibilities for communication, help individuals to improve their health, sense of well-being and life quality, and at the same time reduce passivity and isolation.²

1 The fact that I hold a postdoctoral position in RHYME and am responsible for the gathering and evaluation of the data explains why my authorship is represented in several articles here.

2 The RHYME articles in the present volume are coordinated among one another, but because each will also be accessible online eventually, I have chosen to reintroduce information about the RHYME project. These article sections are marked as 'similar' in the footnotes.

This vision is approached from a music and health perspective in the following empirical and theoretical articles in the RHYME section of this anthology.

The article written by Karette Stensæth and Even Ruud is an extended discussion of the empirical, theoretical and methodological aspects of the first RHYME experiments (which we have called 'actions') in 2011. These actions involved CCTs named ORFI, which included a set of twenty pyramid-shaped objects that looked like toys and/or pillows. Many of the users called them 'the fun orange and black pillows'. To begin a microanalysis of a selection of video samples of two children with rather different disabilities, Stensæth and Ruud ask: How do 'Ulla' and 'Frode' relate to and interact with ORFI, and in what ways can their interaction become potentially health promoting? How could music therapy profit from interactive technology of health?

The point of departure in the following article, written by Stensæth is the testing of the CCTs known as the WAVE in 2012, which offers many cross-media possibilities for interaction and was developed on the basis of the ORFI evaluation the year before. To respond to some of the requests that emerged during the ORFI actions, the WAVE designers built in a microphone and a camera. This article focuses on these new elements via the experiences of two children with disparate disabilities, an active girl named 'Petronella' who loves the microphone and a more passive boy named 'Dylan' who loves the camera. This study's data collection includes a video analysis triangulated with a focus interview conducted with a group of professional experts to elicit their observations regarding the video footage. The research question is as follows: Why do the two children relate so differently to the same musical and interactive CCT, and what would facilitate the most meaningful and health-promoting co-creation experience for each of them?

The next article, which is also empirical and also written by Stensæth, is a case study that looks at how a lively girl with Down syndrome, together with her mother, father and grandmother, experiences the CCTs known as REFLECT, which was developed for the RHYME tests in 2013. Once again different from its predecessors, ORFI and WAVE, REFLECT has RFID tags, a type of technology that requires that participants scan one CCT onto another to activate the music through the RFID reader. Data were recorded via video observations of the family while they explored REFLECT, and an interview was done with the family immediately following their second experience with the platform. The question Stensæth asks is as follows: How does one family experience REFLECT, and how might their musicking with REFLECT potentially enhance their quality of life?

Ingelill Eide, who has also written her master's thesis in music therapy on RHYME, takes Umberto Eco's aesthetic ideal of the *Open work*, as well as his

concept of the *Field of possibilities*, as her operative analytical models in the next article. She explores how a group of users activates certain types of dualities inherent in the CCTs in their co-creation with the musical and interactive media, including object/agent, predictable/unpredictable, structured/unstructured, and field/agent. Eide finds that the activation of these dualities is vitalizing for the users and can in turn be framed in relation to health. She draws upon a qualitative research design with structured analysis and five semi-structured interviews with the close others who assisted the children to answer her research question: Can Eco's concept of a Field of possibilities explain the dualities found in the CCTs developed in the RHYME project, and if so, how does it affect our understanding of co-creation as vitalizing and health promoting?

Even Ruud, presents a theoretical exploration of the health affordances of the RHYME artefacts in response to the following questions in the following article: To what extent can the RHYME project be seen within the theoretical framework of cultural psychology? How might concepts like 'artefact' and 'affordance' prove helpful to our understanding of the health benefits of the musical co-creative tangibles? He concludes that if we regard the CCTs in RHYME as artefacts, whether material or ideal, we come to appreciate the ways in which the aesthetic aspects of their design features, as well as the programming code of their interactive music, are novel scripts that inform our existing schemas for such 'musical objects'. Another question that derives from his discussion is as follows: Can interactive and musical media such as those in RHYME broaden our understanding of how we can promote health through music?

The research team for RHYME has also realized that words and concepts are interpreted differently in different fields. In the next article, Stensæth, together with Harald Holone and Jo Herstad, takes an interdisciplinary stance to elaborate upon the central project notion of *participation*. They address the following research questions: How is participation described in the disciplines of informatics and music and health, and what does participation imply in the RHYME project? To promote some common ground here, they also ask the following: How does the focus on user participation in the RHYME prototype evaluations differ for informatics researchers and for health and music researchers, and with regard to participation, what can the fields of music and health and informatics learn from one another?

The other part of this anthology is devoted to research projects other than RHYME. Alexander R. Jensenius, a Norwegian music researcher and research musician working in the fields of embodied music cognition and new interfaces for musical expression, discusses a set of video-based visualization techniques that he has developed for the analysis of music-related body motion. He describes how

these techniques have been used in studies of music and dance performances, and how they have unexpectedly proven useful in laboratory experiments for the documentation of the diagnosis of attention-deficit/hyperactivity disorder and clinical studies of cerebral palsy.

In the next article, Jaakko Erkkilä, Esa Ala-Ruona, and Olivier Lartillot, three prominent Finnish researchers in the areas of music therapy and music technology, discuss the use of technology in clinical improvisation. They elaborate upon a process that ranges from production and playback to analysis and interpretation. They also present the music therapy toolbox (MTTB), which was created at the University of Jyväskylä, Finland, for the purpose of computational music therapy improvisation analysis in the context of a research project called 'Intelligent Music Systems in Music Therapy' funded by the Academy of Finland. Aside from providing updated insights into processes that involve modern technology in the field of music therapy, this article usefully illustrates some of the ways in which music technology can be utilized in everyday clinical practice.

Lastly, another prominent researcher in music therapy, Wendy L. Magee from the United Kingdom, who recently edited a book on music technology in therapy and health settings, has contributed an article on gender and age aspects of technology and music (therapy). Magee uses a narrative style to look at the impact of these factors on music therapists and the people with whom they work. She finds that age and/or gender can impact upon the 'comfort' factor for both client and therapist, as may other factors, such as ethnicity, cultural background and socio-economic wealth. Magee's article returns to Turkle's critical question: How can we keep technology from becoming another experience of exclusion?

One could question where we go from here. In another anthology from the same series as this one, Edvin Schei (2009, p. 10) notes how important it is to remember that machines do not break if they lack beauty, recognition and self-expression, people do! I have learned from my participation in RHYME and from editing this anthology that technology appears to be valuable for inclusion, human interaction and health promotion. In some cases the technological medium can even emerge as an ecological tool – one that supports the individual human being in 'becoming one's fullest potential for individual and ecological wholeness' (Bruscia, 1998, p. 84). For this to happen, however, we must be utterly aware of *how* and *why* we relate to the medium in whatever way we do. Along those lines, one of the participants in RHYME commented, 'Ideally, the CCTs, to allow for meaningful co-creation, should have some of the same qualities as a good close other'. We might then wonder whether it is the *flexibility* that close others demonstrate when they co-create with children with disabilities that facilitates meaningful activities

and promotes a healthy interaction? Likewise, can we bring that flexibility to our devices? A mother who was involved in the project also pointed out, 'We need things to do at home, together – things that are meaningful for all of us, over time!' This is harder than it sounds, but it is my devout hope that the articles collected in this volume begin to trace the ways in which technology, properly harnessed and adapted – properly flexible – can contribute in that regard. Who knows, perhaps our future home environments will have musical and interactive media that can operate as agents of health promoting co-creation? For this to happen, I believe the design must be universal to include the needs of all of us. I also believe it is of major significance that people across disciplines and schools of thoughts talk together to approach a common ground of understanding.

I wish to acknowledge the institutions and people who contributed to the realization of this anthology, and in the RHYME project more generally. I am grateful to the Norwegian Research Council and their VERDIKT program for supporting the RHYME project financially, and to the Norwegian Academy of Music for their positive attitude toward RHYME and this publication. I especially thank Kjetil Solvik, head of academic affairs at the academy, whose gentle guiding hand is everywhere evident in the research process and my role in the project and publication. Thanks also to Anders Eggen and Tore Simonsen for their constructive helping with the publication process. I hasten to thank the working group at the Centre for Music and Health as well – Lars Ole Bonde, Even Ruud, Gro Trondalen, and Tone S. Kvamme – whose cooperation and support was always freely given and utterly appreciated. A special warm thank to Gary Ansdell for his wise counsel during the RHYME experiments and in meetings afterward as I worked on this anthology. I am very grateful to Haug School and Resource Centre, Merete L. Tobiassen and all of the other people there: Next to providing housing and rooms and professional assistance for the experiments, your inspiring co-operation and wonderful mind-set and enthusiasm kept the whole project on track! Thanks to the professionals who contributed to the focus group interview. Your comments were very valuable, and you showed me how much fun deep insight can be! Thanks to Nils Nadeau for his dedicated help with the language and editing – I learned much about research communication through our collaboration, and I always appreciated his punctuality as well. Thanks also to Anna Louise Claughton Lilleaas and Bjørn Kruse for their support and language advise in the final rounds. I also appreciate Natasha Barrett's contribution on the foreword and for reading the articles so well. To all of the authors in this anthology, whether you participated in RHYME or not: your names have been mentioned already but I want to thank you again for your contributions and excellent cooperation with the articles. I also wish to thank all of the reviewers for the critical and constructive responses! I am confident

that, in all, this anthology supplies a broad and synergistic perspective on the potential connections between music, health, technology and design. I also need to acknowledge the research team for RHYME, even as we work to finalize the project. What a creative bunch of people: Birgitta Cappelen, Anders-Petter Andersson and Fredrik Olofsson, who came up with the art project MusicalFieldsForever (which really started it all), as well as Jo Herstad, Harald Holone and Even Ruud!

Lastly, I am so grateful to the participating families in RHYME – the mothers, fathers, sisters and brothers, grandparents, relatives, and personal assistants who spent time with the project. I know that your everyday lives are busy and demanding, and all of us involved in RHYME owe you much gratitude. Personally, your enthusiasm has been a driving force for me, and therefore I wish to end this editor's foreword with the words from one of you, Inga Bostad:

A room with a parental view

The everyday life of a different family cannot be described. It must be experienced. Not that it is too complex or too hard to describe or communicate to those outside, but because it is as unique as every other family. And this reflection expresses a deeper insight as well: to have a child with special needs, a child that is different, is to hold on to something unknown. You do not know how this child will react to her surroundings, how she will enjoy the physical and artistic inputs that are presented to her, because she is as unique as any other child in the world. And her experiences of joy and sorrow, pain and excitement, have a right to be taken seriously.

The RHYME project has this very fundamental perspective: they observe and they see the different child as an autonomous being, with her more or less familiar and more or less unknown behaviour. As a mother of a child that is totally dependent on others to have a good life, you look for every opportunity to share this responsibility: How can we facilitate the everyday life of the whole family? How can we best help one another to be together and share a desired moment? How can we plan for the basic need of respite care? And how can her right to independence come to life in dependent situations?

Looking through the windows of my family's wooden house on an ordinary afternoon would probably contain no surprises – we look like an ordinary family, except for all the specialized equipment. Simultaneously, what is not seen are the complex needs as well as the many opportunities that are present in this very house. After dinner is over, sitting in the wheelchair needs to be replaced by a new activity – my daughter has already been sitting too much during the day, while at the same time the family members have their own agendas – things have to be done, homework has to be completed, dishes have to be washed and emails have to be answered. Everyone has their needs, and everyone has legitimate reasons for believing they are right in trying to fulfil them. Is there any playful furniture to relax in, which at the same time gives you a sensory experience, stimulates your whole body and invites the other family members to join you? The RHYME project has gathered the right questions, and transdisciplinary research is never successful without asking the relevant and complex questions. And the researchers have answered them as well: we have to work across the disciplines, across the dogmatic and conservative division of science and art and health and technology, to fully understand the needs of those who are different from us.

Thanks for this also!

Karette Stensæth,
Oslo, October 24, 2014

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Designing four generations of ‘Musicking Tangibles’

Birgitta Cappelen and Anders-Petter Andersson

This article, which builds on several conference papers, describes what we call ‘Musicking Tangibles’, a novel approach towards *understanding* and *design* of *interactive music technology* for people with special needs.¹ The health values of music are well documented, but so far little research on interactive music technology has been developed for music therapy and health improvement in everyday situations. In our opinion, the music technology that has been used exploits little of the potential that current computer technology has to offer these fields because it is designed and used within a narrow perspective on technology and its potential. With our long experience from design and development of interactive music technology, especially from the interdisciplinary research project RHYME (rhyme. no), we present and argue for a broader understanding of music technology for empowerment and health improvement, building on a multidisciplinary approach with perspectives from tangible interaction design and inspiration from resource oriented music therapy and empowerment thinking. We hereby suggest the notion, *Musicking Tangibles*, inspired by Christopher Small’s (1998) term ‘musicking’, as a label for our understanding.² Based on our experiences and user observations from the RHYME project we argue that the Musicking Tangibles have unique empowering qualities with health potentials.

1 This article, in contrast to the other articles in this volume, is not peer-reviewed. However, it is a revision of many peer-reviewed papers and conference proceedings created and held by the authors.

2 The notion, Musicking Tangibles, relates sometimes to what several other authors have described as the ‘co-creative tangibles’ (CCTs) in the RHYME project. Read about the CCTs and the RHYME project in the empirical articles of Eide (2014), Stensæth & Ruud (2014), Stensæth (2014a, b) or elsewhere in this volume.

Introduction

Music and music related activities promote vital experiences for human beings and should be a right in every person's life (Rolvsjord, 2006). The health value of music, for a number of diseases, has been well documented within biomedical and humanistic health research over the last 15 years (Bjursell, 2008; Blaxter, 2010). Currently we know many ways in which music can empower people and promote vitality and health (Bruscia, 1998, 1987; Rolvsjord, 2010; Ruud 2010; Stensæth 2008). Musical instruments, with or without computer technology, represent and offer various cultural and interactional possibilities. However, when research on music technology for people with special needs focuses on the abilities of the people using it and not the computer technology, there is a chance that potential health values are overlooked. In this article we rethink music technology's potential for empowering the users. By keeping the design and the development of the technology and its potentials for promoting interaction and vitality in the centre of our attention, we suggest new ways of designing this technology for health improvement. The article is structured as follows; first we present the related work we build on in developing our notion of the Musicking Tangibles. Then we present the RHYME project, followed by the four generations Musicking Tangibles prototypes we have developed. Thereafter follows a discussion on the differences between an approach that includes our understanding of the Musicking Tangibles and traditional and current instrument- and switch-oriented perspectives. In the conclusion, we summarise our contribution to the field of design of interactive music technology for people with special needs.

From musical instruments to Musicking Tangibles

Tangible interaction and computational artefacts³

Tangible interaction (Dourish, 2004) is one of many labels of the design of physical things with computer capabilities. Our focus is on the design and interaction possibilities that lie in the physical, "hybrid" artefact (Latour, 1999), the tangibles, when including computer components, such as sensors, network, hardware and software, into cultural artefacts and everyday objects and things. The computational artefact, the tangibles, embodies cultural interpretation possibilities, which we build on when designing and in using artefacts (Dourish, 2004; Appadurai, 1986).

3 See also Ruud's (2014) discussion on the RHYME artefacts elsewhere in this volume.

Computer based instruments

Musical instruments are artefacts, and computer technology has for a long time been used to enrich musical instruments. Many computer-based instruments can be found in Toy stores and assistive technology shops, including software to make any computer into a musical instrument. Some of the most advanced computer based instruments on the market, such as the music game Guitar Hero (Harmonix Music Systems, 2005) and Reactable (Reactable, 2009; Jordà, 2003) are results of research within the field. Compared to acoustic music instruments, with their material-based stimuli-response, computer-based music interfaces don't require direct relation between input and output (Cappelen & Andersson, 2008; Magee & Burland, 2008). For people with special needs, music technology therefore offers new and adaptable ways to interact (Magee, 2011; Magee & Burland, 2008). Potentially, when it is designed in a thoughtful way, this makes music experiences more accessible for people with special needs.

Assistive music technology

Most music technology used in the assistive technology field is MIDI-based, containing hard plastic contact switches, such as the piano – like Paletto (Kikre, 2005). Other frequently used electronic instruments have ultrasound sensors like Soundbeam (Soundbeam Project, 1989) and Optimusic's Opti-beam (Optimusic, 2011), where the speaker can be placed anywhere in the room, separate from the input sensors. The fact that most of these instruments are MIDI-based represents an aesthetical limitation of the musical output. Furthermore, most of the instruments are shaped as toys, which expresses – design vice – what and who they are designed for. We considered them therefore to be aesthetically and socially limited.

Music for health and empowerment

In the humanist health approach – an approach which inspires us – health is an experience of wellbeing rather than a cure from illness (Blaxter, 2010). Music then becomes a resource for health promotion (Ruud, 2010). The music therapist and researcher Randi Rolvsjord has thoroughly presented and argued for a resource and empowerment oriented perspective in music therapy (Rolvsjord, 2010). From this perspective the focus is on the abilities and strengths of the person, not on their diagnosis or weaknesses. The goal is to improve vitality, self-esteem, social relationships and participation, through mutual and equal, positive relation building

musical experiences (Rolvsjord, 2010; Ruud, 2010). To design music technology with such goals, the challenges shift from the interface design, to the relation building potentialities of the tangibles. The focus shifts from controlling the interface to motivating social interaction, co-creation and ‘musicking’ (Small, 1998).

Musicking

The word musicking, which is developed by the composer and musicologist Christopher Small, focuses on the equal, meaning making and relation building activities related to music, such as listening, playing, composing and dancing.⁴ When designing for people with different abilities, motivations and activity intensities, we need to design for many possibilities to music in order to resonate with their specific ways of approaching the artefacts and their ways of interacting and sharing experiences with other people.⁵ In other words, we must design music technology artefacts, tangibles that are open to many interpretations, relations and musical actions. Therefore we call them *Musicking Tangibles*.

Switch-oriented, instrument approach

In a study of music therapists’ use of MIDI-based electronic instruments like SoundBeam, Magee and Burland (2008) conclude that the client has to first understand the cause and effect of switches, before being able to operate complex musical interactions and music making. They also point at the challenges with fatigue and decreasing motivation, caused by too strong a focus on trying and failing to master the interface switches. In our notion of the artefacts as Musicking Tangibles, the focus is different: Rather than focusing on making the users understand how the switch works technically, because they consider the technology as an instrument for controlling, we instead emphasize the technology as a potential arena (Stensæth & Ruud, 2012) or actor (Cappelen & Andersson, 2011) for positive musicking experiences. This actor or arena should motivate the users to take part and co-create in a manner that is positive and empowering (see also Stensæth & Ruud, 2012, 2014; Stensæth, 2013). Importantly, to keep up the motivation and interest among the users, the Musicking Tangibles could be programmed as actors to act and ‘improvise’ musically and ‘intelligently’ on their own terms. This is what we have tried to do in RHYME (Andersson & Cappelen, 2014; Eide, 2014; Stensæth & Ruud, 2014; Stensæth, 2014a, b).

4 See also Andersson & Cappelen (2014) or elsewhere in this volume.

5 Read about this in Andersson & Cappelen (2014), or in the empirical articles of Eide (2014), Stensæth & Ruud (2014), Stensæth (2014a, b), or elsewhere in this volume.

Musicking Tangibles for empowerment

Based on a resource oriented and empowerment view we argue that music technology should offer a multitude of positive musicking experiences simultaneously. The Musicking Tangibles have to be open to many interpretations, interaction forms and activity levels, where there are no wrong actions. They have to offer many possible roles that can be taken (Cappelen & Andersson, 2011b). The software should build on musical, narrative and communicative principles in order to motivate and develop musical competence and musicking experiences for many users over a long period of time (Ibid.). In this way, Musicking Tangibles is not just a notion but also suggests an approach for *understanding* and *designing* health improving music technology for people with special needs. The aim is that people with diverse abilities and motivations can experience vitality, mastering, empowerment, participation and co-creation through their musicking (Small, 1998; Rolvsjord, 2010, Stensæth, 2013). To achieve these ambitions the Musicking Tangibles should:

- Evoke interest and positive emotions relevant to diverse people's interpretation of the tangibles and the situation
- Dynamically offer many roles to take, many musicking actions to make and many ways of self-expression
- Offer aesthetically consistent responses and build relevant cross-media expectations and challenges over time and space, consistent with their character
- Offer many relations to make to people, things, experiences, events, places

Technically this means that the Musicking Tangibles should be able to respond to several types of events and to evoke interest and positive emotions. The Musicking Tangibles hold musical and rhetoric knowledge (programmed musical, narrative and communicative rules) and competence, remembering earlier user interactions in order to respond aesthetically consistently over time and to create coherent expectations. They can, physically or wirelessly, be networked to other actors – people or things (Latour, 1999) – in order to exchange value and to build relations over time. The Musicking Tangibles have physically and musically attractive qualities related to material, shape, texture, character and identity, social and/or cultural (Cappelen & Andersson, 2011a). Further on we will present the project context in which we design, evaluate and discuss Musicking Tangibles.

The RHYME project⁶ and the Musicking Tangibles

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality.⁷ The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design, music, and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs, to be developed in collaboration with the Haug School and Resource Centre, the users and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

Through multidisciplinary action oriented empirical studies, multidisciplinary discussions and reflections, RHYME has developed new generations of Musicking Tangibles and related knowledge. The first empirical study in the RHYME project was of the Musicking Tangibles that we have called ORFI (see picture 1). The second was of WAVE (see picture 2), the third of REFLECT (picture 4, 5, and 6) and the fourth of POLLY (picture 7, 8, 9, 10, 11). From the RHYME experiments (which we call 'actions'), we have moved from one action to the other, making changes and development based on the previous action, weekly user surveys, observations and multidisciplinary discussions. All sessions were video recorded from several angles to capture as much as possible of the situations.

6 The section inside the frame is similar in all of the RHYME articles in this anthology, *Music, Health, Technology, and Design* by Stensæth (Ed.).

7 For more about the health potential found in the testing of the CCTs, see elsewhere in this anthology or in Eide (2014), Stensæth & Ruud (2014) or/and Stensæth (2014a, b).

First generation – ORFI

The first generation of Musicking Tangibles is called ORFI and was created earlier by RHYME’s development team in 2007 (MusicalFieldsForever, 2000; Rhyme, 2010). ORFI consists of 26 soft pyramid shaped tangibles, pillow like modules in three different sizes ranging from 30 to 90 centimetres. The modules are made in black textile. Most of the pyramids have orange origami shaped ‘wings’ with bend sensors, and an orange transparent light stick along one side, which gives a high-tech expression. Every module can communicate wirelessly with the others. The modules can be connected together in a Lego-like manner into large interactive landscapes. By interacting with the orange wings (see picture 1) the user creates changes in light, dynamic graphics and music. Some modules contain speakers so that one can experience the vibrations from the sound by sitting or holding a module in one’s lap. ORFI currently offers eight different music genres. Two orange pyramids contain microphones, which in the Voxx-genre create live music, based on the users’ input. ORFI has a full wall projection of dynamic graphics, expressing visually the music genre and the interaction (see picture 1). We have designed ORFI based on the ideal of Eco’s Open work in order to offer as many interpretations, actions and experiences as possible, where there are no wrongs or failing possibilities (Cappelen & Andersson 2011; Eide, 2014).⁸



Picture 1: Boy interacting with an ORFI wing,



Picture 2: The whole family musicking in their own manner in front of the wall projection

⁸ More details on the interactive Musicking Tangibles ORFI are presented earlier on (Andersson & Cappelen, 2008; Cappelen & Andersson, 2011b). Read also about Eco and his theories in Eide (2014) or elsewhere in this volume.

Second generation – WAVE

WAVE is the second generation of Musicking Tangibles, which we have designed based on the requirements from the experiences of the ORFI actions. WAVE is an attempt to explore the most advanced *wired multimedia technology* available at the time (2011). It is therefore a very different technology than the wireless ORFI technology from 2007.

The WAVE Carpet is a seven-branched, wired, interactive, soft, dark carpet (see picture 3), with orange velvet tips that glow when the user interacts with the carpet's 'arm'. One arm of the carpet, which is central, contains a microphone. Two arms contain movement sensors (accelerometers) that change the recorded sound, while two other arms contain bend sensors that create the rhythmical background music. In one of the arms there is a web-camera that the users can play with. Currently WAVE contains 5 software programs, offering different music and dynamic graphics to show with the Pico projector embedded in one arm, or on the full wall projection. The WAVE carpet contains two robust speakers and a strong vibrator placed as a soft "stomach" in the middle of the carpet.

We have also created a glowing soft velvet 'bubble field' in the dark WAVE carpet. The bubbles contain IR-sensors and RGB LEDs that represent an aesthetically and sensorially unique device.⁹ With its size, shape, texture and input and



Picture 3: Family musicking in WAVE: Father sings into microphone and gets glowing response. The daughter interacts with the 'bubble field' while the son dances to the wall projection.

⁹ Design details are documented in a separate paper (see Cappelen & Andersson, 2011a).

output possibilities WAVE offers infinite ways in which to interact and co-create musicking experiences.

We have made many design choices and solutions when creating WAVE. Choices and solutions that were based on the ideas, wishes and demands from the users of ORFI and others, joined together with our Musicking Tangibles qualities. We also designed WAVE to evoke interest and positive emotions by making a soft, glowing, velvet surface and a strong, characteristic shape with many arms that invite different forms of interaction and intensity levels. In addition, we designed WAVE to offer many roles to play. On one level it is only a carpet to sleep on with a strong, sensorially stimulating and musical vibrator in the centre. On another level WAVE is designed as a giant console game where two people can sit on each side and compete with each other. The WAVE Carpet can also be interpreted as a big seven-armed octopus that you can sing with, get responses from and improvise music together with.

Lastly, we designed WAVE to offer many ways in which to express oneself, both physically, musically and visually. One example of the latter is by playing with the user's picture and reflection, alternating between the camera and the handheld projector. By designing WAVE to be an interactive landscape on the floor we wanted it to become a cosy meeting place, arena and initiator for sharing and creating relations between all members of the family.

Third generation – REFLECT

REFLECT is one of many Musicking Tangibles designed within the third generation of tangibles in the RHYME project. In this third generation we focused on mobile and wireless technology.

REFLECT consists of a lumber-like soft thing, shaped as an abstract glowing head with a trunk or an arm. The user can play with REFLECT on the floor, hold it in her arms, or over the shoulder while dancing. But the user can also carry it over their shoulder playing it like a soft glowing guitar. When designing it we have we have tried to shape REFLECT to be as ambiguous as possible to motivate different interpretations and interaction forms (Gaver, 2003). Data from RHYME, including the interviews with the children's siblings and parents, the focus groups and the RHYME researchers' dialogues gave input to the selection of music, i.e. what kind of music and musical tunes they wanted to include in REFLECT.¹⁰

¹⁰ See Stensæth's analysis of REFLECT in Stensæth (2014b) or elsewhere in this volume.



Picture 4: REFLECT's lumber-like soft things with RFID-tagged scene cards and tagged things to create choir sounds

REFLECT 's embedded sensors, such as touchable glowing stars, its speakers and lighting makes it possible for the user to create dynamic music and light experiences.

REFLECT has several embedded sensors, such as touchable glowing stars and with its speakers and lighting, it is possible for the user to create dynamic music and light experiences. REFLECT has a RFID-reader at the end of its trunk (see picture 4) so the user can select music tunes by choosing RFID-tagged Scene cards looking like CD Covers, and dynamically change the music by interacting with the tagged things (see picture 5 and 6). The user can further dynamically manipulate, distort and add effects to the sound samples while interacting with touch and bend sensors.

The software in REFLECT is written in the object oriented programming language SuperCollider (SuperCollider 1996) and is running on an iPod Touch. The hardware is a mixture of custom-built circuits for sensors and light, and standard mobile phone technology such as portable speaker and battery pack. This makes the platform self-sufficient and wireless, and offers high quality sound experiences compared to current instruments and assistive music technology.

REFLECT is an attempt to join together input and ideas from workshops, user studies¹¹ and other user inputs, in order to realise a *mobile computer platform*. We

11 See Stensæth's analysis of REFLECT in Stensæth (2014b) or elsewhere in this volume.



Picture 5 and 6: Maracas and Monkey with white RFID-tags

designed REFLECT in order to offer the user a multitude of ways in which to interact and regulate their emotions and actions. For instance this could be done by selecting the kind of music they liked, by varying the volume level and by choosing among many objects to play with in order to take part in the musical activities (see picture 5 and 6).¹² From the earlier RHYME actions we also knew that we needed to give the user direct light and sound response at the same place as the user interacted.

We have made many design choices and solutions when creating REFLECT. Design choices and solutions that in the mobile REFLECT is an attempt to answer to all the ideas, wishes and demands joined together with the Musicking Tangible qualities described above. We chose to make REFLECT in soft black wool with contrasting white lighting fields to stimulate the tactile and visual senses and to motivate different forms of interaction. The thick soft wool made it robust and cozy to hug, sleep on and dance with. The contrasting, bubbly, yellow velvet stars made it magic to touch because of its softness and immediate light and sound response. We gave REFLECT an ambiguous soft shape with head and trunk to make it easy to interpret in many ways, and to offer many roles to take. For instance, the user can hold it upwards as a partner while dancing with it, or to play on it as a guitar with its strap over the shoulder. Furthermore, the user can sleep on it as a glowing cushion, or beside it as a giggly sounding bedmate.

¹² Learn how Petronella and family played with these in Stensæth (2014b) or elsewhere in this volume.

We chose to use RFID-technology in REFLECT as an important design solution. RFID-tags are often used in keycards, where the RFID-reader is the door lock, or as security marking of goods in stores. We used RFID-technology in order to offer the user of REFLECT many forms of interaction, self-expression and self-regulation. Firstly, it made it easy for the user to choose a RFID-tagged CD-cover-card to choose the kind of music she wanted to make and play, according to her mood and liking. The CD-cover-card concept was an attempt to build on the user's knowledge and experience of CD-covers and similar laminated cards often used within Augmented and Alternative communication. We linked the CD-cover-card with the white, round RFID-tag onto a contrasting black textile. We designed the tag 'eye-like' (see picture 5 and 6), to make it easy to see and similar to the white end of the black trunk where we placed the RFID-reader.

Secondly we added a lot of different ordinary things with this eye-like RFID-tag to catch diverse users' interest, evoke positive emotions and motivation to interact with REFLECT. We added musical instruments like maracas and drums, on which the users had previous experience of playing. Furthermore, we also added objects like pots and pans that made sounds while playing on them, and soft slippers and several soft toys that obviously did not create a sound of their own, but by putting the RFID-tag onto the end of the trunk they added a synthetic musical layer. The RFID-tag could also be connected to the user's own things to include them into the musicking experience. All of this was in order to offer the users many ways in which to interact, create music, express themselves and relate to things. Some things, like the slippers, could be worn as a form of self-expression. Other things could be played on and with, in order to extend the musical experience and challenge musical mastery. The interaction knowledge the user achieved on one level could be built into more complex musical mastery later, because of its consistency.

Fourth generation Musicking Tangibles – POLLY

We have chosen to call the last and fourth generation of Musicking Tangibles within the RHYME project, POLLY. The name POLLY comes from "poly", the Greek prefix for 'many'. This suits POLLY in that it is manifold: There are many ways to create music, many musical tunes and visual expressions, many ways to play and interact, many ways to participate socially, many colours, polygon shapes and many possible sensorial experiences, to mention just a few.

The design of POLLY is an attempt to meet all of the demands, suggestions and wishes from the users and experts related to the three earlier generations of RHYME's Musicking Tangibles. In addition it includes social media functionality.

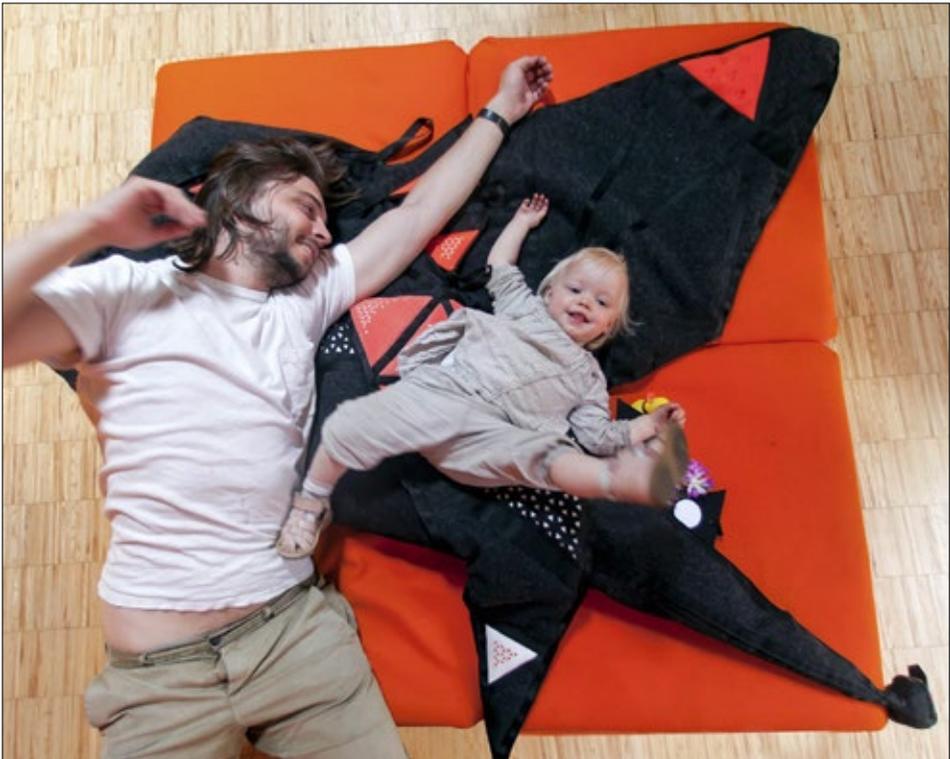
As we experienced from the REFLECT actions, we needed to include a microphone, RFID-functionality and other sensors we had in REFLECT, in order to offer more ways for self-expressions. We also needed more musical choices in order to increase the self-regulating functionality. There were also demands for better sound quality in the mobile Tangibles, regarding both sound frequency range and volume regulation, since some users need stronger and some softer sensory stimulation. Therefore we had to include stronger speakers and better battery solutions into the mobile Tangibles to answer the diverse demands from the users. This increased both size and weight of the mobile tangibles, POLLY Land, POLLY Planet, POLLY Fir and POLLY Ocean in the POLLY World (see pictures 7–11).



Picture 7: Family interacting in the POLLY Land in the POLLY World



Picture 8 and 9: POLLY Planet



Picture 10: POLLY Fire



Picture 11: *POLLY Ocean*

During the RHYME project we have tested several projection solutions. These are full-wall projections, handheld laser projector with dynamic-focus-projection and no projection. The latter solution was experienced as a lack by some of the users. Other users again experienced the full-wall projection as too attention demanding and passivizing.¹³ Therefore, as a response to the focus group demands (see Stensæth 2014a), we have developed a closer and more intimate and embodied relation to the video projection, compared to traditional wall projection, TV and Computer Screens. The current screen solution in POLLY is an 80cm x100cm back projection, which can be either hard or soft, depending on the material used to project on (see picture 7).

In the POLLY World we have also expanded the musical choices radically, both regarding musical genres, number of music tunes or Scenes as we call it in POLLY, in order to expand the users' possibilities to regulate their emotions and actions.

¹³ Read about this elsewhere in this volume in Stensæth's (2014a) analysis of Petronella and Dylan interacting with WAVE.

The user can choose a scene by activating the scene card by using the RFID-reader. We call it 'scene' because it also adds a visual dimension to the music, with dynamic graphics and light play in the textile tangibles to extend the sensory experience, compared to what we have in REFLECT.

We have put an effort into creating a richer sensory experience visually, audibly, tangibly and haptically. Much work has also been put into creating a more seamless transition between the material and computational surfaces, the textile surfaces that stimulate senses in a visual and tactile way and surfaces containing computational sensors and activators. This is done in order to always offer the user positive experiences and challenging mastery possibilities, by first being stimulating in a sensorial sense and later by being controllable in an instrumental and computational sense. This is an example of how our Musicking Tangibles approach differs conceptually, in opposition to a 'switch-oriented' and instrumental mindset, where the user first has to understand and learn how the system works before making music.

We have also put considerable work into creating many ways to interact with every sensor. The microphones can for instance just be strapped to a hook or handle or over the hand. The shape and the light weight of the microphone makes it easier to hold but still has the important responsive light when activated. Again, this is done to make it easy and stimulating in multiple ways, and hereby to lower the threshold and increase the mastery possibilities. Since all sensors are built on mathematics they are in principle absolutely precise, and because all music compositions in POLLY are built up of music elements that are based on advanced musical rules, they can be used to build even more complex musical compositions and thereby offer increased mastery levels. This makes POLLY both much simpler and much more complex at the same time. In one sense POLLY is only a pillow, blanket, ball or piece of furniture, but in another sense it is a very complex, collaborative, inviting and musical computational actor or machine.

All the design and development effort in RHYME has been done in order to lower the threshold for always evoking positive experiences, where there are no wrongs or failing possibilities, and simultaneously offer advanced actability and mastery possibilities. Furthermore, the design is developed in this way in order to offer the users a place – and an arena – where they can be together and create together in the same co-creative tangibles, in the same environment. Additionally, the design is developed in order to offer distributed communication by interacting via smartphone or a tablet over the Internet, both in a graphical and text-based interface. In this way the family and their child with disabilities are offered ways in which they can be together, co-create and share positive and meaningful experiences while either being at home or away from home. We have also created functionality for daily and

weekly programs, to use music as a coping, self-actualising and ritualising medium, in the user's everyday life.

Conclusion

In this article we have presented a novel approach for the understanding and the design of interactive health improving music technology, what we call Musicking Tangibles. The Musicking Tangibles approach represents an alternative approach to the traditional instrument, interface and switch-oriented music technology perspective. The Musicking Tangibles approach combines a humanistic, resource and empowerment oriented health approach with an aesthetic and culture based design approach towards music technology. We have presented four empowering and health improving qualities for the Musicking Tangibles. These qualities emphasize:

- 1) Continually evoking interest and positive emotions relevant to diverse users' interpretation of the tangibles and the situation
- 2) Dynamically offering the users many roles to take, many musicking actions to make and many ways to express themselves
- 3) Offering the users aesthetically consistent responses and building relevant cross-media expectations and challenges over time and space, consistent with their character
- 4) Offering the users many relations to make: to people, things, experiences, events and places

Furthermore, we have presented and argued for some design solutions of the Musicking Tangibles ORFI, WAVE, REFLECT, and the POLLY World from the RHYME-project. In developing POLLY we have tried to put together as many design qualities as possible in order to exemplify our view and current understanding. Lastly, because he is not the co-author of this article, we want to express our gratitude to our co-member of the RHYME development team and MusicalFieldsForever (MusicalFieldsForever 2000), Fredrik Olofsson, for his contribution in the creation of the Musicking Tangibles.

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Vocal and tangible interaction in RHYME

Anders-Petter Andersson and Birgitta Cappelen

Our voice and body are important parts of our self-expression and self-experience for all of us. They are also essential for our way of communicating and building relations across borders such as abilities, ages, locations and backgrounds. Voice, body and tangibility gradually become more important for information and communication technology (ICT), due to increased development of tangible interaction and mobile communication. The voice and tangible interaction therefore also become more important for the fields of assistive technology, health technology and universal design. In this article we present and discuss our work with voice and tangible interaction in the on-going research project RHYME. The goal is to improve health for families, adults and children with disabilities through the use of collaborative, musical, tangible and sensorial media. We build on the use of voice in music therapy, knowledge from multi-sensory stimulation and on a humanistic approach to health. Our challenge is to design vocal and tangible interactive media that are sensorially stimulating and through use can both reduce isolation and passivity and increase empowerment for many users. We use sound recognition, generative sound synthesis, vibrations and cross-media techniques in order to create rhythms, melodies and harmonic chords to stimulate voice-body connections, positive emotions and structures for actions.¹

Introduction

Traditionally, ICT for persons with disabilities, so called augmentative and alternative communication (AAC) technologies, have focused on interaction with screen-based visual graphics and text. However, the interest for embodied and tangible interaction (Dourish, 2004; Dourish & Bell, 2011) has grown because of the development in mobile communication, computer gaming and social media. Compared

¹ This article is not peer-reviewed but is a revision of many peer-reviewed papers and conference proceedings created and held by the authors.

to traditional ICT and AAC technologies, tangible technologies are computer based and therefore have unique abilities to memorise and learn. They also have unique qualities for the user due to the use of the body, touch, hearing, voice and music as a complement to visuals and text. These qualities have made them accessible for large groups of people who were earlier excluded and are now motivated to participate and cross borders; motivated to cross from being a more or less passive disabled spectator to being a music creator, playing games and engaging socially with other people. To cross borders in this active, creative and social meaning in many cases also means to *break with personal social or physical boundaries*.

In this article we explore the voice in tangible interaction design and its possibility to strengthen health by reducing isolation and passivity. Our approach is to use knowledge about the voice from music therapy and multi-sensory stimulation for designing computer-based tangible interaction. We argue that the use of resource-oriented methods by these two fields strengthens all participants involved and is particularly interesting for interaction design and computer-based interactive sound design when working with a diverse mix of people with or without disabilities. In two design cases we explore vocal, bodily and tactile interaction as input, and music, tactile sensations and lighting as output. The two cases are first and second generation of interactive, tangible installations in the on-going research project RHYME (Rhyme, 2010). To analyse and integrate the findings in the design we have followed user-oriented research-by-design methods conducted as cycles of actions with design, interviews and video observations of families with children who have severe disabilities.

Related work

Vocal and tangible interaction

Our approach is multi-disciplinary and based on earlier studies of *voice* in resource-oriented music and health research and music therapy (Sokolov, 1984; Austin, 2001; Bruscia, 1987; Lyngroth et. al, 2006; Loewy, 2004) identifying how music works by strengthening *voice-body* relations, *positive emotions* and creating *structures for actions*. Furthermore, our approach is based on research from the fields of tangible interaction in interaction design (Dourish, 2004; Dourish & Bell, 2011; Löwgren & Stolterman, 2005), voice recognition and sound synthesis in computer music (Roads, 1996; Wilson, Cottle & Collins, 2011) for interacting persons with laymen expertise (Andersson, 2012) that use assistive technologies (Magee, 2011; Magee & Burland, 2008). Vocal and

tangible interaction has spread with computer games such as the *Nintedo Wii* (Nintendo, 2008), improving strength and balance (Nitz, 2010). Music creation and gaming are combined in *GuitarHero*, and the voice-controlled karaoke game *SingStar* (Harmonix, 2005; London, Studio 2004). Often though, the interfaces do not suit a person's individual needs. Therefore the design for persons with disabilities has led to the development of switch-based interfaces such as *Paletto* (Kikre, 2005) and the ultrasound sensor *Soundbeam* (Soundbeam, 1989). *Soundbeam* triggers notes in a synthesiser and is used for rehabilitation. Assistive technologies like *Paletto* and *Soundbeam* have in common that they support direct response with the goal to give the user clear feedback. There are however major drawbacks. It can be hard for persons with severe disabilities to master assistive technologies supporting a strong focus on direct response, because it creates expectations that a person with severe physical disabilities might never be able to meet. As a result, the individual can experience demotivation instead of mastering. The mechanical repetitiveness can lead to fatigue (Magee & Burland, 2008) with the risk of disempowering rather than empowering the person interacting (Cappelen & Andersson, 2012b; Renblad, 2003; Rolvsjord, 2010, 2006). Additionally, when the therapist leaves the room the device (instrument, switch-based controller) in practice stops working because it depends on the therapist's actions. Therefore, there is a risk that the person with the disability becomes either over-stimulated or isolated.² Meanwhile, other successful methods and practices are being used within traditional computer gaming and interactive music and art. However, very few of the existing computer-based and interactive devices for health improvement consider the knowledge in these fields of music and health for cultural reasons. Our suggestion as designers is to look for inspiration in the area of music therapy practices and adapt them for computer-based media.

Voice, music and health

Listening, playing and dancing to music motivates people to create and socialise in all cultures, to cross borders between age, background, culture, cognitive, social and physical abilities. Music is both a highly virtuosic activity and has long cultural traditions among people with layman expertise (DeNora, 2000). Music is therefore a fantastic 'cultural material' (Appadurai, 1986) to dig into when designing. Many amateurs have life-long music memories strongly tied to emotions and development

² See also the discussion in Cappelen & Andersson (2014) or elsewhere in this volume.

of social and individual self. When growing up, music is often used as a medium for breaking boundaries of social rules and to form one's own identity (Ruud, 2010).

Music and health is a research field that has expanded the music therapeutic situation into everyday life (Ibid.). *Music and health* research complements biomedical, cognitive and psychological methods with *humanist*, cultural and ecological approaches (Blaxter, 2010; Ruud, 2010). Instead of only focusing on diagnosis and illness, *music and health* is *resource-oriented* (Rolvsjord, 2010, 2006). No matter how weak or ill, it is always possible to motivate a person to use her own resources with the purpose to *empower* all persons involved in a relation in a certain situation. The positive psychology (Seligman & Csikszentmihalyi, 2000) and resource-oriented (Rolvsjord, 2006, 2010) approach that is practised in RHYME, that there are no wrong actions, is connected to musicologist Christopher Small's term *musicking* (Small, 1998). Small sees music as an on-going, everyday *relation building activity*, not as an art object but as an activity. He therefore uses the verb – *to music*. The approach involves everyone in an amateur community or family to interact and potentially be empowered.³

Voice in music therapy

Being an inner instrument of the body, the voice is at a unique and powerful vantage point for working with the self from within (Bruscia, 1987, p. 357).

As music therapist Kenneth Bruscia writes, the voice is powerful and yet vulnerable since it is constantly in contact with our body through breathing. The voice is vulnerable because it reveals a person's emotions and expresses her identity (Ruud, 2010; Sokolov, 1984; Bruscia, 1987, p. 359). Music therapist Joanne Loewy brings forward four complementing models for working with voice throughout a person's life and in different situations (Loewy, 2004). These are models for *prelinguistic* stages, in *developing* a language and a personality, for *recovery*, both listening and creating vocal sounds after severe damage to the brain or trauma, and with voice and *psychotherapy*.

The music therapist uses *rhythm*, *melody*, *harmony* and *speech* as working tools. Rhythm is used to motivate a person to *enhance motoric* and *vocal play*, *stressing borders* and *strengthening* the person's *sense of self*. For example, sounds that are

³ Again, see the discussion in Cappelen & Andersson (2014) or elsewhere in this volume.

sharply separated, such as the consonants 'S', 'K', 'T', 'P', help increase the rhythm in vocal interaction. *Melody* is based on tones, joining events together in sequences, and music therapists use it to localise and open up emotions and parts of the body (Sokolov, 1984). *Harmonizing* is to simultaneously play two or more voices on separate notes. In music therapy it is used to explore situations of separation and relationship between voices (Austin, 2001, p. 8) belonging to the same chord. The music can become a safe environment and “test-bench” for trying out difficult emotions.

The therapeutic voice

Voice in music therapy can be used to create *voice-body* relations, to evoke *positive emotions* and to provide *structures for actions*. Voice is used for developing relations to the individual's own *body*, through singing and holding the tone while finding and freeing an emotion or part of the body (Austin, 2001). In therapy, the body can extend to relations to other persons and their bodies, recognising that voices belong to a functional *family body* and even a *cultural body*, as in music therapist Lisa Sokolov's *Embodied Voice Work* (Sokolov, 1984; Bruscia, 1987). The voice is used to evoke *positive emotions*, and to empower all persons to use their resources, weak or strong. It is part of the empowering and resource-oriented approach that is common within music therapy (Rolvsjord, 2010; Ruud, 2010).

Music is important in the *prelinguistic* stages. Before a child develops a verbal language she uses musical non-verbal communication to explore her own body and to mirror relations with her mother and others. Rhythms, melodies and harmonising ground a person in her body and evoke positive emotions. They are also used as *structures for actions* that facilitate actions for identifying difficult emotional and physical boundaries and for breaking with those boundaries (Sokolov, 1984; Bruscia, 1987). Often the actions are aimed at empowering people to act of their own free will, or to break with a negative behaviour. Bruscia describes this as four phases, starting with:

- 1) Exploring the difficult boundary through use of one's voice, listening and trying to
- 2) release emotions and Strengthen one's person,
- 3) integrating the new knowledge and techniques into everyday actions, and finally seek
- 4) independence and to break with the therapist (Bruscia, 1987, p. 359).

Harmonizing, through chord changes and harmonic modulation, supports and helps *recast* the music and emotions that a person has when listening and creating music. By changing chord and style, the voice of the person is put in a new musical context and is therefore *recast* and given a *different role* (Sokolov, 1984; Bruscia, 1987:358). It can empower the person to whom the voice belongs to integrate emotional conflicts by overcoming them, acting out the emotions in a chord of two or more co-existing tones.

Melodies are used to focus on emotions and parts of the body by singing extra long notes. With these *vocal holding techniques* (Austin, 2001), the therapist provides the means to explore sound, breathing and voice.

The RHYME project⁴

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality.⁵ The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical ‘smart things’ with multimedia capabilities. Within the project, these interactive and musical tangibles are called ‘co-creative tangibles’ (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs, to be developed in collaboration with the Haug School and Resource Centre, the users and the families. Its user-oriented research incorporates the users’ influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children’s mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

4 The section inside the frame below is similar in all of the RHYME articles in this anthology, *Music, Health, Technology, and Design* by Stensæth (Ed.).

5 For more about the health potential found in the testing of the CCTs, see elsewhere in this anthology or in Eide (2014), Stensæth & Ruud (2014) or/and Stensæth (2014a, b).

Project goals and approach

A project goal in RHYME is to improve health and life quality through the use of *vocal and tangible interactive media*. In the project we develop prototypes, focusing on different user situations, from multimodal, to mobile to social media. RHYME is based on a humanistic health approach (Blaxter, 2010; Ruud, 2010). The first empirical study in the RHYME project was of the vocal and tangible interactive medium *ORFI* (see picture 1) made by three of the members of RHYME (MusicalFieldsForever 2000). Prior to the RHYME project *ORFI* had been tested and documented with video observations and interviews with adults and children at a public hospital in Stockholm. Later in the RHYME project, *ORFI* was observed with the participating children, between 7 and 15 years old with special needs, in their school's music room together with assistants who knew the children well (also called 'close others' in RHYME). The RHYME team prepared the experiments in four different rounds, also called 'actions'. These actions took place over a period of one month. The team made weekly changes based on the previous actions. The second empirical study at the school was of *WAVE* (see picture 2) following the same schedule as in *ORFI*. All sessions were video recorded to be presented for a cross-disciplinary focus group for further analysis. The health aspects are described in the articles written by the music therapists Eide, Stensæth, and Ruud (see Eide, 2014; Ruud, 2014; Stensæth, 2014, 2013, Stensæth & Ruud, 2014, 2012).⁶

Designing *ORFI*⁷

ORFI (Picture 1) is a vocal and tangible interactive installation. It consists of 20 mobile soft triangular shaped cushions or modules in three different sizes. Inside the cushions there are speakers, microphones, LED-lights, generative graphics projection and sensors that react to bending and singing. *ORFI* has been studied from the perspectives of tangible interaction (Cappelen & Andersson, 2011a, 2011c, 2012a), health (Eide, 2014, 2013; Stensæth, 2014a, b, 2013; Stensæth & Ruud, 2014, 2012), computer music and interactive audio (Andersson, 2012; Andersson & Cappelen, 2013; Cappelen & Andersson, 2011b), assistive technology (Cappelen & Andersson, 2012b) and universal design (Cappelen, 2012). *ORFI*'s software, made with the real-time audio-synthesis programming language SuperCollider (Wilson,

⁶ See also Stensæth, Holone & Herstad (2014) or elsewhere in this volume.

⁷ Read about how two children interacted with *ORFI* in the article written by Stensæth & Ruud (2014) elsewhere in this volume.



Picture 1: Father and son playing with ORFI



Picture 2: Family playing with WAVE

Cottle & Collins, 2011) makes it possible to change the sound dynamically. It leads to greater flexibility in changing the music and gives relevant direct responses. ORFI has eight different music genres, where one is the voice-based VOXX. ORFI has separate modules with microphones that record and manipulate singing with delay, time-stretch and cut-up effects, but keep the voice recognisable. ORFI is designed so that the person who interacts with it can select any module at any time and interact with it over a long span of time. A user can change and develop the musical variation as well as *shifting* (Latour, 1999) from one role to another: from exploring alone to creating music and playing with others, or just relaxing.

Designing for voice-body, positive emotions and structures in ORFI

The speaker modules in ORFI are mobile, soft, and lightweight, vibrate wirelessly and can be hugged and lifted up into the lap. This makes it easy to feel the rhythms and tones on the body. The mobile microphones and speakers make it possible to feel the voice on the body, potentially creating voice-body relations like *vocal holding* in the music therapy sense (Sokolov, 1984; Bruscia, 1987). To motivate *positive emotions* we use musical rules in the software to add effects to the sound: pitch-up-effects and looping to a rhythmic beat create funny, rhythmic sound effects. ORFI contributes to the *structures for actions*, as the individual records a vocal sound into a microphone module and then, as the software places it into one of the other modules, finds it again through music making, play, and relaxation.⁸

Design for border crossings in ORFI

ORFI motivates to cross the age border with the eight different musical scenes based on different music styles from different times such as jazz, noise, funk, minimalistic, chamber orchestra music, etc. Showing interest in musical style has been used to reveal what a person remembers and in what age and cultural group the person belongs to (Lyngroth et. al, 2006). *Openness* (Eco, 1979) to offer many potential and different interpretations, and *ambiguity* (Gaver, Beaver & Benford, 2003) as an aesthetical quality, has been used to design a floating border between ORFI as a toy, instrument, and soundscape environment to relax in. Thus, it can be interpreted as a teddy bear by a person taking a child's perspective and at the same time as furniture by a person interested in Interior Design or as an instrument by the musically interested, etc.

⁸ Read about two children's playing with ORFI in Stensæth & Ruud (2014) or elsewhere in this volume.

By being wireless, ORFI motivates to cross the *location border* with the possibility of spreading all of the 20 modules throughout a radius of 100 metres. ORFI motivates to cross the borders of different personal backgrounds, for instance between employed health worker and their clients. At the same time it gives direct response to the beginner, rhythmic patterns for people that want to dance, play together and collaborate and creative variations challenging the music professional.

Designing WAVE

When designing WAVE Carpet (picture 2) our objective was to combine many more media types than those present in ORFI. The goal was to explore the potential for rich cross-media interaction among several persons. The solution became WAVE, a big seven-branched carpet, where all branches or arms have different functions and sensors, all with LED-light feedback. The thick landscape carpet has stereo speakers and a heavy vibrating transducer in the middle. WAVE projects generative graphics from a small handheld laser projector in one arm connected to a camera combined with microphone in another arm, adding delay-echo effect to the sound. In addition, WAVE has a separate microphone that records the user's voice in a third arm. The recording is played back when the user interacts with two other arms reacting to shaking (accelerometer). Shaking adds funny-sounding pitch shift effects to the voice. One small arm is used for pitching up and one large one for pitching down the sound. The other two arms have bend sensors playing looping base melodies. The advanced real-time sound design, sound synthesis and effects are made in the SuperCollider programming language (Gaver, Beaver & Benford, 2003).

WAVE has been studied from the perspectives of tangible interaction (Cappelen & Andersson, 2011a, 2011b), health (Andersson & Cappelen, 2014; Stensæth, 2014a), computer music (Andersson & Cappelen, 2014, 2013), assistive technology (Cappelen & Andersson, 2012b) and Universal Design (Cappelen, 2012).

Designing for voice-body, positive emotions and structures in WAVE

We developed WAVE with stronger stereo speakers and vibrating transducer or 'butt-kicker', used in cars to create heavy sound vibrations. This made it possible to explore *voice-body* relations (Sokoler, 1984; Bruscia 1987), motivating bodily

interaction such as sitting, hugging and relaxing in WAVE that wasn't possible in ORFI with weaker speakers and no transducer.

The potential for *positive emotions* (Seligman & Csikszentmihalyi, 2000) is created in WAVE with possibilities to record without preparation or other interactions other than holding and talking into the glowing microphone arm. The flow can be maintained by adding effects interacting with the two arms with accelerometers.

The software and tangible design, with separate arms for record and play, provide *structures for actions* for several persons. It makes it more motivating to record and play if there are two users rather than just one. Instead of isolating touch and bend sensors to one specific part they are spread out so that feedback comes from any part, making the experience more playful and motivating. Furthermore, WAVE makes it possible to add rhythmic beats that change tempo and timbre qualities dynamically with interaction, also affecting the generative graphics projected on the wall with one small graphical circle per arm that is being moved.

Design for border crossings in WAVE

WAVE's seven arms with the possibility of selecting many different functions at any one time motivates users to cross borders of different *abilities*. One person can lie down and talk into the microphone while another changes the sound with the two arms with accelerometers.⁹

WAVE motivates to *cross age borders* by sounding like a toy-parrot with the pitch shift effect, motivating children to interact. By referring to a carpet and furniture, it motivates adults to sit or lie down on it, or to use it as an instrument to play on.

WAVE's glowing led light on every sensor motivates to *cross location borders*. Compared to ORFI, the lighting in WAVE strengthens the awareness of the different locations where it is possible to interact and therefore motivates interaction.

WAVE's tangible form referring to different actors such as a sofa, floor carpet, instrument, toy and cushion to sleep in, motivates to *cross borders between backgrounds and cultures*. If a person with an interest in WAVE as a sofa lies down and hears somebody else singing, he or she can shift to singing, therefore viewing WAVE as an instrument.

⁹ Read about Petronella's playing with the microphone in WAVE in Stensæth (2014a) or elsewhere in this volume.

Two short user observations

David crossing borders in ORFI

'David' is a person who loves music.¹⁰ He uses a wheelchair and has impaired hearing. At first it seems like a contradiction, but David listens through vibrations. Normally this is hard for David since most speakers are too heavy for him to lift up and into his wheelchair. In ORFI though, he plays sounds, holding one of the small soft and light speaker cushions in his lap, 'listening' to the assistant's voice through the vibrations. According to his assistant, David likes to explore the relations between music and body (Sokolov, 1984; Bruscia, 1987). He is deaf since birth, but in ORFI he starts to imagine which songs he would bring with him the next time. A defining moment in the first session is when David realises that he can *record his own voice*. He starts to cry. David has never heard his own voice and even if he cannot create many sounds when he tries it the first time, he is determined to go home and practice.

To summarise, we observed the user David as he and ORFI created the following:

- *Voice-body connections*. David was motivated to lift up and feel vibrations from ORFI's speaker modules on his lap. He was motivated to use his voice to create sounds he could "hear" from sensing the vibrations and feeling his voice.
- *Positive emotions*. ORFI promoted *positive emotions* by motivating David to master. Whatever he did, ORFI answered, inviting further interaction.
- *Structures for actions*. ORFI offered *structures for creative actions* as David went home to prepare music to sample in the next session. ORFI offered *structures for vocal actions* as David at first could not make vocal sounds, but was motivated to practice to be able to record and play with his voice in ORFI.

Based on the above we observed how the users *crossed borders* of:

- *Abilities*. ORFI motivated David to cross borders between *abilities* as he went home to practice something he did not think would be possible: To master his voice and 'hear' his voice through vibrations. Through developing voice-body connections and through being offered alternative structures for actions in ORFI the user *broke the boundary* of not hearing and not being able to sing. He made an obstacle into a positive challenge. Instead of feeling passive and excluded,

¹⁰ David is not a participant in RHYME. He explored ORFI outside the RHYME test situations.

the user's actions with ORFI strengthened wellbeing, mastery and relations to people as he could contribute socially by singing.

- *Locations*. ORFI motivated the user to cross borders of *locations* as he broke the boundary between the institution, where he had his rehabilitation and his home.
- *Backgrounds*. The possibility to sample his own music made it possible to cross the borders of *backgrounds* as the user went from being a person with disabilities to a connoisseur interested in salsa music, sharing interest with the group.

Petronella crossing borders with WAVE¹¹

Petronella is a 15-year-old girl with Downs syndrome. She loves music and likes to sing, but is sometimes shy. She records her voice in one of WAVE's glowing arms and recites names of favourite dishes like 'Taco' and 'Pizza'. Her assistant interacts with the two arms of the WAVE and pitches the recording up and down. Petronella laughs at the parrot-like pitch effect. Petronella lies down, on top of the transducer with heavy vibrations and tangible responses. The vibrations from the beat in the synthesised voices in WAVE make her calm and feel safe as she feels the bass rhythms on her body. In a safe environment Petronella takes the initiative. Instead of being withdrawn, she and her assistant collaborate and create melodies with their voices that they manipulate and vibrate throughout WAVE. This makes them giggle. WAVE is programmed to analyse melodic events built up from binding vowels and separating consonants as described above in the section called *Voice in music therapy* (see also Bruscia, 1987, p. 358, Sokolov, 1984). On increased and repeated interaction, the timbre of the sound changes towards sharp percussion sounds and FM-synthesis and high-pass filtering effects. Petronella holds on to certain sounds, where the binding vowels are supporting her actions. She also reacts to sharp consonants and timbre changes that help her to distinguish the sounds and increase her sense of mastering (Ibid.). Petronella and her assistant improvise together as the assistant toggles between the last three sounds by playing with the arms, and Petronella continues to record new words.

¹¹ Read about Petronella exploring the WAVE carpet in Stensæth (2014a) or elsewhere in this volume.

To summarise, we observed the user Petronella, her assistant and WAVE create:

- *Voice-body connections.* Petronella sang as she lay on the vibrating transducer.
- *Positive emotions.* Petronella's self-created vibrating vocal holding (Ibid.) made it possible for her to explore her voice in a safe environment.
- *Structures for actions.* Petronella relaxed as WAVE offered her and the assistant fun feedback, playing around with her homework in speech therapy. Petronella and her assistant negotiated the meaning of the words and the manipulations as they went on interacting, varying the sound of Petronella's voice, *improvising together.*

Based on the above we observed how the users *crossed borders* of:

- *Abilities.* Petronella was motivated to use her voice, to explore the musical potential of the words. Petronella and her assistant developed new roles to each other, from being a person with disabilities and an assistant, to musicians playing as a group.
- *Ages.* WAVE motivated the young user and her adult assistant to develop an understanding of the vocal possibilities of WAVE hence crossing the borders of *ages.*
- *Locations.* WAVE motivated the assistant and Petronella to cross the borders of locations, from their interaction at an office desk to relaxing on the WAVE Carpet.
- *Backgrounds.* Interpretations that made it possible for Petronella to cross the border between different *backgrounds.* Interpreting WAVE as a playful octopus, she took the role of a player. Viewing WAVE as an instrument she mastered it. As furniture, WAVE offered her a vibrating and safe sofa where she took the role of relaxing.

Conclusion

Our voice and body are important ways in which to communicate and build relations across borders such as abilities, ages, locations and backgrounds. In two design cases of vocal and tangible interactive media, we have adopted vocal composition and improvisation techniques from music therapy, with the goal of informing our own design practices in the field of interaction design, assistive

technologies, musicology and interactive sound design. Traditionally, the music therapists' techniques are used to create rhythms, melodies and harmonic development, in order to motivate activity, voice-body connections and social interaction and to evoke positive emotions. In the subsequent observations we have shown how they can be designed in order to motivate vocal and tangible interaction through the strengthening of voice-body connections. For instance, with the use of *vocal holding techniques* creating sound and vibrations on the body for calming and soothing, or for putting focus on breaking difficult boundaries. We have shown how we have adopted music therapy's notion of *structures for actions* to design musical rules and tangible hardware that change and create expectations for future events in time and space. We have shown how vocal and tangible interaction has been able to address issues of crossing borders, like those of abilities between 'patient' and 'care giver'. In this sense vocal and tangible interaction has been successful in breaking individual and social boundaries. Lastly, we thank Fredrik Olofsson in the MusicalFieldsForever (2000) for his creative contribution and collaboration on the design and the development of the musical and interactive tangibles.

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An interactive technology for health: New possibilities for the field of music and health and for music therapy?

A case study of two children with disabilities playing
with 'ORFI'

Karette Stensæth and Even Ruud

Digital music technology represents new challenges as well as new possibilities for the discipline and practice of music therapy. When such technology also incorporates interactivity, even further steps are taken in our efforts to improve health and wellbeing through musical means. This article explores how interaction with a new type of interactive musical tangibles can contribute to health and life quality for certain children with disabilities and developmental disorders. Its point of departure is the multidisciplinary research project RHYME, which explores a new treatment paradigm based on collaborative and interactive net-based musical 'smart things' with multimedia capabilities, positioned within a broader perspective upon the definition of health. The article is an extended in that we discuss theory, method, and results deriving from the first first test situations in RHYME. Following a short introduction of the RHYME project, part 1, which is theoretical, we will define our position with regards to various concepts of 'music' as well as 'health and wellbeing'. We also briefly relate the RHYME technology to traditional as well as digital instruments within music therapy practices. In part 2, we introduce our methods of sampling and evaluation in this study, including our applications of action research and video analysis. Our process of data collection is reviewed in part 3, which includes two video analyses. In the first analysis, we focus on the relationship and interaction between the child and the co-creative tangibles, and in the second analysis on the interactions among the child, the co-creative tangibles (CCTs) and the close others who assist the children in their exploration of the CCTs. We also introduce the tool called Assessment of the Quality of Relationship (AQR), which we applied in the first analysis. In part 4, we consider the potential health benefits for children who interact with the CCTs. We also look at the ways in which music therapy might benefit from the use of this kind of music-interactive digital health technology.

After presenting the background for RHYME, we will discuss aspects of data deriving from the experiments involving the CCTs called ORFI (see later). We will discuss the results deriving from our video analysis of two of the participating children, 'Frode' and 'Ulla'. Our research question is threefold: *How do the children relate to and interact with the co-creative tangibles; in what ways can their interaction become potentially health promoting; and how could music therapy profit from such interactive music therapy?*

Part 1

The RHYME project:¹

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the children and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

1 The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology and Design by Stensæth (Ed.).

The present article focuses on the first prototype with the help of collaboration partners including children with disabilities, their ‘close others’² (most often someone they know well from school) and the CCTs. In the empirical study of ORFI, the first generation of tangibles (see more later), there were five specific areas that the research group identified for further exploration and development:

- To accommodate more, easier and more varied interactive and shared musicking possibilities.
- To provide responses using sound and light that are *close to the place of interaction*.
- To experience *more sensory and cross-media interactive possibilities*.
- To work further with *voice input* as a base for the musicking experience.
- To develop CCTs that might one day be possible to have *at home*.

Based on what was learned from the early rounds of actions with ORFI, the WAVE concept was developed by the creators and designers in the RHYME research group.³

Music therapy instruments – from ‘unplugged’ to MIDI

The use of digital music technology represents a continuation of previous technologies used to create or reproduce music. Musical instruments, in general, are technologies and we know how for instance music therapists rely upon a whole range of musical instruments in the interests of promoting development and improvement in their clients.⁴ Their options span the traditional piano and drums of the Creative Music Therapy developed by Nordoff and Robbins to the spectrum of Orff instruments in combination with ethnic instruments and sound sources, band instruments and the high quality, aesthetically crafted anthroposophical instrumentarium. More recently, we have witnessed the development of a new generation of electronic instruments that rely upon MIDI technology as well as the digital and interactive sound media that are exemplified through the present RHYME project.⁵

2 In sum, the term close others refer to people who are all open and sensitive to the needs and the expressions of the children with disabilities. For more see Eide (2014) or elsewhere in this volume.

3 See Stensæth (2014a) or elsewhere in this volume.

4 See Ruud (2014) or elsewhere in this volume for a discussion of instruments as artefacts.

5 In the context of electronic musical instruments and digital music technology, we must always include recording equipment and the technology of music production. Though it is beyond the scope of the present discussion, it remains very much the case that music therapists today use portable music technology for recording, editing and producing music in tandem with their clients.

Much electronic music equipment also uses MIDI-generated sounds combined with a special technology for example, Soundbeam. Or the electronic music equipment could work in combination with software that produce sounds through switches, like Midicreator, or with drum machines that use either switches or drum pads. This equipment can also be attached to an acoustic instrument. Magee and Burland (2008), as well as Magee (2013), give an overview of such technology as it is used in music therapy.

The Soundbeam system, for instance, seems to be the most commonly applied music technology in music therapy. Its website reads as follows: 'Soundbeam is a distance-to-MIDI device which converts physical movements into sound by using information from interruptions of ultrasonic pulses emitted from a sensor' (see www.soundbeam.co.uk).

Midicreator is also popular:

A device which converts the various signals from electronic sensors into MIDI. Assorted sensors are available which sense pressure, distance, proximity and direction. These are plugged into the front of the unit, which can be programmed to send out MIDI messages corresponding to notes or chords (Magee, 2008, p. 125).

Other known technologies include switches and sensors attached to computers and custom-designed software. In general, digital music technology is developing very quickly in tandem with research on the interaction between sound and movement.⁶

The ideology behind the construction of ORFI derives from the research group's interest in facilitating musical cooperation and communication on equal terms between different users in different situations. ORFI resonates with music therapy in general in this way, because therapy also puts great emphasis on relating to the individual according to his or her particular needs, interests and skills, and to create mutually meaningful experiences through musical interaction. Cappelen and Andersson sum up the ideology behind ORFI in this way:

The persons consuming the sound are not passive listeners anymore, but active users, able to dynamically *shift between roles*, by choosing position in space, relations and roles to other people and the music. The user can take part in changing the sound experience in real time, based on the rules the composer has created as a potentiality in the software.

⁶ See Refsum Jensenius (2009) and Johansen (2007).

This differs in a significant way from the jazz improvisator or the professional musician. The fact that the composer writes *programming code* is an essential difference. Instead of writing one linear work, he creates infinite numbers of *potential music* that reveal themselves as answers to user interactions in many situations. This might be like an *instrument* responding to a musical gesture, or a competent and *intelligent actor* answering musically in an improvisation session. But everything has to be formulated in advance as rules in the software. The challenge is to create music, through user interaction, that *motivates* to further *co-creation* of the music and moving image narrative. Everything has to be formulated in advance, based on genre and music knowledge and competence in social behaviour (Cappelen Andersson, 2008, p. 84, italics in the original).

The fact that the ORFI music is programmed as an *interactive* composition – that is, as ‘potential music’ which might best facilitate (musical) interaction – will merit further discussion later. Andersson and Cappelen note that they structure ORFI’s software and musical compositions using three layers: sound nodes, compositional rules and narrative structure. The sound nodes are the least-defined musical units – single tones, chords or rhythmic patterns. These nodes can be combined in sequences or in parallel events using the compositional rules (algorithms). The user then perceives these combinations as narrative structures according to his or her experience with existing musical genres. By pressing or flexing the arms of the ORFI pillows, the user can even manipulate the compositional rules that arrange the sound nodes. The results of this intervention create a new musical narrative as well as an altered visual display. The narrative structure may also imply future results and thereby create expectations, not all of which will be satisfied, occasioning further intervention in turn. This is also how ORFI fundamentally differs from traditional and even MIDI-based instruments, which are exclusively responsive rather than co-creative as such.

Part 2

Methods connected to the collection of the empirical material

Given its reliance upon subjective interpretation as well as the in-depth study of selected user interactions with the co-creative tangibles, this study places itself solidly within a qualitative paradigm, and indeed, as a research project, RHYME has been governed by the model known as ‘action research’. Its main tools for analysing its data are two types of video analysis: micro and macro. In what follows, we will discuss some of the methodological challenges that are associated with action research (briefly) and video analysis (more extensively).

Action research

In terms of the present project, action research is understood to encompass both work undertaken to solve an immediate problem and a more reflective process of progressive problem solving. The research group, again, represents three distinct interdisciplinary fields; as such, it is not a ‘community of practice’, and a big part of its reflective action research is the development of common ground. Defining core concepts such as ‘health’ and ‘co-creation’, for example, is crucial.⁷

The RHYME project also incorporates responses from users, as mentioned above, so that researchers must record all of their impressions from the live interactive settings (observed through a two-way mirror or on the video recording of the interaction), analyse the video recordings in terms of user contributions, and compose and consider questionnaires in order to incorporate the reflections of close others or the child’s family members.

The use of video and analysis of video recordings

The word ‘video’ comes from the Latin *vide*, ‘to see’, and the process of analysis, of course, involves taking something apart in order to see it more clearly or systematically, or simply in a different way (Stensæth, 2008). The RHYME project benefits from the use of video analysis thanks to its rich access to the details of intersubjective interaction, both verbal and non-verbal. Introducing video recordings into this

⁷ The concept of health is defined by Ruud and Stensæth in their articles in this anthology. Stensæth (2013) has elaborated upon the salient concept of ‘co-creation’.

research makes it possible to observe details in the expression of emotion and in actions, including, for example, subtle facial expression or small finger movements.

This type of close video analysis is also about *meaning* – what we see, that is, demands interpretation according to the implications of *denotation* (what is recorded needs description and recognition) as well as *connotation* (the ideas and values communicated through the recording, including the manner in which it was done) (Stensæth, 2008).

The validity of the resulting interpretations is enhanced by the research team's collective background and practical experience within the larger field of study, whatever the individual discipline in question (Creswell, 1998). As music therapists, including one person with significant experience with children in special schools, the present authors qualify as *insiders* in the field – scholars with privileged access to interpretations (Kvernbekk, 2005). Still, this does not mean that our interpretations are 'truer' than others. It is rather the case that, because we are trained to look for links, and because we have the terminology necessary to describe those links in these contexts, we are able to interpret and describe the different layers of meaning in the videos more quickly and precisely than most (Creswell, 1998). By linking the different categories of health – like mastery, vitality, meaning – to activity, emotions and co-created actions, we hope that our analysis will demonstrate that children's access to and use of CCTs can improve wellbeing via interactive intersubjectivity.

In the present analysis, the work of videography means 'to observe graphically' – that is, to observe and analyse the video material in either (1) a systematic way or (2) an exploratory way. The aim is the same: to capture and understand the various layers of meaning in the given video recording. In the present study of ORFI, we will present a systematic analysis, meaning that we have decided what to look for in advance (in this case, moments of co-creativity and the promotion of health).

In order to avoid bogging down in excessive detail, we have decided not to characterise the present approach in relation to other established orientations. Instead, we will characterise it pragmatically, by discussing the various challenges and outright hurdles that come into play with a reliance upon video recording for data.

Challenges connected to video recording

Among the problems arising from the use of video recording in research, also discussed in Stensæth's (2008) thesis, are (1) a video camera can disturb the setting/interaction, (2) a video observation might produce 'stronger' data than a firsthand

observation (seeing becomes believing), and (3) the video recording can conceal data.

In relation to the RHYME project, we indeed saw that two of the children were slightly disturbed by the cameras, but this did not prove to be a factor in the video clips as such, and we will not dwell upon it here.⁸ Regarding the possibility of distorted or 'strong' data, we remained vigilant throughout about this challenge to our study's practical validity, always asking ourselves: Are our interpretations representative? Does the way a child with disabilities acts on camera during the RHYME actions necessarily anticipate his or her behaviour elsewhere (and especially at home)? In addition, because we are admittedly privileging initiative and positive interaction among the children with disabilities, their close others, and the co-creative tangibles, body movements can receive exaggerated and even 'undeserved' positive attention. Lastly, because we are only able to process limited recorded material (each child, as of this writing, has been recorded four times for thirty minutes each) we must remember that, even in the RHYME action context, the children could have been acting very differently in situations outside of our video work.

Nevertheless, we know of no better tool for observation than video recordings. In the interests of studying individuals who use few words, we must be able to see and interpret their body language, and particularly individual actions and gestures, and to do so we must have the fullest possible access to the relevant events and processes. The idea that the body is the centre of 'everything', as phenomenologist Maurice Merleau-Ponty (1945/1994) first declared, is in fact a governing principle for the RHYME project. Merleau-Ponty likewise saw that certain areas of artistic practice, such as dancing or playing an instrument, are better understood via the body than the intellect (or language), and this holds true for our CCTs as well. Without our body-related data, our project results would have been weaker and even more distorted. We decided that the limitations of video data and analysis, then, were a hurdle rather than an outright obstacle to our success.

Levels of appearances connected to the video recording

Given the centrality of video data to our enterprise, then, we must elaborate upon the three levels of appearances involved in this material, following upon the work of Stensæth (2008) and Fink-Jensen (2003). They are as follows:

⁸ For further discussion of this particular circumstance, see Stensæth (2008).

- 1) The phenomenological level – that is, the live situation.
- 2) The *quasi*-phenomenological level – in this case, the phenomenon in a video recording is perceived indirectly, so that the researcher experiences it as if he/she were actually there.
- 3) The objective level – this derives from the researcher’s memory, via a diary or a log, and there is no direct perception of the phenomenon as such (Fink-Jensen, 2003, p. 263).

The first-order perspective (level 1), which could be called a pre-scientific level, is where the subject and the phenomenon meet. At level 2, the researcher has already created an object. At level 3, the objective level, the researcher does not experience the phenomenon directly at all. Sometimes these levels interact and alternate. Levels 2 and 3, for example, have something in common, in that parts of the situation can only be perceived indirectly. Yet it is more important to note the differences among the levels, because the quasi-phenomenological level tends to resemble the phenomenological level if the observer experiences the video recording as if he or she were really there in the live setting. As our interpretations move away from the phenomenological level, we will observe a certain degree of reduction in them, which in turn begs the following question: How much do we let the video recording *interfere* with ‘reality’? Stensæth observes (2008, p. 67):

Because a video recording is always a *re-construction* of a situation, two essential considerations must be made. First, we need to remember that a video recording is not the authentic situation but an image and a representation. A video recording cannot therefore reproduce an objective reality ... Second, we must remember that re-presenting through a video recording involves other qualifications than being present. Basically, this means that observing a video recording allows other modes of consciousness and other levels of reflection to come into play. Since the video recording allows rewinding and stopping, the observer will have more time to include more reflection.

Ultimately, she says, the video recording can only ever amount to a product of the researcher’s interpretation in the context of the project in question:

It is not a neutral representation; rather it represents a perspective of the person(s) in charge of the filming and the interpretations. This is just part of the reflexive nature of social research: as long as human beings are involved, they will influence the social setting in which they take part, either passively or actively. In the end, the overall challenge for every researcher is to convey and discern the various influences connected to the choice of data collection *and* to integrate it all in a sensible way into his/her particular research project (Loc. it).

Part 3

The data

In the following, we will present an analysis of videos taken from the testing of the first generation of co-creative tangibles, the ORFI.

Introducing ORFI⁹

The ORFI test period took place at the special Haug School and Resource Center in March 2011. ORFI is a prototype designed by Birgitta Cappelen, Anders-Petter Andersson and Fredrik Olofsson as part of their art project MusicalFieldsForever (see musicalfieldsforever.com) before the RHYME project began, so it was brought into the project as a basis for discussion of future co-creative tangible development.¹⁰

The technology and the musical ideology behind ORFI are reflected in the use of about twenty tetrahedron (pyramid-shaped) pillows that collectively represent a hybrid of a piece of furniture, an instrument and a toy (see picture 1). The pillows were handmade with black fabric in three different sizes that range from thirty to ninety centimeters in width.¹¹ Most of the black pillows have orange, origami-shaped (see photo) 'wings' with a 'light pin' along the edge. When the user bends the pillow (see picture 1), sensors inside generate light, sound and an image upon a screen or an adjacent wall. Through pressing upon a particular pillow, the user can then choose among eight different musical genres that will in turn govern ORFI's

⁹ Read more about the design of ORFI in Cappelen & Andersson (2014).

¹⁰ 'ORFI' is not an acronym, though it appears to be; it derives from the combination of 'Or' (short for origami) and 'fi' (short for 'field'). It also refers to Orpheus, the father of music in Greek mythology (see www.rhyme.no).

¹¹ See Andersson & Cappelen (2014, 2008) for more details.



Picture 1: *Bending 'arm' of ORFI 'pillow'*¹³

sound output.¹² When the user bends the various wings, he or she is choosing to make music and also change the light and the image(s) on the screen or wall. The co-creative tangible is both mobile and multimodal, and it could be said to behave in an 'intelligent' fashion that is quite different from a traditional musical instrument or a regular CD player. Because the co-creative tangible is programmed to remember and 'learn', that is, it can react musically but also idiosyncratically, either imitating or even improvising something new to suit the situation at hand.

12 These genres are labeled Arvo, Funk, Glitch, Mini, Jazz, Tati, Techno and Voxx. For more information, see www.rhyme.no.

13 All photographs courtesy Birgitta Cappelen.

The ORFI analysis

Collecting the data

Frode and Ulla are two of the five children who participated in the exploration of ORFI. Each child arrived at the music room with an adult from class whom the child knew well and trusted. Each child stayed for half an hour over the course of four consecutive Fridays. The ORFI room had been adapted for the test; its piano, chairs and musical instruments had all been removed, and the floor had been covered with a large, square, single-colored woolen carpet, placed in front of a large blank screen for the images. This screen covered an entire wall, and the different-sized ORFI CCTs were scattered atop and around the carpet.

We chose to give only a few instructions. The adults with the children were told to 'go ahead as they liked' in terms of both the CCTs themselves and the interaction that they might inspire. We did identify one pillow as the special 'genre pillow' – that is, the one whose manipulation changed the style of music produced by the ORFI.

The entire session was then recorded on three video cameras. Two of the cameras were fixed to the wall, one filming the ORFI and the other filming the screen in the background. A member of the research team, sitting unobtrusively in the background and some distance away from the carpet, used a handheld camera as well.¹⁴ Multiple cameras allowed us to obtain the most comprehensive amount of data.

AQR: how children develop a relationship with musical instruments

A developmental psychologist specialising in early mother-child interaction (especially involving children with disabilities) Claudine Calvet, and a music therapist specialising in working with children with autism or other developmental disturbances, Karin Schumacher, first developed the scale Assessment of the Quality of Relationship (AQR). They in turn relied heavily upon the theories of Daniel Stern, which we will summarise in what follows.

The experience of what Daniel Stern calls the subjective self, which is related in turn to the onset of intersubjectivity, becomes part of the development of the child between the seventh and ninth months of life. At this point, the child becomes aware of the fact that other people have feelings, motives and intentions that the child

¹⁴ This person did not know any of the children or adults who entered the room. The idea of having him in the room was to allow the participants to address him if they had any questions regarding the furniture. While he was there, we considered it expedient to have him capture minor movements and facial expressions, at his discretion.

cannot influence directly. Stern calls this complication the 'self with the other', noting that with it commences the development of the child's ability to interpret and evaluate, rightly or wrongly, what is going on in his or her environs (see Stern 2000).

According to Karin Schumacher and Claudine Calvet (Schumacher & Clavet, 2007), the AQR is meant to function as a tool to assist in the evaluation of the *quality of a relation*. The scale (see below) describes the relationship between the child's self (body and voice), objects (such as musical instruments or, in this case, the RHYME) and the music therapist. There was no music therapist present in the room during the test. However, the child did relate to the CCTs through the accompanying adult, whose role was to be with the child and support the child's exploration.

AQR describes the development of the user's relationship to the object using a series of 'modi', as follows:¹⁵

- Modus 0: Lack of contact/contact refusal/pause
- Modus 1: Contact reaction
- Modus 2: Functional sensory contact
- Modus 3: Contact with oneself/sense of a subjective self
- Modus 4: Contact with others/intersubjectivity
- Modus 5: Relationship to others/interactivity
- Modus 6: Joint experience/interactivity
- Modus 7: Verbal-musical space

In brief, then, this scale extends from modus 0, where the child do not show any conscious awareness of the object, to modus 7, where the child, through contact with the object, undergoes emotional changes and/or creates a new meaning (or 'imaginary', in the authors' words) which leads to verbalisation (either description or reflection). As none of the children in our video analysis have any verbal language, modus 7 is unlikely. To both Frode and Ulla, that is, non-verbal forms of expression such as bodily communication, movement, vocal expressions, facial expressions and simple finger signs (mostly sign-to-speech based) are much more relevant. Modus 6 is a possibility, because it describes a form of play that allows the child to experience and in turn demonstrate a particular feeling or affect.

With the help of AQR, then, we will be able to distinguish among the various conditions, interactions, and emotions that appear on the video recordings. This scale represents a point of departure for looking at the ways in which ORFI

¹⁵ For an extended explanation, see Schumacher & Calvet (2007).

can lead to various forms of vitalisation and interaction, all in the interests of the possible health benefits associated therein.

The selection of video clips and children

From a total of thirty hours of video footage in this first action (reflecting all of the coverage from all three camera angles), we have found that an analysis of only one minute from the interactions of Frode and Ulla, respectively, gives us a sufficient amount of information. We chose these two children because of their varied interactions with the CCTs, which in turn shed light on the experiences of the other children as well. We ultimately chose the video clips based upon their inclusion of those glimpses and camera angles which most clearly demonstrated varied activity, including actions and both physical and emotional reactions.

Short presentation of Ulla and Frode

These two happy and engaged twelve-year-olds entirely lack verbal language and exist at a developmental level that is correspondingly lower than their age. They both use sign-to-speech in their everyday communication, but Frode does so more than Ulla. Frode can walk and is very active, and he communicates primarily through his body, signs and laughter. He is moving all the time and often addresses the adults around him. He is also interested in technology and likes to explore his surroundings. Though she relies upon a wheelchair, Ulla can also be very communicative; she displays this by assuming an attentive attitude. She can be very persistent when she becomes interested in something, and she is particularly curious about sounds. Ulla has received individual music therapy lessons for years, which may have increased her appetite for exploring and playing with sounds.

Both children were known to one of the present authors, who worked for years as a music therapist in the Haug School and Resource Centre.

ORFI: the video analysis

The following video analysis is based upon two almost equally long excerpts of video footage of Ulla and Frode. The six Ulla clips total 1:03 minutes. They are all taken from her final session, which contained the greatest variation in interaction with the co-creative tangibles. The five Frode clips total 1:17 minutes. They are taken from three different sessions, in order to reflect the ways in which he

developed his interaction with the CCTs as he became more familiar with the setting.

The analysis places the individual clips into the following categories:

- a) Description of events
- b) Sequences of action
- c) Emotional action
- d) Interpretation

In (a) we describe everything that happens, while in (b) we focus specifically on the action that occurs. In (c) we describe the affects and emotions which we observe, and in (d) we interpret our observations. By ordering the categories horizontally, the relations between them become more obvious, as for example in the following analysis of a sequence from a clip of Frode:

Description of events	Sequences of actions	Emotion actions	Interpretation
F throws the pillow forward at the same time as he falls heavily down onto his butt while he laughs softly with an open, smiley mouth—and sends a look and gestures at the adult.	Throws pillows forward, falls down onto his butt, laughs softly, sends a look and gestures at the adult.	Laughs softly, lands on his butt, gesticulates at the adult.	He is comfortable in the setting; he is vitalised; and he communicates humour through his body when he approaches the adult.

Figure 2: Analysis categories

By looking at the interrelations that generate our interpretations, we can try to determine the degree to which they apply to the different AQR modi.

Analysis of Ulla with ORFI

We will next relate our different interpretations to the levels in AQR, beginning with the Ulla material.

- Clip 1: Is open and wandering while she explores the pillows.
Conscious action when she bends the wings on the pillows, as if she knows that there will be a sound response.
Addresses A and expects that A will 'play' with her.¹⁶
Becomes bodily and mentally stimulated, senses a surplus, and seems like she at times dances to the sound and with the pillows.
- Clip 2: Is safe (knows something about what is going to happen?) and shows expectation.
Filled with pleasure and accompanies sound and interaction with dancing movements with her head.
A lot of expression with head and upper part of body. When she turns her head downwards (towards her pillow), she focuses on what she hears (from all the pillows and the one that is held directly in front of one of her ears).
When she turns her head upwards and out into the room, she takes in everything that happens and at the same time shows (to A) that she is actively involved. When she senses the pleasure, surplus and motivation, she 'dances' with her head while the upper part of her body follows the movement.
Relates actively to the things, sound/music – and A.
- Clip 3: Focuses and listens in an engaged fashion, breaks out in laughter, experiences a surplus and listens intensely and with expectation. Does she experience flow?
- Clip 4: An intimate and intense moment – she is confident and safe and seems to think that this is exciting. She listens intensely and with expectation both at the sounds and the initiatives from A. High intensity – peak experiences. Senses that both are making sounds and that they are interacting. Shares feelings with A.
Intersubjective actions, turns to both the pillows (the co-creative tangibles), the other (A), and also inwards. Strong experience of sharing, seeks confirmation from A and gets lots of pleasure.
- Clip 5: Is engaged. Does she imitate the saxophone?
Does she recognise her own voice, and does this lead to her using her own

¹⁶ The abbreviation 'A' refers to her adult caretaker, while 'l' is left and 'r' is right.

voice? Does she experience mastery when she laughs and nods her head afterwards?

Clip 6: Intimate moment – shares feelings.

When A stops, she understands what is happening, smiles as she acknowledges it and seeks confirmation from A – and gets it.

If we compare these interpretations from clip 1 with the AQR, we find that they all fit well with modus 3, because Ulla explores the pillows and further seems to recognise them as potential ‘musical instruments’ that she can play, listen to and ‘watch’ (on the screen). Her affective state – she ‘becomes bodily and mentally stimulated, senses a surplus’, and further ‘dances to the sound and with the pillows’ (see above) – could be seen as a sign that she has become vitalised. We see this state when the responses she produces from correctly bending the wings on the pillows directly affect her body and feelings. The process of vitalisation intensifies in clip 2. Here, she brings her experiences forward as well, because she indicates *expectations*. Music therapist Ulla Holck writes that expectations are fundamental to meaningful interaction:

Expectations make it possible to recognize a *departure from the expected*, and thus the child will recognise humour, building of intensity, surprise, teasing, frustration, or aversion, depending on his/her intersubjective development (Holck, 2004, p. 8).

Expectations are therefore essential to vitalisation. We also see through Ulla’s laughter and intensive listening in clip 4 that she experiences the events with pleasure and even humour. When she begins to expect a response from the co-creative tangibles, she is relating to them in an intersubjective fashion. The sound becomes a social phenomenon, thereby evoking both AQR’s modus 4 and 5, because ‘the instrument is played in the form of a dialogue, as in question and answer games’ (Schumacher & Calvet 2007:83).

When it comes to Ulla’s intersubjective relation to her close other, we are able to discern its impact throughout, from clip 1, when she ‘addresses A and expects that A shall ‘play with her’, to clip 6, when she ‘shares feelings’. In this way, she also evokes modus 6, because she establishes a space for interaction through the CCTs where she can be together with her close other. The CCTs in this modus represent what Schumacher & Calvet (2007, p. 83) label a playful way to demonstrate an affective state.

Analysis of Frode with ORFI

When we extract the various clip interpretations from the video analysis of Frode, we produce the following summary:

- Clip 1: Is attentive and wandering while he explores the pillows, the screen and the interrelation between them. He tries out several ways to handle the pillows. *Are they heavy?* He seems to think it that this is exciting and wants to communicate this to A. He wants A to share this experience with him – he both wants and needs validation from A? Speaks and gesticulates through the pillow (when he ‘bends-points’ with it). Is excited and wants to share feelings with A.
- Clip 2: Thinks this is exciting. Associates the pillow with a drum.
Gets aroused and feels surplus – is stimulated to creativity and imagination, which leads him to musicalise his movements by ‘playing drum’ on things and people around him.
Becomes energised. Transposes and transfers the idea of playing music on body and surroundings. After playing on the pillow he explores the possibility of playing on his own body (stomach); when he stretches his stomach in the air, he makes his own body visible to himself as a ‘drum head’. At the same time this becomes a way for him to place himself in the background and his ‘musicking’ in the foreground. Do we glimpse, for a moment, ‘flow’? He challenges A and wants to share experiences with her.
- Clip 3: He becomes engaged bodily and more daring in his exploration of the co-creative tangibles.
He seems to think that the sound/music is exciting and funny. He explores body and balance (vestibular sense).
Plays actively with himself and with A. He mirrors himself in A (who mirrors him) and invites a dialogue when he claps his thigh and laughs, then looks at A, as if to say ‘this is funny!’
He wants A to verbalise for him.
- Clip 4: Is safe in the situation and getting ‘warmed up’.
Explores both alone and together with A, through body and senses (hearing, sight, touch, movement and vestibular [balance-related] experiments) – everything with increasing energy and greater intensity.
- Clip 5: He presents himself with vitality and is exploratory using his body, while the pillows stay in the background. He uses a funny bodily language, including ways of landing on his butt.

He seems confident in the setting and lets himself loose. Shares experiences. When Frode's expressions of vitality are applauded by A, he is encouraged to maintain the intensity of his activities. He challenges his own sense of balance and also uses his body communicatively (as an exclamation mark) when he falls on his butt, as if to say 'this is funny!' He experiences mastery and flow.

As was the case with Ulla, the interpretations from clip 1 first evoke modus 3, because Frode primarily explores how the pillows are functioning, how the sound is created by bending the wings and how the device responds by producing graphics on the screen in front of him. In the same clip, he comes to regard the pillows as musical and as co-players, and he responds to the sounds and images in a positive and adequate way. He also makes social gestures in the situation by addressing the adult for validation as well as to communicate what he is discovering and experiencing. These social gestures evoke modus 4. Perhaps most surprising, he seems to 'speak'/gesticulate through the pillow (when he bends-points it) to remark upon his explorations. It is, of course, possible that Frode, who relies upon simple finger signs in his everyday communication, performs these movements unconsciously – that is, he automatically 'draws' with the pillows because he happens to be holding them while 'speaking'. But it is also possible that Frode in fact finds a 'voice' in the CCTs exemplified by ORFI, evoking modus 5 in AQR, which describes use of the object as part of a form of dialogue in lieu of vocalisation (Schumacher & Calvet, 2007, p. 83). If the CCTs are found to function as an alternative voice, they would clearly be strengthening communication and thus demonstrating a therapeutic potential.

The clips also indicate that Frode becomes vitalised during the testing periods. His state of affect increases from clip to clip, from 'safe and enthusiastic' to 'getting heated'; we find him 'getting loose', and later he 'challenges his sense of balance' when he falls on his butt while trying to be funny (see above).

In these sequences, we interpret all of this behaviour and interaction as an experience of mastery and flow, evoking modus 6 in AQR, which encompasses interaction with the object 'in a consistently positive state of affect, i.e. mostly played with pleasure', because the object 'helps to playfully demonstrate a state of affect' (Schumacher & Calvet, 2007, p. 83). However, we also note that Frode's body is more foregrounded than the CCTs, and that he is exploring with all of his senses. Happily, the CCTs are activating several different parts of him: Frode is challenged both physically (via his senses) and intentionally (when he throws himself into his many different movements) as well as mentally and emotionally. It seems like his

body negotiates his self – that is, when he explores his body (or challenges it), he produces proximal bodily movements, which in turn gives him an experience of flow and an increased sense of self (or sense of mastery, as in our interpretation above). For most children, it is often the case that the body is the focus when the world is to be explored. This may be even more likely when the child is younger and has less verbal skills, or when the child has disabilities. When the body creates a hindrance, it must be overcome, and it therefore represents a potential entry point to healthful aesthetic-creative activities (Stensæth, Wold & Mjelve, 2012).

Another unique event transpires in clip 2, when Frode associates the pillow with a drum he can play on, then transfers this notion to his own body and starts to play his stomach like a drum. As we read above, he stretches his stomach in the air and makes the middle part of the body more visible, positioning his musicking directly in the midst of everything. This activity evokes modus 6 in AQR, where it is said that playing the instrument ‘can lead to associations’.

A last interesting point in the interpretations of the video clips with Frode is the degree to which he enjoys the setting and the way in which he makes his close other verbalise this pleasure for him (see the last sentence in clip 3). It seems as though Frode is at the threshold of those emotional changes that can lead to verbalisation, following modus 7 in AQR: ‘The instrument sets off emotional changes and/or imaginary contents that lead to verbalization (description/reflection)’. We do not believe that anything in this clip qualify for modus 7 as such, but it is nevertheless exciting that our interpretations reveal a potential for the use of verbal language by a child like Frode.

Summary of the ORFI results

As we have seen, our analyses of both Ulla and Frode place their actions among modi 2 through 6 in the AQR, with an emphasis on the upper part of the scale. This means that Frode and Ulla relate to the CCTs on a basic sensorial level (modus 2) and on a more advanced level, whereby they share feelings with others (interactivity) (modus 6). Though it remains evident that these children are able to explore ORFI only to a limited extent, they clearly bring expectations to the activity: they perceive the objects as co-creative instruments through which they can explore feelings as well as interactions with others. In turn, we have determined that this exploitation of the CCTs leads to different forms and intensities of vitalisation.

Summing up, the ORFI analyses reveal that the CCTs seemed to *vitalise the two observed children both bodily and mentally*:

- 1) The children seemed to be *stimulated to explore through their basic senses*, including hearing, sight, touch, the kinesthetic sense, the proprioceptive sense, and the vestibular sense; in turn,
- 2) *mastery and a sense of agency seemed to be strengthened*, which
- 3) afforded the children new ‘possibilities of actions’ (see Ruud, 1998) and ‘new possibilities of interaction’ (see Stensæth, 2008), which ultimately
- 4) *empowered them* to become creatively and aesthetically engaged.

The vitalisation that accompanied exploration of the CCTs seems to represent their greatest health potential. The fact that the children felt enabled to explore the object in their own way was also significant. Both of these aspects of the analyses correspond to an ecological perspective on health, which asserts it to be an ongoing (active) process that must be reconstructed continuously. The encouragement of personal exploration also corresponded to Bruscia’s ecological health concept, which emphasises the realisation of ‘one’s fullest potential for individual and ecological wholeness’ (1998, p. 84).

Aside from the vitality aspects, our observations likewise encompassed the facts that the two children could experience and develop communication through

- contact with themselves and the feeling of a subjective self,
- contact with the CCTs (objects) and with the co-creative close others (intersubjective aspects),
- developing relations to subjects, objects and environment, and
- *qualitative sharing* of feelings (interaffectivity) (Stensæth & Ruud, 2012).

In addition, it seemed as though the shifting in responses, which is the aspect that most distinguishes the CCTs from other interactive toys and instruments, created much joyful expectation in the children.

Part 4

Discussion

Our initial questions were: *How do Frode and Ulla relate to and interact with the co-creative tangible; in what ways might this be potentially health promoting; and how might music therapy benefit from such interactive music therapy?*

The analyses of the video clips have clearly demonstrated some of the ways in which the children related to and interacted with the CCTs. We see that the CCTs afford Frode and Ulla *something other* than what traditional instruments and toys do. For example, both children seem to relate to the CCTs in a more bodily and sensuous way. They both use their primary senses fairly actively, as is clear when they are stimulated to 'touch', 'dance with', 'play at', 'throw in the air', 'listen to', and 'focus on', for example. With ORFI, Frode even imitates playing a drum, first by using the CCTs as drums and then using his own stomach. The results of our interpretation also demonstrate ORFI's impact on the wider aspects of health, thanks to its ability to

- stimulate increased creativity;
- provide space for the exploration of objects as well as subjectivity;
- build new relations (both to objects and to subjects);
- create new potentials for action and mastery;
- experience meaningful here-and-now situations with objects.

In terms of ORFI's impact on health, we have concluded that subjective experiences such as these are associated with an increase in life quality. The question that remains, then, is this: To what extent does ORFI encourage actions and experiences that can build health for participants?

If we look first at the health-related aspect of *vitality* in the ORFI analyses, the resonance with modus 6 on the AQR scale points to the fact that the CCTs, like ordinary musical instruments, represent a means through which users can express themselves. What becomes clear as well is the relevance of the device to the body in particular. Perhaps the sound, coupled with the experience of the different genres, the open space and the free exploratory form of the device, along with the shifting of its responses, invites bodily involvement?

If we look at the health-related aspect of relations or bonds with other people, we see that each of the children in the analyses frequently orients him/herself through the accompanying adult. In this sense, the adult becomes an alternative medium through which the child explores the ORFI environment. This is not a new idea as such; children with disabilities are surrounded by caregiving adults. What is significant in this case, as we can see from the video analyses, is the fact that new possibilities for co-created actions emerge in the testing periods, both with and through the interactions among the child, the CCTs and the adult. These possibilities for co-creation in turn produce new and valuable experiences of communication. Thus not only what the subjective self but also a healthful intersubjectivity is

promoted by the device. This means that the child shares the experience of understanding with another person.

In the end, we might expect that the suite of experiences of co-creation and mastery enabled by ORFI give the user new resources and increase the sense of agency or empowerment. The technology accomplishes this by offering the user a new space for action and creation.¹⁷

In clip 4 of Ulla, we note that she experiences *flow*, and we note the same thing in clip 6 of Frode. Flow is a term for an intensive state of affect, one that transcends the everyday. Csikszentmihalyi describes flow as a state that represents a value in itself; it is without any goal and strongly affected by the 'here-and-now', and it makes us feel as though we are operating at our optimal capacity (Csikszentmihalyi, 1985). Flow, which can accompany play as well as creative and aesthetic activities, impacts two aspects of existence: (1) the individual's possibilities for action as well as for challenges, and (2) the individual's efficiency, skills and competencies. In the present context, flow represents an intense experience of vitalisation which both balances and challenges Ulla and Frode's need for action. Flow therefore becomes another indication of health (or optimal capacity).

In light of the ORFI analysis, we might say that reaching a higher modus in the AQR tells us something about the CCTs' potential for health. By associating meaning with health and with the interactions enabled by ORFI we beg the question about the relationship between music and meaning. That is, when we claim that our engagement with music involves the experience of meaning, we are referring to non-propositional forms of meaning. These forms do not rely on language or verbal utterances but are felt as a sort of embodied participation in the world – a felt tension and expectation (Aksnes & Ruud, 2008; Johnson 2007). We experience meaning through our embodied participation in the world when we find ourselves in a state of flow.

Stensæth (2013), in her article on the concept of co-creation, suggest that for co-creation to afford health musicking, we must allow for *combinations* of collaborations among all of the CCTs, the child with disabilities and the close other. For some children participating in RHYME, it is the relation between the child and the close other that creates the most effective collaboration with the CCTs. In the future, when the CCTs are tested at home within core families, it may be that a brother's particular interaction with the CCTs can promote collaboration between him and a sibling with disabilities.

17 See Rolvsjord (2008) on the philosophy of empowerment.

Conclusion

How can we summarise our experiences after our tests with the interactive ORFI objects, and what consequences might they suggest concerning the development of new generations of CCTs and for their use in music therapy? Before we draw any conclusions as such, we must recall that, so far, we have only analysed a positively laden excerpt of a few of the video clips by Ulla and Frode in the two first actions. In these situations, the children were always together with adult close others whom they knew well. Still, it is evident that the different spaces of action and interactive forms of co-creation afforded by ORFI point to something healthful – at the very least, to an empathic shared experience of a meaningful moment. At the same time, they strengthen own subjectivity and agency.

However, we also saw that the CCTs afford forms of interaction and possibilities for use that the children did not manage to appropriate. The plurality of genres and possibilities for creating complex music present many musically interesting challenges for social groups of different ages and cultural background. For this particular group of children with disabilities, the musical complexity might be too great, at least within the timeframe permitted by this testing. At the same time, some of the ORFI responses were not obvious or relevant enough, which occasionally produced confusion and insecurity about the reliability of the CCTs. A more individualised approach for these particular children might have ensured more transparency, better directions and more predictable structures for expectations related to certain music-therapeutic goals.

In short, it is certain that ORFI afford playful and relational interaction. It would further appear to be possible to develop new prototypes that allow for even more individually adapted forms of interaction and expression.

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Potentials and challenges in interactive and musical collaborations involving children with disparate disabilities

A comparison study of how Petronella, with Down syndrome, and Dylan, with autism, interact with the musical and interactive tangible 'WAVE'

Karette Stensæth

Vignette 1:

When Petronella and her 'close other'¹ enter the semi lit room, the only thing they see is the big octopus-like pillow known as the WAVE carpet, which is interactive and musical and has a built-in camera and microphone as well as capacities for vibration and audio. Petronella lies down on the WAVE carpet while her close other sits beside it, next to her. Soon, Petronella finds the particular arm of the WAVE carpet that houses the microphone. She picks it up and says 'Say Europe' into it. When her close other bends the sensor of another arm of the WAVE, they both hear the carpet say 'Europe!' in a voice that is similar to Petronella's but somewhat distorted and different as well. Petronella finds this amusing and says other words into the microphone, all of which the WAVE carpet repeats back to her. However, when Petronella eventually says 'Say Taco!' into the microphone, the WAVE says 'Europe!' instead. Petronella is surprised, then laughs. Her close other laughs too.

Vignette 2:

Another time, in the same room with the same WAVE carpet, Dylan arrives with his close other. They both sit down next to the WAVE carpet. The close other shows Dylan the camera that is built into one of the WAVE carpet's arms. She knows that he loves cameras and hopes that this will encourage him to play and collaborate. With guidance from his close other, Dylan picks up the arm where the camera is placed and projects his own face on the nearby white wall. He keeps the camera still and sits like

1 This term generally refers to family members or others who the child with disabilities views as close or even family-like. Aides who assist the children to the RHYME action know the children well and are also close others. The role of the close other in the RHYME project is discussed thoroughly in Eide (2014) or elsewhere in this anthology.

this for a long time. Because the camera is not being moved, its function pauses and screensaver graphics appear on the wall. The graphics create colourful patterns that move slowly across the wall. Dylan stares at the patterns and seems to withdraw or lose contact with himself, his close other, and the whole room.

Introduction

The vignettes above, small narratives derived from the video analysis presented later on in this article, illustrate the potential differences in reactions of two children with disabilities as they are introduced to the musical and interactive tangible known as the 'WAVE', which was developed for the on-going qualitative interdisciplinary research project known as 'RHYME' (www.rhyme.no). RHYME addresses the lack of health-promoting and musical interactive communication technology (ICT) for families with severely disabled children, and the present article presents a comparison study of two of the participating children. The children are the rather active girl named Petronella, with Down syndrome, and the more passive boy named Dylan, with autism. Through an examination of the manner in which these two children approached the WAVE, this article will present some of the possibilities and challenges associated with the development of such health-promoting media for children with disabilities.

The study's data collection includes a video analysis of the children in co-creation mode with the WAVE and their close other. The video analysis is triangulated with a focus interview conducted with a group of professional experts to elicit their observations of the video footage of the children.²

The research question to which this article is devoted reads as follows: *Why do the two children relate so differently to the same musical and interactive tangible, the WAVE carpet, and what would facilitate the most meaningful and health-promoting co-creation experience for each of them?*

The article will start out with a short introduction to the RHYME project and the WAVE. I will then define *co-creation*, one of the core concepts in RHYME as well

² These experts included three occupational therapists (specialising in activity and sensory integration and the building of sensory rooms), one special education teacher (specialising in children with autism), and two music therapists (specialising in musical improvisation in therapy). All of the experts were experienced with children with disabilities, and all of them had worked or were working at the school where the data was collected or a school like it. This means that some of them knew Dylan and Petronella well.

as this study, and introduce the two subject children. Before I present the video analysis, I will discuss methods of video analysis more generally. I will also begin to incorporate comments from the interview with the experts.

The RHYME project:³

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the children and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

WAVE

The WAVE concept consists of two *different forms* of tangibles, the WAVE carpet and the WAVE orange. The WAVE carpet, which is the CCT used for the present analysis, is a seven-armed carpet, which is wired for a range of cross-media

3 The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology and Design, by Stensæth (Ed.).

possibilities. The WAVE orange is a wireless iPhone/iPod-based toy/beanbag chair with two arms. This study deals entirely with the WAVE carpet (from now on generally referred to as the WAVE).



Picture 1:⁴ Resting on the WAVE carpet

The WAVE concept consists of (and in turn reflects) many connections. A wave is frequently used as a representation for music, but it is also a way to interact with accelerometer sensors, which the creators wanted to use. Waves are aesthetically inspiring, particularly in relation to nature – the movement of water in the ocean or of wind across a field of barley, for example. The specific design of the WAVE therefore resonates with wave-related shapes, structures, surfaces, sounds and interactive forms.

The WAVE experiments took place in March 2012 at Haug School and Resource Centre, outside Oslo. During the first empirical studies devoted to a prototype of the CCTs called ORFI at the same place in March 2011, many goals and requirements were proposed and formulated for the first generation of CCTs in the RHYME project – that is, WAVE. As music and health professionals, the project group was particularly interested in the fact that CCTs users wanted *the sound source to be closer to the place of interaction*, along the lines of how an acoustic instrument

⁴ All photographs courtesy Birgitta Cappelen.

works. For interactive CCTs, then, this meant placing the input sensors close to the output speakers. Through a more proximate sound source, the children with disabilities would generate a more direct response to their actions. The research group concluded that this would not only help them to understand the CCTs' responses to their actions but also stimulate those actions (and reactions) more directly.⁵

For similar reasons, in terms of lighting, the project group learned that CCTs' users wanted *proximity between input sensors and light*. The group also sought a sensor that would be easier to interact with than the bending sensors they had in ORFI, which were tested the year before WAVE.⁶ The bending sensors worked in a sense that the user had to bend a part of the CCTs to get a response, which was (too) difficult for some of the weak children. In the end, then, WAVE incorporated significant cross-media collaborative interaction, combining musical interaction with visual interaction using a camera and projection.

Because the WAVE carpet is connected to an external computer and the power grid, it features many input and output possibilities and offers new cross-media interactions that transcend those of the ORFI.⁷ The creators described one of the new qualities of the programs incorporated into WAVE as 'Music Interaction – Voices' because of the play with voices that is involved, whether synthetic and computer-generated or simply human. For example, users can record their own voices (recall vignette 1). Being a participator in the RHYME research team I suggested this particular functionality because, for one thing, the microphone is typically very attractive to children. How many times do we find children singing into a hairbrush in the bathroom mirror, imitating a pop star holding a microphone? In addition, I realised from my experience as a music therapist, if the CCTs were able to strengthen these children's (tentative) voices, the use of a microphone could also fulfil another health-related potential of the CCTs.⁸

In order to stimulate the users in a bodily and sensory fashion, which we know is vital from successes with music therapy on people with severe disabilities, the

5 The creators of the CCTs remark upon the complex design challenge that is involved here, especially regarding wireless objects, in terms of object size and weight, sensor qualities, sound quality and wireless sound transmission. Due to these various complications, they believe it would be wise to base future prototypes on Smartphone technologies, because they have perfected a very compact package of wireless technology, sensors, battery and sound transmission.

6 The creators faced design challenges here as well, regarding the transparent (illuminating) material, its tactility and the desirable qualities of the sensors. They wondered: How could they design sensors that motivated the user to interact comfortably in a variety of ways over an extended period of time?

7 See the article on ORFI by Stensæth & Ruud (2014) or elsewhere in this anthology.

8 See the article about vocal interaction in RHYME by Andersson & Cappelen (2104) or elsewhere in this anthology.

research group also wanted to *include vibration responses* in the CCTs. A vibration element is therefore built into the WAVE in the centre of the WAVE carpet.

In all, then, the WAVE carpet includes the following input and output devices:

- Six infrared sensors with light response in a bubble-shaped field (see picture 5)
- Microphone with light response in one arm (see picture 4)
- Camera with light response in another arm (see picture 2)
- Pico projector in another arm (see picture 3)
- Two bend sensors with light in two separate arms
- Two accelerometer sensors with light in two separate arms
- Sound vibration element (Visaton)
- Two speakers
- LEDs included in the orange, velvet textile

As we have seen in the vignettes, the two children discussed in the present study were attracted to the camera element and the microphone element in WAVE. Petronella also played with the WAVE bubbles. These elements are depicted in the photographs below:⁹



Picture 2: WAVE Arm with camera



Picture 3: WAVE Camera projecting on a wall

⁹ Video illustrations of the WAVE carpet can be seen at http://rhyme.no/?page_id=1034.



Picture 4: Singing into the WAVE microphone



Picture 5: Playing with the WAVE 'Bubbles'

Additionally, the WAVE carpet includes the following technology:

- Arduino Mega and a custom shield
- Arduino software for controlling the input and output
- Two amplifiers
- Mini-Mac
- SuperCollider as sound software
- Processing as video and graphical software¹⁰

Defining co-creation¹¹

In the RHYME project, *co-creation* is a key word – in fact; it describes the very path to achieving the project's aforementioned goals of defeating isolation and promoting health and well-being. In the present article, I will rely upon my earlier elaboration of the notion:

¹⁰ For more about this technology, see www.rhyme.no

¹¹ See also Eide (2014) or elsewhere in this volume.

First, co-creation implies health musicking, which incorporates the family's desire *to do* (action) *something* (activities) *meaningful* (intentional) together (*intersubjective and interpersonal*). This is an ecological aim in that it implies the process of continuously promoting health while also preventing poor health. It also implies a strengthening of agency and mastery, as well as the creation of embodied, sensory and empowering interactions with both the tangibles and other people (Stensæth, 2013, no paging).

The specific notion of *health musicking*, to which I will also refer below, is borrowed from Stige (2012), who in turn draws upon Small (1998) to link the workings and ramifications of music to actual musical and social activity – that is, to ‘doing’. Andersson (2012), one of the creators of the CCTs, concludes that the main musical ‘doings’ consist of playing, listening, exploring, composing and collaborating. In the present study, of course, such doings engage the users with the CCTs, because, in order to fulfil its *health* potential, musicking must also become a ‘provider of vitality’ (Bonde, 2011; Ruud, 2010) or, further, a ‘tool for developing agency and empowerment; a resource or social capital in building social networks; a way of providing meaning and coherence in life’ (Ruud, 2010, p. 111). This mode of thinking anticipates a salutogenetic understanding of health that privileges the factors that support health and well-being over those that cause disease. Antonovsky’s (1987) notions of health as a personal experience (and an ongoing process) rather than a biomedical state inspire this understanding. An underlying question for the present study, then, is whether its data reveals such an occurrence of health musicking?

Through the process of co-creation, the three concerned ‘parties’ – the child with disabilities (CwD), the close other (CO) and the CCTs – can realise complex collaboration combinations. Figure 1, which is collected from my earlier work (Stensæth, 2013), shows what collaboration combinations can come into play. It is presented here in order to map some of the ways in which Dylan and Petronella might co-create with their close others and WAVE.

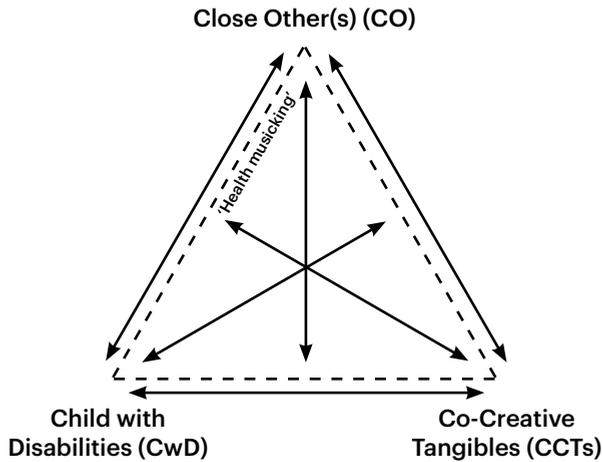


Figure 1: Collaboration combinations in co-creation

The figure is explained as follows:

The triangle has three corners. The three actors, CO, CwD and CCTs, are each placed at a corner. The arrows outside the triangle show possible collaborations between the actors in each corner; they can also be understood as *relations* and consequently as units that can in turn collaborate with another actor in another corner. The arrows inside the triangle show what these potential collaboration combinations are:

- a) The relation between the CwD and the CCTs collaborates with the CO.
- b) The relation between the CwD and the CO collaborates with the CCTs.
- c) The relation between the CO with the CCTs collaborates with the CwD.

I further noted that these various collaboration combinations are both *flexible* and *situated*. This means, among other things, that the same people can create various collaboration combinations in different situations, and that the intensity and level of co-creation will vary. For example, when a child has a tough day (physically or/and mentally), she can be more dependent upon her close others. She will then perhaps not play so much with the CCTs. It is also true that sometimes it is simply more fun to explore the human relation than the relation with the CCTs. Sometimes

it is the other way around; the child finds it more fun to explore the CCTs. In such cases, one collaboration combination will supersede the others. Often, however, especially after some collaboration time, several collaboration combinations will be in play:

Over time, it is likely that experienced and embodied collaboration combinations pave the way for other collaboration combinations. The child with disabilities, having co-created intensively with her brother, might then expect more intense co-creation with other close others as well (Stensæth, 2013, no paging).

Collecting the data for the WAVE actions

When the WAVE experiments started in March 2012, the children arrived at the music room at the school together with an adult from their class whom they knew well and trusted, and they stayed for half an hour each time over the course of four executive Fridays.¹² In preparation for the test, the room's piano, chairs and musical instruments had been removed, and the WAVE carpet was placed in the middle of the empty floor.

Throughout the WAVE actions, few instructions were actually given to the participants. The close others who accompanied and 'advised' the children were told simply to 'go ahead as they liked'. One person from the research team welcomed them and remained passively in a corner of the room, after having first showed them what they could do to produce responses from the WAVE carpet; this person was also available for any necessary technical assistance. Other than this, no rules were announced in relation to how to use the WAVE carpet.

All of the consequent actions were recorded using three video cameras, to assure the most comprehensive access to the data. Two of the cameras were fixed to the wall, one trained upon the screen in the background, the other one on the wall furthest away that could capture the whole scene from a distance. The member of the research team who was in the room used a handheld camera.¹³

12 Testing related to ORFI, the prototype of the first CCTs, is discussed in Stensæth & Ruud (2014) elsewhere in this volume.

13 This person did not know any of the participants who entered the room. As he was going to be there anyway, we considered it expedient to have him try to capture subtle movements and facial expressions to complement the fixed-camera data.

The selection of video clips and children

The use of videos made it possible for research team members to study a given interactive event systematically, repeatedly, and deliberately. Videos were also useful for analysing emotions and body expressions, including the subtle nuances of mimicry and the small body movements that could be associated with the process of co-creation. The method used for the present study is *structured video analysis* (inspired by Lindahl; see Stensæth, 2008), which requires the researcher to verify his or her assumptions about what to look for in the videos over the course of multiple viewings.

In order to determine particularly evocative video clips, I had to first review all of the video material of all of the participating children. The next step was to scan for clips that revealed moments of both strong and weak collaboration combinations in the co-creation process. The best clips derived from those glimpses and camera angles that most clearly demonstrated co-creation activity, for example when the face expressions and actions were clearly interpreted as unequivocal.

There were several reasons why Dylan and Petronella were picked for the video analysis process. First, in the interests of a comparison study, Petronella's *active* exploration of the microphone seemed to supply useful information about the *positive potential* of the WAVE, whereas Dylan's rather *passive* exploration of the camera seemed to supply useful information about the potential *challenges* associated with the WAVE. Second, Petronella in particular was chosen because she showed such a specific interest in the microphone, which was one of the new elements implemented in the WAVE. Also, it was largely due to Dylan's involved engagement with the cameras in the observation room during the ORFI actions of the previous year that the creators of the CCTs decided to build a camera into the WAVE carpet. It was therefore of special interest to the project group to return to Dylan and his use of the new camera effect.

Of course, the use of video recording in the research process can cause problems as well. There is, for example, the danger that 'seeing becomes believing'. If one spends too much time with the two-minute video clips of Petronella and Dylan, one might begin to think that they will *always* approach the world in the same manner as in the clips, which is not the case. We must always remember that, in a comparison study such as this one, the selection of video clips is designed to reflect the aims of the research – in this case, the possibilities and challenges that ought to inform the development of interactive and musical tangibles for children with various disabilities. The clips are not otherwise indicative of much of anything, including the general behavioural inclinations of the children in question.

I must further note that, having worked as a music therapist in the school where these project actions took place, I knew both of these children, and I am constantly conscious of the fact that my double role as a music therapist and a researcher can create a conflict of interest. However, I prefer to think that my twenty years of experience with children like Petronella and Dylan informs my role as a critical researcher, and that any potential bias that might result will not skew my discussion in any substantive sense.

Introducing Dylan and Petronella

The overview profile (figure 2) explains some of the differences in the ways in which Petronella and Dylan relate to the world:

Name and Year of Birth	Interests / Personal Characteristics	Communication	Physical Condition / Treatment	Diagnosis	Sensory Preference	Cognitive Level
Dylan, 1996	Likes technical things, computer work, music (has favourites) and cooking. Is anxious and withdraws easily in social settings. Loves trains and everything connected with trains (gets easily caught up in activities that include trains, as in a type of absorption which is also a characteristic of the autism spectrum). Turns to adults when he has needs.	Verbal (simple sentences), ICT (can send e-mails and find things on YouTube), visual communication	Heart problems/ medicine	Atypical autism, mental retardation	Vision	→4 years
Petronella, 1996	Loves dancing, music, and baking/ cooking. Is social with one person at a time (either children or grown-ups). Can be shy sometimes.	Verbal (two- to three-word sentences) and signs of speech	None	Down syndrome, mental retardation	Uses all senses, but cuts out vision sometimes	→5 years

Figure 2: *The children's profiles*

Both children function well physically and use verbal language, though in a limited fashion. They both like to be with others, but they do not actively seek them out for company. Their cognitive levels, at up to four or five years old, are comparable. We might add that Petronella joined the RHYME project just before the WAVE was introduced, and the video analysis captures her first interaction with the CCTs. She communicates with both words and sign language and is a fun girl who likes to explore new things but also keep everything in order. Dylan had experience with the CCTs through the ORFI actions of the previous year. He is fun too, a boy who

smiles a lot and is generally ready to try new things. However, he needs time and familiarity before he feels secure enough to surrender any control. Dylan can use words, but they do not always mean much to him; he communicates more precisely using mimicry/mimicking and body language. His visual sense is quite strong, which is probably why he is good with ICT, screens and computers.

Presenting the video analyses and some reflections

In what follows, Petronella's active exploration of the microphone in the WAVE carpet will be analysed in detail, as will Dylan's rather passive exploration of the camera there.

The largest font in the table of observations indicates the most obvious actions to be seen on the video (whether by the child, the close other or the CCTs). The text in red indicates my interpretation of what was happening. The green arrows suggest collaboration lines in the co-creation that was observed between the child, the close other and the CCTs.¹⁴ The video clips of both Petronella and Dylan share a length of about two minutes.

¹⁴ Note that 'Mic' is short for microphone, P for Petronella and W for WAVE, and C for Caroline.

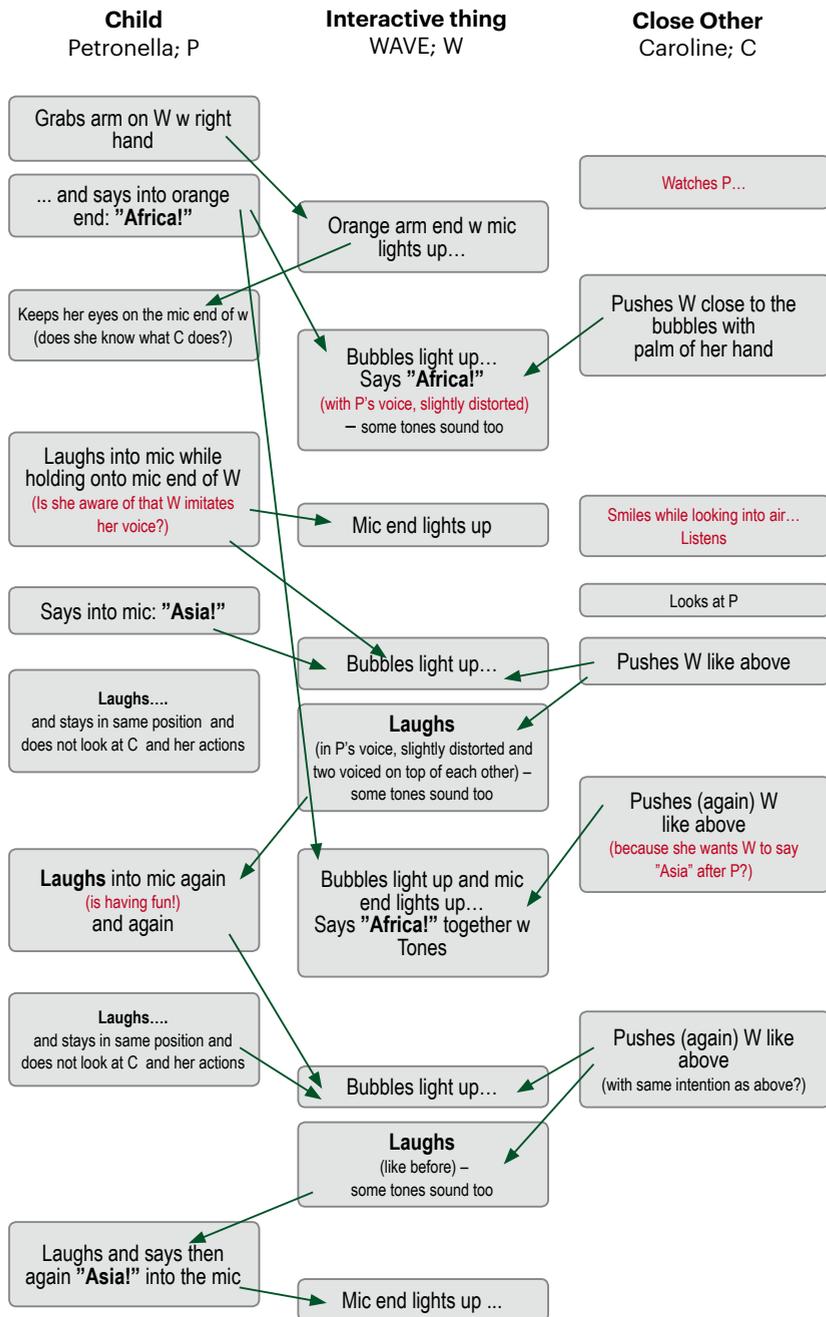


Figure 3: Video analysis showing co-creation between Petronella, the close other and the WAVE carpet, part 1

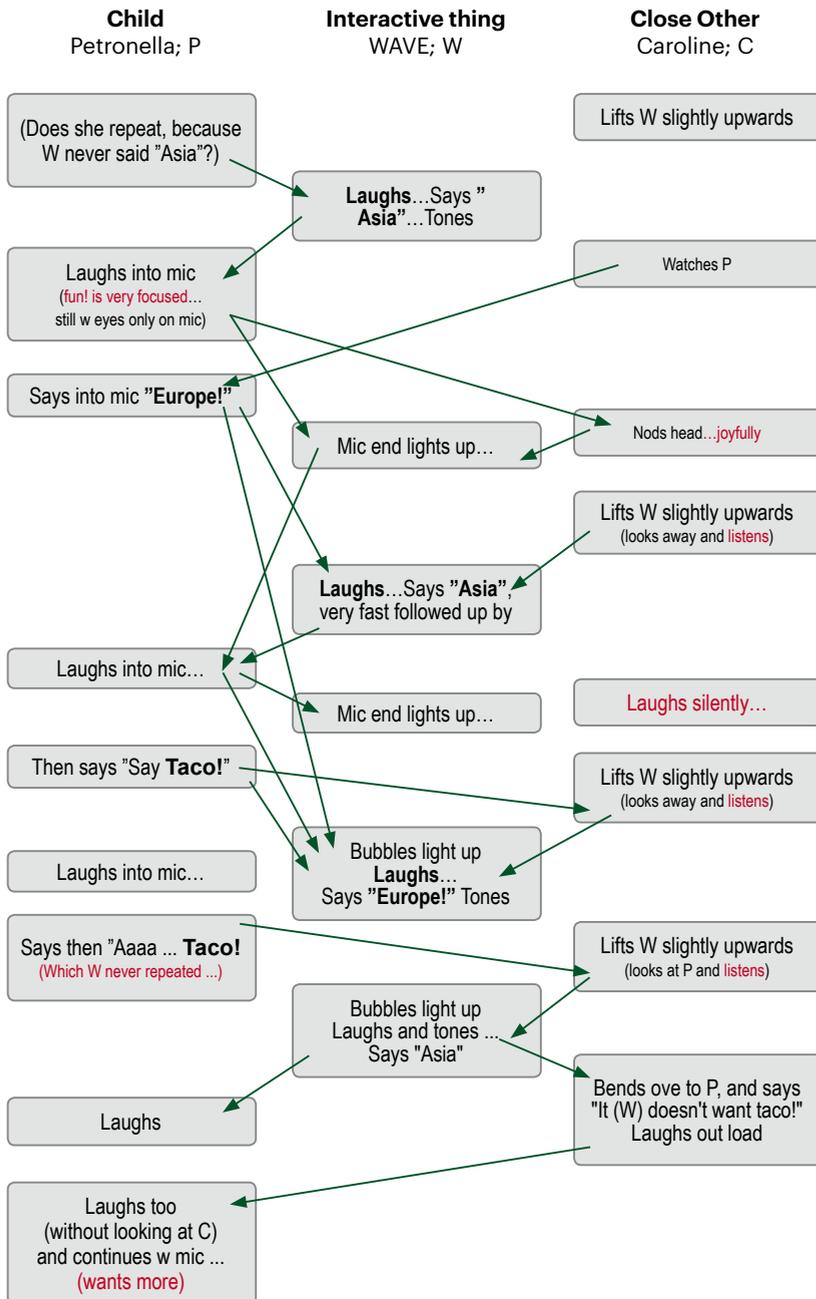


Figure 3: Video analysis showing co-creation between Petronella, the close other and the WAVE carpet, part 2

Reflections on the analysis involving Petronella

As we can see from figure 3, which works from a micro-level perspective, there is a lot happening in all three columns between Petronella, her close other (Caroline) and the WAVE. All three parties are active in the co-creation that is underway – the arrows indicate many lines of collaboration moving between, across, and through them. Upon closer examination, the arrows also reveal a chain of co-creative actions: when Petronella says something into the WAVE microphone, it responds by lighting up, at which point Caroline pushes the bubbles and the WAVE responds by imitating Petronella's voice (more or less) and words. This soon-predictable chain of responses rapidly occasions joyful co-creation that builds expectations in both Petronella and Caroline and makes them want to continue to play on. All of the sudden, however, the WAVE does not respond as Petronella and Caroline expect. When Petronella announces 'Say Taco!' into the microphone arm, the WAVE responds (after Caroline's push) with 'Europe!' Here, the CCT breaks from expectations, which surprises Petronella and Caroline and then makes them laugh.

It is unclear how aware Petronella is of all of the links in the chain of co-creative actions. When Petronella grabs the WAVE's arm and says 'Africa' into it, and the microphone arm responds by lighting up, Petronella keeps her eyes on the microphone arm and does not appear to be aware of what Caroline is doing. While Petronella *hears* the WAVE respond to her and is perhaps aware of the fact that the WAVE is imitating her (after a fashion), she may not associate any of this with her close other. This could indicate a weak collaboration link between her and Caroline. However, because they are sitting rather close together, it is reasonable to assume that Petronella is somehow aware of what Caroline is doing. Their shared laughter at the end of the clip also appears to acknowledge their mutual investment in the co-creation process.

Caroline knows Petronella well and here accepts the fact that Petronella does not approach her directly but stays focused upon the microphone. Caroline draws upon her knowledge and skills to remain patient and supportive of the child's interaction, even intensifying it by pushing the bubbles and makes the WAVE respond with sound. Without Caroline's collaboration, in fact, the fun and motivating co-creation among the parties here probably would not have happened – that is, the video analysis would have indicated fewer and weaker collaboration combinations.

To sum up, we might say that this short video clip shows how a child with a disability and her close other realise a meaningful togetherness with and through the WAVE. The collaboration links between the child, the close other and the WAVE are

numerous, which indicates a complex and active co-creation process among them where many collaboration combinations come into play. For this child, in particular, the microphone element was especially attractive, and when the CCT breaks the chain of expected responses, it seemed to be very enjoyable and amusing.¹⁵ The sympathetic behaviour of the close other towards the child is of course also an important element of this interaction's success.

Let us now see what happens when Dylan and his close other encounter the WAVE:

¹⁵ Learn about how the designers designed and developed WAVE and its microphone effect in the articles by Andersson & Cappelen (2014) and Cappelen & Andersson (2014) or elsewhere in this volume.

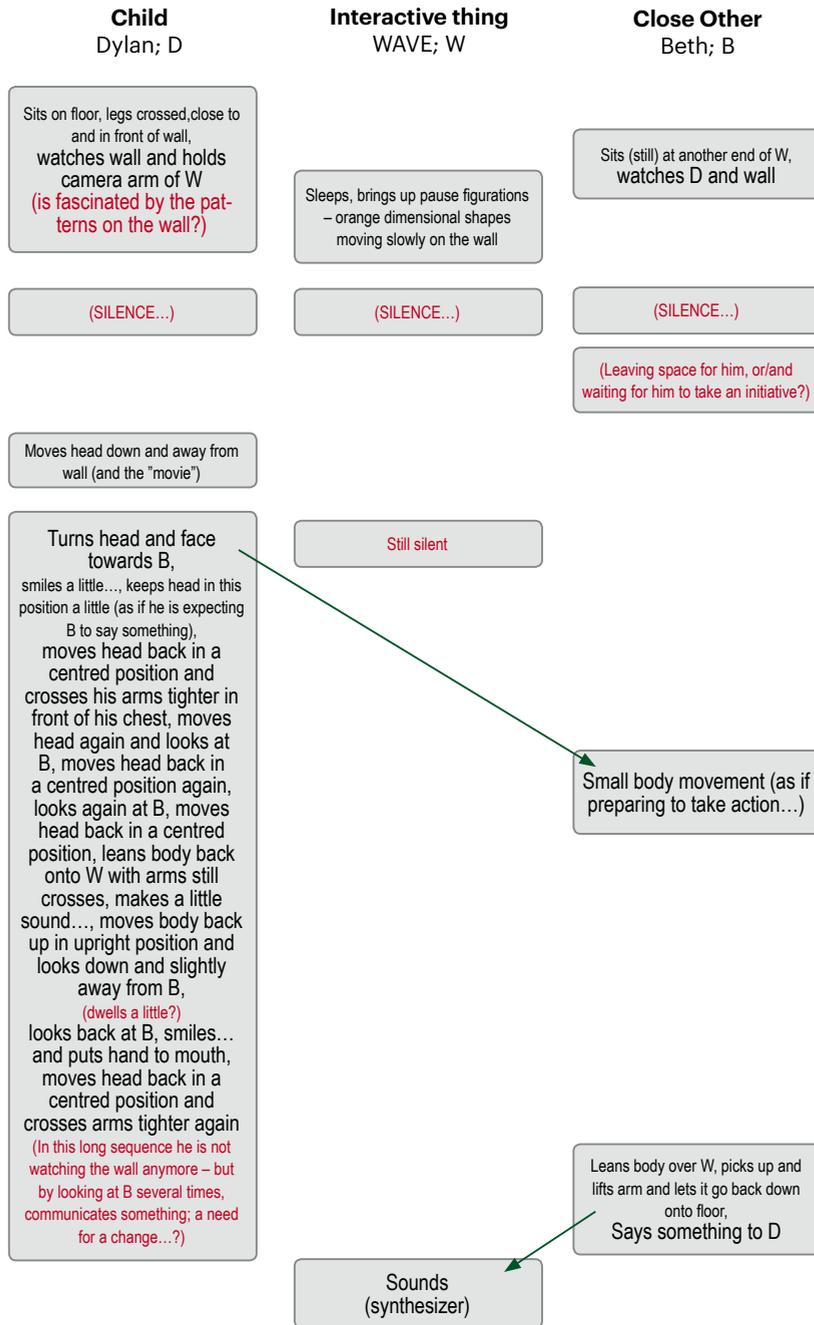


Figure 4: The video analysis showing the co-creation between Dylan, the close other and the WAVE, part 1

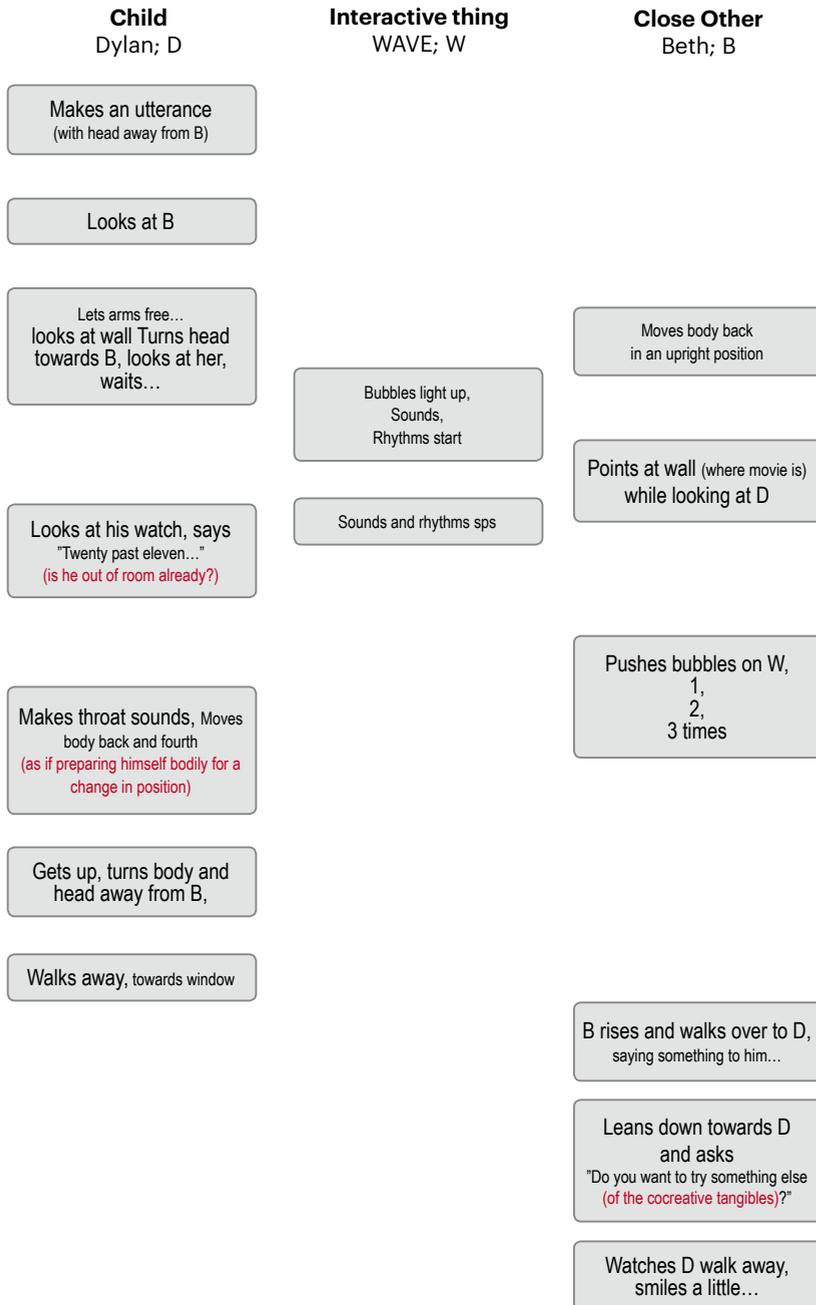


Figure 4: The video analysis showing the co-creation between Dylan, the close other and the WAVE, part 2

Reflections on the analysis involving Dylan

Compared to the analysis of Petronella, Dylan's analysis is obviously very different (see figure 4). As we can see, there is little text in the three columns describing the co-creation between Dylan, his close other (Beth), and the WAVE. Little seems to have happened, and there are few collaboration lines among the three of them. In addition, if users remain passive beyond a given time period, the WAVE is programmed to fall asleep. When it did, patterns of screensaver graphics turned up on the wall in front of Dylan. Then Dylan too seemed to 'fall asleep' too, in his utter absorption in the graphics. Later on I will return to how the focus group discussed this built-in screensaver.

If we look more closely at the arrows that do reflect an act of collaboration between two of the three parties in the analysis above, the first arrow indicates a moment when Dylan turned his head towards Beth and smiled a little. This smile is not an invitation to play or a reflection of his general contentment, however; instead, it is a hesitant cry for help to Beth, because Dylan has become lost in the situation and unsure about what to do with either the WAVE or Beth. He then crosses his arms in front of himself, several times, as a sign of not wanting to act, or not knowing how to act, or just wanting to depart from or otherwise deny the situation.

But Beth, who knows Dylan very well and notes these actions, does not take the initiative. Instead, she contents herself with remaining actively present, making small body movements 'as if preparing to take action'. In a test situation like this, where one knows one is being filmed, it takes courage to simply await responses from the other two parties in question. Beth evaluates the situation and decides only to prepare herself to help Dylan if he invites help. In this way, she tries to give Dylan space to come up with his own initiative. She knows that Dylan needs time, and she knows that for him to get involved, he needs to find his own way. If she takes control and interrupts this process too soon, Dylan could withdraw completely and leave her to play alone, which is not what she wants. In the end, Beth does take action by bending one of the arms of the WAVE carpet and saying something to Dylan as well. She tries to come up with new ideas for their co-creation, but Dylan, who first looks at his watch and then the window, is not interested.

To sum up, this video clip shows how another child with different disabilities and his close other struggle to create meaningful togetherness with and through the WAVE. There are few arrows in the analysis that indicate collaboration lines between the child, the close other and the WAVE. The fact that the close other was so tolerant could explain why the child stayed in the situation at all, rather than withdrawing completely by leaving the room.

As mentioned, the camera element was expected to be of special interest to this child. Surprisingly, however, as the lack of collaboration lines among the three parties in this video clip shows, Dylan's genuine interest in cameras was not enough to promote co-creation here.¹⁶ There must be other reasons for the strong and the weak co-creation processes in the cases of Petronella and Dylan, respectively. In the following discussion, then, we will triangulate the results of the video analysis with the results of the focus interview with the group of professionals.

Discussion

The idea in this discussion is to systemise the ways in which the video analysis and the interview relate to the research question that inspired this article. The people in the focus group, in turn, were presented with the following question: *On the basis of your professional competences, your general experiences with the children with disabilities, and what you have seen in the videos, what are your impressions of the WAVE, and what do you think its potentials and challenges are in enabling co-creation for the participating children and their close others?*¹⁷

Methods and results of the interview

Malterud (2008) inspires the method that I used to systemise the video material, because I pursued those aspects of most relevance to this study specifically by identifying extracted units of meaning. Those units were collected in the following manner:

- 1) Derive an impression of the whole situation.
- 2) Identify meaningful units/parts.
- 3) Abstract the content from each of the meaningful units.
- 4) Sum up the meaning of it all.

16 Read about how the designers developed WAVE and its camera effect in the article by Cappelen & Andersson (2014) or elsewhere in this volume.

17 The focus group saw videos of several children and several CCTs, not only the two dealt with here and not only the WAVE. Therefore, the following discussion focuses upon an extract of the larger interview that relates specifically to Petronella, Dylan and the WAVE in relation to the research question.

Step 2 implies a process of *interpretative coding*, as described by Bruscia (2005), which means that, as the researcher, I will be interpreting the data based on my insight (my experience, knowledge of theory, and research) into the coded material. This interpretation will be informed in particular by theories of co-creation such as those presented by the creators of the CCTs in RHYME – Bruscia (2005, p. 183) describes this process as ‘the researcher imposing an outside construct or idea on the data; (see also Eide, 2014). Naturally, I am also influenced by music therapy thinking in regarding communication and improvisation (in Stensæth, 2008).

The interview lasted approximately two hours, and I transcribed it for this study. The results from the interview can be summarised according to three main categories:

- the children’s profiles, (cognitive) levels and use of senses and interests;
- the flexibility of WAVE (including its staging and facilitation);
- the close other’s skill and understanding of both the child and the WAVE.

The children’s profiles

As discussed above, Dylan and Petronella are comparable when it comes to age (both born in 1996), cognitive levels (four to five years old), and ability to use words (however limited). They also have clear interests: Petronella likes music and dancing and Dylan likes ICT and trains. In addition, the focus group found them both rather social in relation to many children who are facing the same types of challenges as they face. Petronella is perhaps more socially interested than Dylan. Both children showed great interest in one of the elements of the WAVE – Dylan grabbed the camera, while Petronella favoured the microphone. According to the focus group, this indicates a shared inclination towards active collaboration with things (interactive or otherwise) and with severe disabilities.

Ultimately, the focus group observed that it is their use of the senses, and especially sight, that appears most relevant here in terms of challenges to the WAVE platform for interaction. These observations are extracted in the following unit:

For the child to make active use of his/her personal resources, knowledge about his/her profile and in particular how he/she uses his/her senses is needed in order to facilitate WAVE in the most suitable way for him/her. The visual sense is very strong and dominating. That which stimulates vision can be both engaging and inhibitory with regard to the use of the other senses. This tendency is often reinforced in a child with disabilities, who relates to the world differently than expected, perhaps in a rigid way and/or in a narrower way than many other people, in that he/she uses fewer senses at a time.

The focus group believes that for Dylan in particular, vision is more dominant than the other senses. When Dylan is interested in what he sees, in short, he promptly abandons his other senses – recalls the point in the video analysis when Dylan gets stuck watching the screensaver graphics on the wall and forgets about both the WAVE and Beth. In this case, Dylan does not use his vision in a creative way. The graphics on the wall are so absorbing to him that it is impossible for him to co-create with the WAVE or Beth. For him, the camera, and especially the patterns in the graphics, has an almost hypnotic effect, in the same way that the sight of running water or flames will consume other children with autism. The focus group therefore concluded that the way in which the camera element in the WAVE functions can inhibit interaction:

For Dylan, the camera element seems to invite him to escape and to move into his own world ... [This] can be desirable too, of course, but if he gets stuck or lost in there, which is something a boy like him with such autistic challenges easily does, this could be negative too ... In fact it could strengthen his isolation ...

The same person in the focus group wondered if the screensaver graphics could be disabled. If the close other could turn this function off, Dylan might return, in a sense:

Instead of leaving him in isolation ... the thing [WAVE] should at a certain time do something in contrast, something that affords action and/or co-action, so the child gets out of isolation.

Another person in the focus group added that this had something to do with ethics. For people who cannot move away from stimuli, including those with severe physical challenges, WAVE should provide a means for the person to otherwise change or conclude an interaction that could be experienced as overwhelming, intrusive and/or frightening.

So, while the focus group agreed that it was still a good idea to build a camera element into WAVE for children like Dylan who have a strong visual sense, it was not entirely clear how to ensure that they experience WAVE as a means of co-creation. It would be necessary, they thought, to know a child's personal profile and how he or she would use the senses. Because vision is such a dominating sense for Dylan, it might be helpful to look at how the WAVE could be constructed and/or programmed to make it more likely that his use of a strong sense would activate his other senses as well. One person suggested:

If the camera could project onto the thing [WAVE] something that is tactile, Dylan could combine vision with the tactile sense. Cloth that 'lives', like tulle, invites touching ... Additionally, if WAVE could respond with sound to his touching, it is possible to include his hearing as well!

By combining the senses in this way, Dylan would be encouraged not only to remain at the centre of the interaction but also to overcome his instinct to drift off into his own world. Instead, the focus group noted, he would be inclined to interact more actively with the WAVE as well as with his close other.

For Petronella, the situation is very different. Although she uses all of her senses, she also uses her vision in a special way: she keeps her eyes solely on the microphone and does not look at Caroline or the rest of the WAVE. Does she do this to maintain contact with the microphone, which is at the centre of the fun co-creation that is developing around her? Maybe she feels that if she looks at Caroline or some other part of the WAVE, she would lose track of the process? Or, by partly abandoning the use of sight, in a sense, is she allowing herself to focus more on the sound, which is the focus of her interest, after all? Or, of course, we will recall that Petronella can be shy, and maybe eye contact with other people is simply difficult for her?

Ultimately, we can conclude that Petronella did not depart the situation like Dylan; instead, she used her sight to stay within the situation, and to stay in contact with the meaningful co-creation that was developing there.

The flexibility of the WAVE

Rigid behaviour is sometimes difficult to overcome, but the focus group came up with several suggestions to help children like Dylan to relate to the WAVE in a more creative and interactive way. These suggestions are extracted in the following unit:

To match the child's way of communicating, which can be different from the expected and dependent on individual idiosyncrasies, WAVE must be flexible. This means that for the child to feel that WAVE communicates with him/her, its response must also be experienced as close enough and clear enough. The import of familiar elements, such as images of family members or sounds that resemble the child's voice, is often motivating. Also, WAVE's potential to respond in unexpected ways is a good idea but should be adaptable to the child's cognitive level and sense of timing. WAVE must, in other words, interact in many, varied ways, to fit with what each child finds to be safe and exciting and what maintains his/her interest over time.

More specifically, one person in the focus group suggested that the WAVE should allow projecting images onto the WAVE carpet itself rather than the wall. She thought that this might create a situation in which a child like Dylan and his close other could sit and watch together and perhaps feel as though WAVE were a part of them. Physical proximity to the WAVE carpet would be important to many children with challenges within the autistic spectrum, such as Dylan, and a wall that is five or six meters away is counterproductive in this regard.

The focus group also noted that the quality of the projection should be better in order to engage Dylan more actively. From what they saw on the videos of Dylan, there was too little contrast between the images and between the projected area and elsewhere on the wall. In tandem with the limited lighting in the room, this relative uniformity of image intensity did not really invite activity on his part. For Dylan, a dark room and weak images actually *increased* his passivity and withdrawal. It could even make the setting seem threatening to him, so that he ended up feeling insecure and lost.

The focus group also noted that the WAVE should invite a child like Dylan to combine his senses, in order to ease him out of isolation and into co-creation. But it is likewise possible that, for other children, the WAVE would have to do the opposite. For children with vulnerable sensory apparatus or challenges related to sorting out the various sensory stimuli, for example, it must be possible to eliminate some of WAVE's responses as well. For these children, whose cognitive level is lower than one year old, too many responses at the same time or too many responses following upon one another quickly create chaos and frustration and thus inhibit health. Therefore, the option to add and/or exclude some of the functions in WAVE, and even to control the intensity and/or length of the responses, is important. Such an option would also be useful for children just like Petronella and Dylan when they are having a bad day or are in a bad mood.

One aspect that impressed the focus group was WAVE's ability to occasionally surprise the users by rotating in responses from former utterances. This is evident in the video analysis (as well as vignette 1) when WAVE says 'Europe!' rather than 'Taco!' as expected. This ability, which motivated Petronella so profoundly in relation to the co-creation between her, Caroline and WAVE, is called 'shifting', here described by the creators of the CCTs Cappelen & Andersson (2011):

The interaction rules are the computers' treatment of the users' interactions, and the interesting aspect is that the computers do not treat the interactions mechanically, as a piano for example would do. Rather they treat the interactions dynamically; they are based on the user interactions over time and the composition rules, which in turn are based on aesthetics and/or musical genres and the narrative structure over time. It is this use of the computers' dynamic capacities that makes it possible for the CCTs to vary and shift their responses.¹⁸

Shifting not only introduces an element of surprise into the co-creation but also involves WAVE as a 'player' in a fashion that is different from the way musical instruments or toys work. Cappelen and Andersson (2011) assert that the CCTs therefore behave more like 'improvising co-musicians or co-players', or even as 'friends and partners in dialogue'.¹⁹

For Petronella, WAVE's ability to respond dynamically this way, by acting both as expected and not as expected, makes her happy but also motivates her to play and use her creative fantasy. It also encourages her to take an active part in what is around her and to relate to her close other while playing. The microphone is especially attractive in this regard and in turn stimulates her to use her voice. In fact, from what I know of her, Petronella used her voice more in this video clip than she generally does in other school situations. This could be explained by the fact that Petronella encounters the CCTs for the first time here, so they represent a curiosity for her. But it might also be true that WAVE engages Petronella in ways she has never experienced before, motivating her and perhaps, most excitingly of all, promoting her health.

Shifting is a consequence of programming, which determines parameters including the duration of the interval between the user's initiative and WAVE's response as well as the length of time before the surprise arrives. When WAVE is

¹⁸ See also Stensæth (2013).

¹⁹ These are the words of Cappelen & Andersson (2011).

experienced as an independent actor; as it was for Petronella, co-creation involving it can supply motivation and produce a feeling of mastery. For Petronella, then, the programming of the shifting in WAVE was just right. For other children, though, it might need to be different. If a child is frustrated by the surprise element, for example, one ought to be able to turn it off as well.

The co-creators' skills and understanding of both the child and the WAVE

In the video analysis of Petronella and Dylan, we have seen that the roles of the close others were crucial. The two close others displayed great skill and sensitivity; they were tolerant and empathic and matched their actions with the child's needs. Without these close others' active participation, the co-creation would probably not have been as successful. It was Caroline's pushing of the bubbles that made WAVE respond to Petronella's speaking into the microphone – Caroline linked the actions of Petronella, herself, and WAVE together into a chain of fun and stimulating co-creation. Beth also acted skilfully. Though it did not lead to more co-creation for Dylan, her tolerant and watchful stance prevented Dylan from leaving the room.

The focus group mentioned that the flexibility that is needed for WAVE and other CCTs is likewise needed in the children's collaboration partners. Actually, said one person, it would be even better the other way around:

The flexibility that the close others show when they co-create with the children is what it takes to develop an ideal co-creative WAVE!

It strikes me that the idea that of WAVE's resonance with the instincts and actions of the human caregiver is perhaps as its best the path forward in development of WAVE's (as well as other CCTs') capacity as devices. This is perhaps why the unpredictable element brought into the co-creation via shifting fascinated Petronella so much? This means that WAVE needs to be considerate in the same fashion as the close others and adopt its actions to the personal profiles of the child with disabilities. Also, it means that it should act in a 'human' fashion, for example as an improvising actor that comes up with new ideas every once in a while. Preferably, this should be possible to manipulate through the programming of WAVE.

However, other close others are not likely to act in the professional manner of Caroline or Beth. In a home setting, which is what the CCTs are ultimately intended for, the children's sibling who know their sister and brother well, are also well

qualified to be close others. The setting is simply a bit freer at home. Here, more provocative and rougher interaction would be allowed; siblings would probably not be as considerate and tolerant as the close others on the project video. Therefore, says the focus group, the development of WAVE must take into account the ways in which *any* close other might co-create with the child with disabilities. Moreover, the WAVE should respond to their interests as well, so that they would engage in co-creation out of self-interest as well as some sort of charitable impulse.

Conclusion

The research question of the present study reads as follows: *Why do the two children (Petronella and Dylan) relate so differently to the same musical and interactive tangible, the WAVE carpet, and what does it take to facilitate the most meaningful and health promoting co-creation for each of them?*

As we have seen, the answer to this question relates largely to

- a) the children's individual profiles, cognitive levels, and use of senses and interests;
- b) the flexibility of WAVE (including its staging and facilitation); and
- c) the co-creators' skills and understanding of both the child and WAVE.

The focus group suggested that WAVE should suit the child's 'zone of communication' – that it should accommodate the child's sense of timing, sense of space, interest level and use of senses so that the child feels that the WAVE's responses are directed towards him or her. Petronella felt that WAVE was actually talking to her, and in fact she negotiated and played along with the WAVE carpet. WAVE's reproduction of familiar elements such as the child's own voice worked well, reinforcing her feeling that the CCT approaching her in a 'personal' way.

Dylan, on the other hand, found that the camera element in WAVE created a greater distance between him, the CCT and Beth. As a means of defeating his instinctive sense of isolation and attracting him to co-creation, WAVE must be programmed differently. Preferably, it should encourage Dylan to combine his senses (including sight, touch and hearing), and to respond in some active way.

To sum up, we might say that, in order to accommodate a huge range of cognitive levels as well as the complex combinations of interests and needs in children with disabilities and their close others, WAVE should be able to operate on different levels at the same time. If a child with severe disabilities needs to focus on

one sense at a time, WAVE should be programmed to exclude the others. However, to simultaneously sustain the interest of an older brother, for example, the WAVE would need to retain some flexibility even here. This could be accomplished in many ways and is well within both the creative and the technical potential of the CCTs.

We have also learned that the flexibility of the close others is a good model for developing an ideal co-creative WAVE. Ultimately, of course, it is not possible for an inanimate object to actually match human feelings. The WAVE will never be able to read Dylan's body language like Beth does. Yet this technology does have the potential to be programmed to suit a given child's personal profile to some extent. As such, a CCT like the WAVE carpet vastly exceeds manual musical instruments and traditional toys in its interactivity.

We should also remember that the material informing the present study has been limited to only two children, to short video clips, and to well-qualified and professional close others. WAVE affords many other forms of interaction and possibilities for use than what has been revealed here – forms that these children and their close others did not appropriate. WAVE therefore possesses potentials to enable concrete and tangible health-promoting co-creation.

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‘Come sing, dance and relax with me!’

Exploring interactive ‘health musicking’ between a girl with disabilities and her family playing with ‘REFLECT’
(A case study)

Karette Stensæth

This case study looks at how one family experienced the musical and interactive tangible REFLECT, which was developed for the RHYME project (www.rhyme.no). One of the aims of RHYME is to develop resources that have the potential to promote collaboration among family members when a child has disabilities. Through processes related to *health musicking* (Bonde, 2011; Stensæth & Næss, 2013; Stige, 2012), the RHYME project fosters music activities that can enhance the quality of life within the family. REFLECT, which is a mobile and wireless interactive tangible installation, offers the players possibilities to select and play with music they know and to play together with others, and thereby *reflect* on their (inter) actions (Andersson, Cappelen & Olofsson, 2014). It consists of several interactive tangibles of different sizes that look like toys of different shapes, some of which evoke animals and/or flowers. One of the tangibles is a lumber-like soft thing that one can play with on the floor, hold in your arms, or over the shoulder while dancing. According to the girl in this presentation it looks like a whale with a large belly. The other REFLECT tangibles are accompanied by laminated photos with RFID tags,¹ and to activate the music, the participant must scan the whale’s belly and pointing its trunk with RFID-reader (see picture 1):

Six different kinds of music excerpts were programmed into REFLECT at the time of the case-study family’s interaction with it, namely the songs of *Mamma Mia*, *Kaptein Sabeltann*, *Gimme Gimme*, *Disco*, *Dyrene i Afrika*, *Fairytales*.² The music often resurfaced as loops of melodic or rhythmic motives from the pre-programmed music. By manipulating the tangibles in certain ways, the family could also improvise, both musically and with each other.

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- 1 RFID is an acronym for Radio-Frequency Identification, which relies upon small electronic devices that consist of a computer chip and an antenna. Like the magnetic strip on the back of a credit card, the RFID device provides a unique identifier for that object.
 - 2 Karette Stensæth took this photo, which is not of the family in this study.



Picture 1: Pointing REFLECT's trunk with RFID-reader against the REFLECT RFID-tag.²

The present analysis engages with the issues that emerged based upon the family's exploration with REFLECT. Data were recorded via video observations of the family while they explored REFLECT and an interview that was done with the family immediately following their second experience with the platform. The video observations are extracted and collected as a narrative below.

The research question in this text is as follows: *How does one family experience REFLECT, and how might their musicking with REFLECT potentially enhance their quality of life?*

Before I look at the core concept of health musicking, I will supply a brief overview of the RHYME project and REFLECT. The empirical part of this study will elaborate upon the methods and results, while the discussion and conclusion will apply certain theoretical perspectives to the whole enterprise.

³ Benny Andersson and Björn Ulvaeus wrote the songs *Mamma Mia* and *Gimme, Gimme* and ABBA performed them. Terje Formoe wrote *Kaptein Sabeltann* and Thorbjørn Egner wrote *Dyrene i Afrika*. The two latter are renowned Norwegian children's songs. Fairytale is the Norwegian 2009 Eurovision Song Contest winner written and performed by Alexander Rybak.

The RHYME project:⁴

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the children and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

Defining 'health musicking'

As a notion, *health musicking* is appearing more and more frequently in the field of music and health (Bonde, 2011; Stensæth, 2013; Stige, 2012). The first part of the notion, *health*, refers to those factors that support human health and well-being rather than those that cause disease or illness.⁵ Halstead (2013, p. 75) has assembled many definitions of music from health theorists to broaden the understanding of health in music:

4 The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology, and Design edited by Stensæth.

5 Antonovsky's (1987) notions of health as a personal experience (and an ongoing process) rather than a biomedical state inspire this orientation. Positive psychology also informs the present perspective on health by drawing attention to the nurturing of life's positive aspects in tandem with the treatment of disabilities or illnesses (Seligman & Csikszentmihalyi, 2000)

Health is a concept emphasised variously as a ‘quality of human interaction and engagement’ (Dreier, 1994, cited in Stige, 2002) or ‘a quality of human co-existence’ (Kenny & Stige, 2002, p. 24), a ‘performance’ of processes by which ‘self’ is realised into the world – mentally, physically and socially (Aldridge, 2005) while musical experience has been likened to an ‘immunogen behaviour’ – that is, a health-performing practice (Ruud, 2002). This in turn has widened the scope of music and health studies to include any mode of musical participation that holds the potential to promote well-being.⁶

This series of definitions paints a broad picture of music’s potential as a mentally, physically and socially meaningful health resource. In the present study, I would align music as a family activity as well, following Small’s purposely active concept of *musicking* (1998). Small advocates for music as a social *doing* – as a way to ‘take part’. Andersson (2012), one of the creators of REFLECT, lists the main ‘doings’ in RHYME as playing, listening, exploring, composing and collaborating. These creators of the co-creative tangibles (CCTs), in fact, view them as active and independent partners in the given collaboration (Cappelen & Andersson, 2011, 2014). They even describe REFLECT as an ‘improviser and a co-player’.⁷

In the present study, then, health musicking refers to the ways in which one particular family creates social musical activities with health prospects as they explore the musical and interactive tangible known as REFLECT.

REFLECT⁸

Mobile and wireless, REFLECT consists of three new hardware platforms that were developed on the basis of ORFI⁹ and WAVE¹⁰ to test different concepts and combinations of hardware and software. It is programmed in SuperCollider.

Technology

REFLECT includes the following input and output devices:

- iPhone/iPod (as computer)

6 Full references in this citation are found in Halstead (2013).

7 I will return to this personification later.

8 See Cappelen & Andersson (2014) or elsewhere in this volume for the design process of REFLECT. See also www.rhyme.no.

9 See Stensæth & Ruud (2014), Cappelen & Andersson (2014) or elsewhere in this volume.

10 See Stensæth (2014), Cappelen & Andersson (2014) or elsewhere in this volume.

- RHYME jDevice card to control sensors and actuators
- RFID reader to make musical choices
- 5 velvet star-shaped soft-touch sensors to play and manipulate sound dynamically
- 2 bend sensors to play and manipulate sound dynamically
- RHYME LED control card
- 24 LEDs that are integrated in the textile communicate interaction response and provide rhythmic visual pulses
- Speaker

Additionally, REFLECT includes the following technology:

- SuperCollider as the musical programming language (real-time sound synthesis)
- Arduino as programming language to control the jDevice card
- 6 musical scenes (at present; see above)
- 50 RFID tags with associated physical objects and dynamic sounds

REFLECT invites its users to play and be active. One can dance to the music, explore it by touching (picture 2) or rest and just listen (picture 3):¹¹



Picture 2:¹¹ *Playing with the REFLECT (belly)*

¹¹ Photographs courtesy Birgitta Cappelen.



Picture 3: *Resting and listening on REFLECT*

About the data collection and the people involved

The REFLECT experiments took place on two Saturdays in March 2013 at Haug School and Resource Centre, located outside Oslo, where several rooms were prepared for the testing of many CCTs.¹² REFLECT was placed in one of the school's music rooms, where the piano, chairs and musical instruments had been removed. To create a 'home-like' setting, the room was supplied with furniture, including a big blue sofa and a broad, square, single-coloured woollen carpet, on which the various pieces that comprised REFLECT were placed. All room activity was recorded using two video cameras that were fixed to the walls. In addition, a member of the research team remained silently in the room, using a third, hand-held video camera.¹³ The extra camera supplied broader, more comprehensive data.

The family in the present study – child (I will call her Petronella), mother, father and grandmother – attended testing on both Saturdays. Petronella is a fifteen-year-old girl with Down syndrome and mental retardation. Among the participating children in RHYME, she was perhaps the most able manipulator of REFLECT, and

¹² Essays about the testing of ORFI, the prototype of the first CCTs, and the testing of WAVE appear elsewhere in this volume (see Cappelen & Andersson (2014), Stensæth & Ruud (2014) and Stensæth (2014)).

¹³ This person did not know any of the children or adults who entered the room and was instructed to focus upon relatively minor movements or facial expressions that the fixed cameras might have missed.

this fact, together with the rich interview content from the family, determined her usefulness to the present case study.

Petronella is a fun girl. Next to baking and cooking, she loves music and dancing the most. She speaks in two- to three-word sentences and uses some sign language to communicate as well. She is social with one person at a time (whether young or old) but can be shy in groups. When compared to normal development, her cognitive level is below five years of age.

The first time Petronella came to the testing with her mother and father, they stayed in the room for about fifteen minutes. The second time, the father did not come but her grandmother joined in, and they stayed in the room for over forty-five minutes.

The testing proceeded as follows: One person from the research team welcomed the family but offered few instructions as such. He showed them what they could do to produce a response from REFLECT and told them that he would be available right outside the room if they needed technical assistance. Other than this, there were no rules given – the family was simply told to 'go ahead as they liked' and left alone.

As a member of the research team, I wrote an observation in relation to the collected video recordings of the family after watching them in their entirety four times. In order to control my subjectivity here (I already knew Petronella from elsewhere), I tried to describe the main events as factually and neutrally as possible. Another member of the research team did the same. Based on the main characteristic events that were included in both observations, I produced a final interaction narrative.

The interview was held right after the family's second interaction and therefore includes only Petronella, her mother and grandmother. Coffee, tea, cookies and buns were served to make everyone feel comfortable and relaxed. One member (H) of the research team conducted the semi-structured interview; he did not know any of the participants from elsewhere. H followed an interview guide, which began with the following question: How did all of you, as a family, experience REFLECT? H followed up by asking whether REFLECT 'worked well' for the family or not, and whether they could imagine having REFLECT at home. Would it promote interaction and well-being within the family? Lastly, H asked whether they had any suggestions for improving REFLECT to suit them best.

The interview was audio recorded, and I transcribed it for the purposes of the present study. Following theorist Steinar Kvale (2004), this process produced a hermeneutic interpreting approach that highlighted both the depth and the diversity of the family's responses.

Results

The following passages include the narrative of the video observation and the interview with the family. The narrative relates mostly to the events that took place on the second Saturday, because the family members stayed in the observation room for a longer period of time and showed greater variation in their exploration than on the first Saturday.

The narrative of the video observation

Petronella and mother enter the music room, followed closely by grandmother. The three of them find a room with a sofa and large carpet where some of the toylike things are. There is a basket filled with more things on one corner of the carpet. Petronella goes towards the things on the carpet. The mother follows her, and the grandmother takes a seat on the sofa. The mother sits down on the floor, close to grandmother and in front of Petronella.

Petronella remembers what to do from the first Saturday – she picks up the (laminated) photo and holds it in front of the thing that resembles the shape of a ‘whale’. Immediately, a loop of the song ‘Kaptein Sabeltann’ starts to play. Petronella smiles and moves her body from side to side, as if dancing. Mother and grandmother smile too ... Petronella does this over and over again while mother and grandmother watch and comment upon what Petronella is doing. Then mother picks up the maracas from the floor and plays along ... Grandmother picks up a small drum and taps it a little ... Petronella changes the music to ABBA’s ‘Gimme, Gimme’, then tries ‘Dyrene i Africa’, both of which are played in small melodic loops ... Petronella grabs mother’s maracas and tries to accompany the music rhythmically.

Petronella continues to explore other musical scenes ... When Petronella finds ‘Mamma Mia’, the whole song plays. Petronella stands up. She picks up the ‘whale’ and pulls its strap around her neck and starts to play on it as if it were a rock guitar. Petronella is very enthusiastic and happy, and she starts dancing to her own playing. Mother gets up and starts to dance as well. Petronella looks at mother and dances while holding the ‘whale’, as if she is pretending to be a rock star on stage ... Grandmother smiles and plays the drum from the sofa to accompany their dancing ... Mother and Petronella dance while singing the whole ‘Mamma Mia’ song together.

Grandmother puts the drum away ... Mother and Petronella move towards each other while dancing and singing ‘Mamma Mia’. They seem to negotiate with their bodies, not with words, to choreograph the dance ... Both of them smile, and it is obvious that they are having fun and that Petronella is very excited ...

The sound is loud ... Grandmother resigns herself and leans back on the sofa and watches Petronella and mother silently. It starts to get too much for her, and grandmother tells them to turn down the volume ... Mother does not know how to do this and asks for help from the assistant from the research group outside the room ...

Petronella picks up another photo and changes the musical scene to 'Fairytale' ... The music is not as loud any more. Mother starts to talk to grandmother about REFLECT ... Petronella sings ... Then grandmother and mother sit on the sofa and look at Petronella without saying anything. Petronella sits on the floor and listens to the music while singing along ... Petronella leans back and lies down on the floor. She picks up another toylike thing and cuddles it ... She relaxes ... Grandmother asks for a break and says she wants to leave the room ...

The interview

In the interview, the family members talked about their experiences with all of the CCTs they had explored during those two Saturdays in March. Those parts of the interview where they talked about REFLECT constitute a significant dialogue in and of themselves. This extract follows:¹⁴

H: So, how did you experience REFLECT?

Mother: The session was very stimulating – she [Petronella] seemed immersed ...

Grandmother: The thing [REFLECT] was fun – it was good that it had so many variations!

H: Do you think it worked well for you?

Mother: Yes, but it had too many [variations] ... that she [Petronella] started 'Mamma Mia' and kept on playing that tune just made her want to dance ... this hindered the interaction part ...

H: So ... 'Mamma Mia' ...

Mother: Yes, it destroyed a bit ...

H: So, is it right to say that you feel that 'Mamma Mia' makes it more exciting while at the same time it destroys? Why do you say 'destroy'?

¹⁴ Petronella says nothing during the interview; she is busy eating buns and relaxing in the background.

Mother: Yeah [laughs a little] ... maybe because the thing played the whole song ... and not just fragments or loops, which was the case with the other songs that were programmed into REFLECT ...

H: Yes ...

Mother: And then it becomes more like she needs to do something else to continue her exploring, but here the 'Mamma Mia' tune just played on and on and on – and as long as this tune is on in the background, her entire attention is focused on that ... Yes ...

H: Was it the dancing ...?

Mother: Yes ... then we danced – we had a disco – then those other things were not interesting for her anymore ... But we had fun [laughs] ... it is fun to dance. Yes, we had fun ...

Grandmother: You looked so great! I was impressed. Very creative and fun ... the way these things were made ...

Mother: But as a situation for interaction, we do this type of dancing anyhow ... We do not need more of that, in a way ... That is why I say 'destroy' ... Yes.

Grandmother: But then again you are a family with a lot of music. Not all families have so much music ... and do the things that you do ...

Mother: Mmm ...

H: Was REFLECT different this time than the time before?

Mother: Yes, there were fewer things this time, and the fact that some of the things were put into a box today, that was good. This afforded more activity instead of being met with chaos like last time, which does not invite activity ... so this was good!

Grandmother: Ahhh [nods her head].

Mother: The Dragon! [a name Petronella and her mother gives one of the CCTs] It activated us ... But again, I missed being able to regulate the volume of the things ... especially after a while ...

Mother: But I saw that Petronella found it exciting to do repetitions – whereas, for us, repetitions made us go nuts ... those two to three bars, over and over again ... but she could listen to the same loop over and over again ... I think she could go on forever ... that is good for her, but not for the interaction ...

H: How did you explore REFLECT?

Grandmother: Tried out one thing at a time ...

Mother: Some of them did not work? They did not react ...

H: Yes, I noticed that you missed the sound coming from the 'flower thing'?

Mother: Yes, because last time there was classical music coming from that one ... It was so wonderful ... now there was another sound ... a terrible sound! Created a break in my expectations coming from a flower ... Completely wrong ... Petronella was not so interested in that flower last time either ... do not know why ...

Grandmother: I guess she wants to have music she knows ...

Mother: Yes ...

Grandmother: What is most fun for her ... that is, when she moves ... then she smiles and is satisfied ... and is happy ... When mummy joins in and dances with her, it is most amusing for her!

H: So, does this mean that the ability to control and influence the programming of the things' content would be important to you?

Mother: Yes, to be able to choose what to put in and what to take out ... I would, for instance, take out the whole tune of 'Mamma Mia' ... she can play that on a CD ... I think these things should invite her to do something else ...

H: So there were two things you want to avoid here – one is that the thing plays the whole tune, and another is that it is 'Mamma Mia'?

M: Yes, and to be able to regulate the volume.

Grandmother: Yeah ...

Mother: It is exciting with REFLECT, not knowing what is coming for new sounds ... 'Wow! What was that?' To go together ... Maybe the grown ups were most interested in this part? But I do believe that Petronella, after a while, would be interested too ... She just needs to get used to ...

H: It is exciting that what you [grownups] think is boring, Petronella finds enjoyable. Also, that there are things here that you find exciting, which Petronella, with time, might be attracted to ...

Mother: Yes ... Petronella normally explores for just five minutes ... then she returns to the familiar ...

Grandmother: But this [REFLECT] can also become familiar for her too, can it not?

Mother: Yes. That is true ...

H: If you had REFLECT at home, what would this mean for you and your family, and what should be changed in order for REFLECT to become optimal for you?

Mother: It would be nice if the things could fit into a room ... but then this disco should not supersede other things to do ... At home, she would have to choose one of the songs and put the other song away ...

Grandmother: [Laughs] And then Petronella would beg you – 'Mamma Mia! Mamma Mia! Mamma Mia! Mamma Mia!' – until you gave in ...

Mother: Yes ... but I mean, with the tune 'Dyrene i Africa', the whole tune was not played ... and then she did not want to dance ... instead she explored ...

Grandmother: Mmm [nods her head].

Mother: The ability to regulate the programming is brilliant! For her [Petronella] to explore, maybe it is good to have more neutral songs? But, then again, for her to get interested, it must be familiar first ...

Grandmother: Mmm ...

Mother: Also, at home, REFLECT must compete with DVDs, PC, picture books. I am not sure whether we need REFLECT ...

Grandmother: I think it would be good to have at home. She likes to touch it – it is nice to touch. And she just loves things with music ... Good to have something to hold that she can send around ...

Mother: Well, our need is for her to be active on her own, over a longer time ... As I said, she is easily attracted to music and certain songs ... but she needs variation, new songs ... Maybe music could be used to get her interested in other things? Also, I was wondering whether it would be possible to think of REFLECT as a jigsaw puzzle ... where the fragments of songs could be put together as one whole song ... then she could be stimulated cognitively too?

H: Wow ... Any other aspects connected to REFLECT that you want to comment upon?

Mother: Yes, hygiene ... If Petronella puts the thing's part into her mouth ... which she will ... Also, as we have seen during our exploring of the other things in RHYME, the microphone effect is important for Petronella, to promote her voice – and to do this at home, in a freer setting. . . not so much pressure ...

Grandmother: I am so grateful for this project [RHYME] – that someone explores this with the intention to enhance the everyday life of these children and families ...

Mother: Petronella has been looking forward to the testing of these things! A good sign ...

H: Thank you so much for taking the time to do this interview! This has been very helpful!

Short summary of the main findings in the narrative and in the interview

The narrative describes a family having fun and enjoying themselves while exploring REFLECT. Obviously, the child is very physically engaged, especially when she hears *Mamma Mia* and starts to dance. During the time they spend in the room, the family moves through various moods together, from curious and exploratory, to

energised and motivated in their musicking, to calm and relaxed at the end. The narrative also describes how the family members relate differently to the process of exploring: the child takes the lead and the mother and grandmother mostly follow along, perhaps in the interests of recognising and supporting the child's initiative. Their interaction becomes more mutual later on, when child and mother share the initiative in the choreography of their dance. The grandmother tires after a while and prefers to watch the dancing instead.

In the interview, the family members stress the importance of having things at home that inspire them to interact and have fun together. They need, as another mother participating in RHYME said to me (see Stensæth, 2013), 'to have things to do – together and over time – things that are easily enjoyable and meaningful'. These family members, on the other hand, ask for things that can activate Petronella on their own. They explain that, in her playing and exploring, Petronella is very dependent on other family members to become activated and keep her interest up. They do not always have the time and energy to help her, however. Additionally, Petronella's mother wants things that will allow Petronella to learn and develop. Ideally, says the mother, REFLECT should be programmed so that Petronella's abiding interest in music and dance will lead her to other types of stimulation, especially those that could enhance her speech and cognitive development.

Discussion

This passage discusses how the results of the study in relation to the research question stated above. It certainly appears that this family had many meaningful musicking experiences with REFLECT, from inquisitive tangible exploring with sounds, to excited singing and dancing, to relaxing while listening to music. While there might be many ways in which this family would benefit from having a media platform such as REFLECT at home, can we truly say that it would enhance their quality of life? Before we respond to this last part of the research question, we must revisit the various results deriving from the two data sources in more detail.

Together, the narrative and the interview paint a broad picture of this family's experiences, but the latter provides the most compelling insight into the interaction. Take, for example, the moment when the mother and the daughter sing and dance to *Mamma Mia* while the grandmother applauds them. If we work from the narrative alone, we might have the impression that REFLECT afforded a wonderful musicking opportunity for mother and daughter to share. But the interview

reveals that the mother in fact lamented this REFLECT-inspired dancing, because they often do that sort of thing at home already, and they 'do not need any more of it', as the mother puts it. It is also clearly difficult for the family as a whole to find *one music* and *one activity* that are 'right' for everyone at once. What Petronella finds interesting and fun to do, and to listen to, is different from what the mother and the grandmother want – while Petronella wants ABBA, the mother prefers classical music, and the grandmother, no music at all. It thus becomes challenging to create what musicologist Charles Keil (1995) calls a 'sameness of experience'. Keil explains that people use music to form their own 'idioculture'. This means that it can be challenging for people who are formed by different types of music to experience the same when they listen to the same music. In this study, the conditions that hinder the cultivation of this sameness of musical experience are unique, in that they go beyond simple intentions or musical preferences. Because Petronella faces the world in a manner that is different from and in a way narrower than the rest of the family, it can be difficult to establish an ongoing interaction with her. In the interview, the mother confirms the challenges associated with her daughter's limited ability to sustain interest in other than a few favourite activities for a prolonged duration. She says that it is also hard to keep Petronella from doing the same thing, over and over, which is how she experiences Petronella's dancing (or 'disco', the mother calls it). Therefore, to enhance their quality of life in particular, the family would need to aim their musicking with REFLECT towards *the art of staying within an interesting here-and-now for all of them at the same time*. I will elaborate upon this in what follows.

One reason why this type of 'conflict' or challenge occurs is that personal interests are fundamentally incompatible, and, as mentioned above, Petronella's life world is very different from the life worlds of her mother and grandmother. We must therefore try to extrapolate some of the ways in which REFLECT might become a means of health musicking for each of them. Ansdell (2013, foreword) says, 'To understand the ways in which music helps is also to understand how we relate to it, step into it, love it, share it – and how it still remains central to human flourishing'. We must, in other words, explore the what, why and how of music's meaningfulness in tandem with the REFLECT platform for each individual in turn, with a particular focus on Petronella.

Petronella's relation to music needs to be understood in the context of her cognitive level, which is that of a five-year-old. Although she has fifteen years of life experience, Petronella is still a little girl with a little girl's desires and behaviour patterns – her concentration drifts; she is easily diverted; and she loves to do fun things or listen to the same stories again and again. This means that we need to

understand Petronella's actions and intentions from the perspective of a young child. In the following I will comment upon this point by referring to Vestad (2013) and her recent doctoral dissertation on music and children in preschool.

Vestad (Ibid.) says that young children's ways of relating to music are perhaps best framed as 'strategies of participating'. In fact, Vestad observes that the children manifest a diverse set of strategies for participating through music, which she describes as follows: *doing, integrating, singing, moving, playing, listening and playing with*.¹⁵ Petronella applies some of these strategies while inviting participation from her mother and grandmother as she explores REFLECT. By playing *Mamma Mia*, for example, she invites her mother to dance and sing along with her.

Vestad (2013, 2012) also observes that small children tend to approach music with an instinctive joy and celebrate it through movement. Very often, they prefer particular songs as well. These tags – 'joy', 'movement', 'celebration', and 'favourite songs' – characterise Petronella's relation to *Mamma Mia*, a favourite song that brings her joy and makes her want to move. When she and her mother began to choreograph a dance to it, in fact, the scene is intensified, as if they – to borrow Vestad's words – 'celebrate it through movement'. The grandmother's supports this observation when she says:

What is most fun for her ... that is, when she moves ... then she smiles and is satisfied ... and is happy ... When mummy joins in and dances with her, it is most amusing for her!

Another aspect that explains why Petronella finds REFLECT attractive to explore is its tactility (which, of course, resonates with her developmental level). Her grandmother says:

She likes to touch it – it is nice to touch. And she just loves things with music ... Good to have something to hold that she can send around ...

As we can see, Petronella both explores and plays with REFLECT. She even uses her imagination: at one point, she picks up the 'whale' as if it was a guitar and pretends that she is playing in a band. Her mother thinks that it is the music that motivates Petronella to touch the CCT. It seems important in terms of Petronella's specific interest that the music, as well as the shape and the material of REFLECT, appeals directly to her imagination, her emotions and her sensory apparatus – in particular, the vestibular (balance) and the tactile faculties.

¹⁵ Vestad here quotes Campbell (2010).

To put her body in the centre of the event is not confined to small children alone. We have all experienced difficulty in holding ourselves back when we hear certain types of music: we simply *must* move, dance, nod our heads or stamp our feet to the beat (Ruud, 1997). Music is, above all else, a nonverbal experience that speaks directly to our body. However, for Petronella, the physical effect of musical activity is even more profound. Bonde (2009) observes that, for children, 'music and the body are one' (Ibid.). Later on in life, the psychological effects of the music will become more prominent, but we always feel music as much as we think about it: 'It is impossible to avoid that a sound evokes physical and psychological effects simultaneously' (Bonde, 2009 p. 68).

Another aspect that could explain Petronella's relation to music, is her diagnosis. Two comparable studies done by Johannessen (2013) and Stensæth & Næss (2013) involve grown ups with Down syndrome. Both indicate that these people often seem to connect to music in certain ways, and sometimes in ways that are similar to those of small children. *Joy/fun/celebration*, which Vestad found to be specific for young children's relation to music, is for example a prominent category in these studies too. Johannessen (2013) found, additionally, that her informants preferred dance band music, which she explains through the fact that its lyrics and melodies are typically easy to pick up and sing along to. Also, adds Johannesen, a dance band concert swiftly becomes a joyful community of enthusiastic audience members, which would appeal to people with Down syndrome, just as it would to others. For them, dance band concerts are a means of connecting with other people who search for the same types of joyful experiences as they do.

In Stensæth & Næss's study (2013), which is a study about a rock band for people with and people without disabilities, the members underline fun as most important reason for attending the band. One of the leaders (a music therapist) expresses the following in an interview:

Probably the band wouldn't have existed without the fun! Because that is what it is: it is great fun to play in RR (the band)! We laugh and cry, but we laugh the most!

One of the members with Down syndrome links his music-related joy to situations that are especially memorable – in this case, concerts where the audiences applauded and sang along and danced to the band's musical performances. Performativity is crucial here, as a mode of communication – this grownup band member memorably compared his participation in these concerts with giving people in the audience 'musical flowers'. For him, that is, this form of contact with the audience generates 'social capital' (Stige & Aarø, 2012, p. 102). Through the connection established in the concert setting, the

crowd before him gives him 'high levels of emotional support' (Ibid., p. 115). This example indicates that recognition from others enables the fullest participation for him as a person with Down syndrome, who experiences a feeling of inclusion and of his part in something bigger than himself.

The latter is not an aspect that is only typical for people with Down syndrome. DeNora, who studies how we all relate to music in our everyday lives, links music to situated memories. She says:

Music moves through time, it is a temporal medium. This is the first reason why it is a powerful *aide-mémoire*. Like an article of clothing or an aroma, music is part of the material and aesthetic environment in which it was once playing, in which the past, now an artifact of memory and its constitution, was once a present (DeNora, 2000, p. 66–67).

This author means it is possible to view Petronella's way of relating to REFLECT in a similar fashion, which means that she links ABBA's music to situated memories. However, Petronella's stage is at home, in the living room or kitchen or wherever the family gathers for a (disco) dance. The audience is her family, and anyone else who might be visiting. Home is where she invites people to sing, dance, and relax with her. The fact that her family responds has made dancing into a precious and memorable family activity.

Apart from her request for more classical music in REFLECT, the mother and the grandmother do not say much about the what, why and how of music in relation to constructive family collaboration. In general, they seem to consider REFLECT as a means of enabling Petronella's interaction with them and the rest of the family but in new ways. The mother says that through the use of more 'neutral music', Petronella could be engaged in further learning and development. Because the mother has intentions regarding REFLECT that are independent of Petronella's, the girl's dancing makes her feel conflicted. On the one hand, she wants to validate her daughter's desires and admits that it *is* fun to dance with her. On the other hand, she fears that the REFLECT dancing is destructive for Petronella, in that it reinforces her existing behaviours without inspiring anything new. She therefore wonders whether Petronella's fanatical interest in ABBA and *Mamma Mia* might hinder her creative interaction with other people and other aspects of REFLECT. The mother therefore advocates for other types of music for the platform – ones that might stimulate other types of family activities than dancing.

The mother says that for REFLECT to be most useful to them as a family, it should not compete with other fun activities, such as DVDs, PC and picture books, which

Petronella already finds very attractive. Rather REFLECT must engage Petronella and her family differently than these activities but with the same (or more) pleasure. Understandably, it is not easy to respond to such a request. However, in general we could say that to suit a range of family needs, a media platform such as REFLECT should allow each family to program it in his or her own way, so that their activities and collaborations would generate 'qualitative and meaningful here-and-now experiences that in turn might comprise a 'provider of vitality' (Ruud, 2010; Bonde, 2011) and thereby enhance the family members' feelings of bonding and belonging. With this enhancement, REFLECT might represent a useful tool in the aesthetic home environment, one that has the potential to enhance the quality of life in the family.

Conclusion

Again, this study's research questions were as follows: *How does one family experience REFLECT, and how can their musicking with REFLECT potentially enhance their quality of life?*

Although the results discussed here reveal that the family members do not share existing intentions or *interact* in the sense of 'experiencing sameness', they do manage to *co-act* in a consequential fashion. They realise a moment of 'co-musicking', so to speak, becoming active and having fun simultaneously despite the fact that they do not share intentions or experiences as such. Nevertheless, REFLECT clearly represents a means of deliverance from the problems of everyday life just by allowing the family to be in a better mood. In short, REFLECT vitalises these participants as a family, and *vitalisation* should be included among REFLECT's potentials regarding health musicking as an enhancement of life quality. In this regard, this study correlates with the studies of Stensæth & Ruud (2014, 2012) and Stensæth (2013) in which it is found that vitality incorporates the physical *stimulation of movement and basic senses* like hearing, sight, touch and the kinaesthetic, proprioceptive and vestibular senses. Vitalisation also encompasses mental stimulation through its promotion of a sense of *mastery*, especially for Petronella, and its strengthening of a sense of *agency* for the whole family. Last but not least, vitalisation relates to the feeling of having fun, both by oneself and in the company of others. If REFLECT affords vitalisation in these various ways, we might anticipate that the next generation of CCTs could more directly address strategies of participation for the entire family. Herein reside REFLECT's potentials for

building companionship and strengthening the family as a micro-community joined through intimacy and the shared cultivation of memorable and joyful experiences.

To adapt the programming of REFLECT to fit the intentions and desires of these family members, then, we would want to customise the music selections by including both familiar and unfamiliar songs. A microphone would also allow Petronella to interact with the platform and the musical selections differently through speaking and singing. In general, the REFLECT testing time was too brief to supply a proper overview of the platform's potentials. Testing in the home setting, as opposed to the school setting, would provide broader and trustworthier data as well. What we did learn here, however, is that Petronella readily took the lead in the exploring and seemed to enjoy REFLECT the most. Her initial attempts to engage her mother and grandmother represent a very hopeful start for a platform with a host of possibilities.

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‘FIELD AND AGENT’: Health and characteristic dualities in the co-creative, interactive and musical tangibles in the RHYME project

Ingelill Eide

This article suggests that co-creation as a meaningful interaction deriving from the interpersonal interaction between interactive and musical tangibles (also called co-creative tangibles, or just CCTs) and a group of users activates certain types of dualities inherent in the CCTs. These dualities are: object/agent; predictable/unpredictable; structured/unstructured; field/agent. The activation of these dualities is vitalizing and can be seen in relation to health. Umberto Eco’s aesthetic ideal of the *open work*, as well as his concept of the *field of possibilities* (Eco, 1989), initially focussed my attention upon these dualities, which I first pursued in my master thesis (Eide, 2013) and to which I will return in what follows. The CCTs in question here were developed for the interdisciplinary research project RHYME (www.rhyme.no), and the data was collected at a special education school. The user group included children with disabilities and adults who work in the school and know the children well (hereafter referred to as ‘close others’). As we will see, co-creation is both a goal and a method in RHYME, and it is therefore of particular interest to RHYME researchers. In this context, I devised the following overall research question: *Can Eco’s concept of a Field of possibilities explain the dualities found in the CCTs developed in the RHYME project, and if so, how does this affect our understanding of co-creation as vitalizing and health promoting?* To engage with this research question, I have used a qualitative research design with structured analysis and five semi-structured interviews with the close others. In addition, I showed video excerpts of the testing during the interview in order to remind them of the testing situation.

First of all, I will introduce the RHYME project and define its core concepts: *health, close others, CCTs, children with disabilities, and co-creation*. I will then present Eco’s related notions of the open work and the field of possibilities (Eco, 1989; Eide, 2013). With the help of a selection of quotations harvested from my master’s thesis, I will explore what kind of dualities the CCTs potentially create. In the concluding discussion, I will suggest that the CCTs possess a two-dimensionality in the

co-creation event.¹ I will also elaborate upon the ways in which this new awareness might influence the field of music therapy.

The RHYME project:²

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the children and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include from six to ten families who have volunteered to participate, and the children with disabilities in the families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

Defining core concepts

Health

The aim of the RHYME project is to promote health and quality of life for users with disabilities and their families (Stensæth, 2013; Stensæth & Ruud, 2012). Health is

1 All quotations are translated from Norwegian by me.

2 The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology, and Design by Stensæth (Ed.)

here understood from a salutogenetic perspective.³ This perspective emphasizes health as continuum (Bruscia, 1998; Ruud, 2010), which means that health can exist even in the presence of factors that threaten it – it is a subjective, experienced condition, or something you *are* not something you *have* (Bruscia, 1998; Ruud, 2010; Stensæth, 2010). It also means that health is process; it is something you can influence and adapt under given circumstances.

Nordenfelt names this perspective a *social-holistic health strategy* (Nordenfelt in Stensæth, 2010),⁴ which draws attention to the fact that health is not only a medical phenomenon but also a social phenomenon. A healthy person functions well as a *whole*, both mentally and physically:

Being in good health is then about more than surviving and feeling well-ness. It is also about self-actualisation and participating (Stensæth, 2010, p. 109).

This social-holistic perspective on health dovetails well with the circumstances and intended outcomes of the RHYME project, because the children who participate in it experience their health as constantly threatened by their disabilities. Nevertheless, they are obviously able to experience quality of life through self-actualisation and participation, and even more so when the environment and the people surrounding them focus on those factors that promote health. From this perspective, RHYME likewise supports the ideals of Universal Design, which frame 'disability' as simply a mismatch between the particular individual's prerequisites and the function-related requirements that reside in the physical and social surroundings. Thus the disability is not understood as a characteristic of the individual, or as something they are. Instead, it is something he or she *has*, and it can be dealt with in constructive ways, less via individual facilitation than design for all (Skjerdal, in NOU 2005).

Children with disabilities

In the present article, the notion of *children with disabilities* is intended to encompass the children who are participating in the RHYME project. These children are pupils at Haug School and Resource Centre, a special-needs school in the Oslo area of Norway. They represent a heterogeneous group of children, some of whom are

3 Salutogenetics focuses on the factors that promote health, in contrast to a pathogenetic perspective, in which good health is understood to be the absence of disease (Bruscia, 1998).

4 Whereas he names the pathogenetic perspective a biological-statistical health strategy (Stensæth, 2010).

very outgoing and participatory, others of whom are introverted and observant. Their disabilities range from autism-spectrum disorders to multiple disabilities, and their mental age equivalents range from six months to seven years. Some of the participant children are wheelchair dependent (Stensæth, 2013).

‘Close others’

Because of their disabilities, the children participating in the RHYME project are often dependent on the assistance of another person, here known as a *close other*. Horgen (2010) emphasizes that being a close other to a child with a severe disability entails the responsibility of accommodating the child in a way that facilitates to communication, life enrichment and learning.

Because it is only together with the close other that a child can unfold; without the close other, the child cannot do anything (Ibid., p. 9, my translation).

Being a close other also requires being open and receptive to the child’s initiative and expressions. A close other responds to the child in such a way that the child understands that she/he is being understood (Ibid.).

These aspects of the close other, of course, intersect with certain aspects of the phenomena of dialogue. In Norway, for example, the dialogical perspective has become crucial to music therapists in recent decades (among others, see Stensæth, 2010, 2008b; Garred, 2008, 2001; Tønsberg, 2010), emphasising a particular complementarity and closeness in the therapy relationship (Garred, 2008). Meaning is negotiated through dialogue (Stensæth, 2008b), and a profound ethical responsibility is implied here, as effective dialogue demands both receptiveness and a genuine wish to take the perspective of the other. According to Stensæth (2010), this responsibility informs the music therapist’s ability to co-experience meaning *together* with the child. When the music therapist does manage to understand the child and share feelings and experiences *together* with him/her, an active, receptive responsiveness is created (Ibid., p. 120). Tønsberg (2010) also finds that if music therapy is to be dialogical, it is essential that the music therapist *co-experiences* or *and co-creates* together with the child. As we shall see later on, these perspectives are included to describe the concept of co-creation in relation to the dualities in focus.

In sum, the term *close others* refer to the staff members who attended the testing situation – adults who are all open and sensitive to the needs and the expressions of the children they assisted. They are the children’s teachers, milieu

workers or teacher assistants, and they possess the qualities and ethical responsibilities described above.

The Co-Creative Tangibles (CCTs)

In the present study, the CCTs are the tangibles that have been tested within the RHYME project.⁵ They are interactive, ICT⁶-based, musical 'things' that invite play, exploration and co-creation (Holone & Herstad, 2011a, c). The empirical material that supports this article is based on the interviews with some of the close others who participated in the testing of the particular CCTs known as ORFI and WAVE, two first-generation interactive music tangibles that were tested within the RHYME project.

ORFI

ORFI is an interactive installation consisting of twenty tetrahedron-shaped modules, or pillows.⁷ They are made of black textiles with orange 'wings', which give them an origami-like presentation. A light is placed in the middle of the wings. By bending the wings, the user can effect change in the lighting, video and music (Cappelen & Andersson, 2011a, b; Stensæth & Ruud, 2012). The modules come in three different sizes (ranging from thirty to ninety centimetres). There are microphones in two of the modules, and all of them contain a microcomputer and transmitter to permit wireless communication (Ibid.). A genre pillow allows the user to switch among different genres of music. These genres are set up to interact in endless combinations:

Some of the genres use sound files that can be combined, following musical principles for layering and sequential ordering. In other genres the music and the dynamic graphics are based on programming code, making it possible to order content in layers and sequentially, based on how the users interact. Every sound node is designed so that each can be composed together with others, following musical rules (Cappelen & Andersson, 2011c, p. 3).

5 I will refer to these tangibles as 'interactive music tangibles', 'co-creative tangibles' or just 'tangibles'.

6 ICT is shortened for Information and Communication Technology.

7 ORFI already existed as a prototype when the RHYME project started. It was developed by three of the members in Musicalfieldsforever (www.musicalfieldsforever.com), Cappelen, Andersson, and Olofsson, who represent the design team in the RHYME research group. ORFI had been tested prior to the RHYME project, but the research group decided to make this prototype a starting point for experiencing the new target group and for developing the new generations of co-creative tangibles.

The modules thus represent hybrids of furniture, toy and instrument, and they are designed to invite the users to arrive at different interpretations and develop individual interactions (Cappelen & Andersson, 2011b). The designers also describe the following:

You can sit on it as if it were a chair or play on it as if it were an instrument. Or you can talk, sing and play with it, as if it were a friend and a musician in a communicative way, whereby ORFI answers vary musically after a time (Cappelen & Andersson 2011c, p. 3).

According to its creators, the ORFI installation is meant to create a field of interaction with no primary point of entry. One can interact with it from nearby or further away. ORFI should, in short, promote interaction and communication on equal bases among different users in different situations (Cappelen & Andersson, 2011a).

The users gave a lot of feedback after testing the installation. One suggestion was that the sound should appear to be closer to the interaction area. Another was that it should have more sensory experiences, possibly involving vibration. This feedback led to the development of the second generation of tangibles, called WAVE.

WAVE

WAVE consists of two different interactive tangibles: WAVE Carpet and WAVE Orange. In the following, I will focus on the former, which is presented as a seven-armed carpet. In comparison to the many tangibles involved in ORFI, the WAVE Carpet represents *one* tangible with many inputs and outputs, including infrared responses in a bubble-shaped field, a microphone in one arm, a camera in another arm, and a projector in a third arm. In addition, there are both bend sensors and accelerometers, and there are lights in four of the arms, which are also programmed with sound. In the middle of the carpet, there is a sound vibration element and speakers. The WAVE Carpet differs significantly from ORFI and therefore affords other interpretations and types of relations.⁸

⁸ See Cappelen & Andersson (2014) or elsewhere in this volume for the design process of the co-creative tangibles.

Co-creation

A simple definition of *co-creation* is creating something together. The *something* and the process of *creating together* merit further comment, however.

Creating 'something third'

According to Cappelen and Andersson (2012, 2011a, b, c, d, 2008, 2003; Stensæth, 2013), play and collaboration, along with listening, exploration and composing, are important factors in co-creation. Yet co-creation involves something more. It means "collaboration where the users *create something third* together" (Cappelen & Andersson, 2011c, p. 1). Whereas play is described as a random and spontaneous activity shared between people, collaboration happens when people act towards a common goal and co-creation is additionally understood to be an extended, socially motivated experience of collaboration (Ibid.). It also results in the creation of 'something third'. But what might that mean?

When exploring the concept of *co-creation*, Stensæth (2013) describes the *third* as something that exists on its own terms. She also refers to Trondalen's (2004) exploration of *thirdness* in music-therapy improvisation, where it is linked to intersubjective *moments of meeting*. *Creating something third*, then, might involve an intersubjective meeting that changes our experience of the given relationship. Take Stensæth's perspective a step further in relation to the RHYME project, this sort of meeting might also have the potential of changing our experience of *ourselves* in relation to the community of which we are a part. The community itself is then experienced as an active and vital collaboration party, which influences the people interacting with it and the way they interact with each other.

Stensæth also discusses Benjamin's use of the term *co-created third*:

The co-created third has the transitional quality of being both invented and discovered. To the question of 'Who created this?' the paradoxical answer is 'Both and neither' (Benjamin in Stensæth 2013, no paging).

The third's duality as both invented and discovered, and this shared experience of having invented or discovered something that cannot be traced back to a specific idea, initiative or action, is a good explication of the dynamic process that is characteristic of *co-creation*.

Musicking

Cappelen and Andersson (2011a) also link co-creation to *musicking*, as described by the musicologist Christopher Small (1998):

To music is to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for performance (what is called composing), or by dancing (Ibid, p. 9).

By making *music* into a verb, Small redefines it, moving away from music as an individual enterprise with the work in the position of privilege and toward music as an act with a social dimension. In this sense, *musicking* includes not only the music in itself but also the musicians and everyone involved as agents in a musical realisation of some sort.

In addition to the social dimension discussed by Small, music therapist Even Ruud (2010, p. 11) links *musicking* to vitality, agency, empowerment, social capital, meaning and coherence in life. Ruud this way applies resource oriented and humanistic dimensions to *musicking*. As we shall see in the following, these dimensions also relate to the health aspects in co-creation.

Health aspects in co-creation

As mentioned, the aim of the RHYME project is to promote health and quality of life for users with disabilities and their families (Stensæth, 2013; Stensæth & Ruud, 2012). This health dimension is further emphasised through the combination of intersubjectivity and the processes of co-creation and musicking, as summarised by Stensæth (2013, p. 24):

We have learned that co-creation implies health musicking. Health musicking incorporates the families' desire *to do* (action) *something* (activities) *meaningful* (intentional) *together* (intersubjective and interpersonal). The aim is of an ecological kind; it is the process of continuously promoting health and at the same time preventing poor health. Accessing these goals implies also strengthening of agency and mastery, as well as creating embodied, sensory, and empowering interactions both with the tangibles and with other people.

Based on the perspectives I have presented here, I might (re)define co-creation as *meaningful interaction deriving from the interpersonal interaction of the users and the CCTs* (see diagram 1). Together, these three agents (the bubbles in diagram 1) invent or discover *something third*.

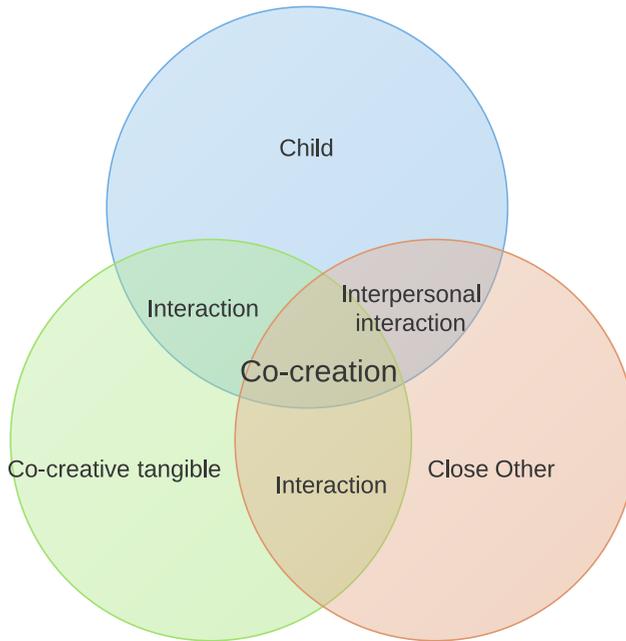


Diagram 1: *Co-creation.*

Eco's aesthetic ideal

In developing the co-creative tangibles in RHYME, the designers of the project, Cappelen & Andersson (2011a, b, c, d, 2008, 2003), stated that they were inspired by Umberto Eco (1989) and his aesthetic ideal of *openness*, as it is presented via the *open work*. Eco's thinking also inspired my exploration of the potential of the CCTs in relation to children with disabilities, and from a wider perspective, to music therapy. I will discuss his notions of *openness* and the *field of possibilities* in what follows.

The open work

In *The Poetics of the Open Work*, Eco (1989) focuses upon works within music, literature and theatre that allow for several possible interpretations from the reader, performer or listener. He considers them to be open because there is no *one* 'right' way to interpret and present them. He quotes Pousseur, who claims that the open work...

... tends to encourage 'acts of conscious freedom' on the part of the performer and place him at the focal point of a network of limitless inter-relations, among which he chooses to set up his own form without being influenced by an external *necessity* which definitively prescribes the organization of the work in hand (Eco, 1989, p. 4).

Eco also identifies a subcategory within the category of *open works*:

However, it is clear that a composition such as *Scambi* poses a completely new problem. It invites us to identify inside the category of 'open' works a further, more restricted classification of works which can be defined as 'works in movement' because they characteristically consist of unplanned or physically incomplete structural units (Eco, 1989, p. 12).

What, then, is an open work, according to Eco? An open work, in the sense of *a work in movement*, is characterised by an invitation from the artist to the receiver to make the work together (Eco, 1989) – that is, to *co-create*.

In addition, we must remember that Eco does *not* associate this openness exclusively with either chaos or coincidence:

They will always be seen as 'works' and not just as a conglomeration of random components ready to emerge from the chaos in which they previously stood and permitted to assume any form whatsoever (Eco, 1989, p. 20).

In other words, if the composer creates an open work, all of its subsequent interpretations and performances will, from this perspective, be the product of the composer as well (Eco, 1989). The programming code that lies in the CCTs could also be understood in this perspective. The interactive characteristics that come alive in co-creation, including the music, is not coincidental but a result of the designer teams' work.

A field of possibilities

The RHYME designer team was also inspired by the aesthetic ideal of Eco's take on the *field of possibilities*. In what follows, I will link this notion with the RHYME CCTs, the principles and dictates of universal design (Skjerdal, 2005; Lid, 2012) and a holistic health strategy (Stensæth, 2012; Ruud, 2010).

Two of the designers of the RHYME tangibles, Cappelen and Andersson, think of the CCTs as representing a field of possibilities, noting the various interactions implied by the technologies related to image, sound and light and their potential impacts upon the relations that occur among persons, roles and positions (Cappelen & Andersson, 2011b, 2008, 2003).⁹ Many possibilities, then, can be realised through the users' interaction with the CCTs, particularly in the course of time (Ibid.).

It was Posseur who first suggested the concept of a field of possibilities, but Eco (1989) looked more closely at the terms *field* and *possibilities* from a historical and social/philosophical perspective. The former, Eco notes, is the opposite of a linear cause-and-effect model:

[...] a complex interplay of motive forces is envisaged, a configuration of possible events, a complete dynamism of structure (Eco, 1989, p. 14).

The field, then, represents a configuration of *possible* events or simultaneous structures. Along those lines, the notion of possibilities specifically rejects the claimed unity of intellectual authority in favour of personal choices in real social contexts.

Cappelen & Andersson (2003) allowed the notion of the field to change how they thought about the relationship between user and designer in the interaction design. In particular, the user is invited to become a *co-creator*:

The *Field* concept changes our understanding of what we create because it makes us focus on other qualities in our designs, like circulatable, inscribable and multivalent. If these are qualities that we want to achieve in our designs and works of art, then this changes our creative process – how we acknowledge our users and our own contribution. The users become co-creators and our contribution is maybe only an expression in an ongoing discussion, instead of being a finalised artwork (Cappelen & Andersson, 2003, p. 88).

⁹ The designers refer specifically to spatial, temporal and actorial relations; see Cappelen & Andersson (2011d) and Stensæth (2013).

Eco's field of possibilities, then, is more than just a philosophy and/or a design concept – it is a metaphor for the CCTs in relation to universal design (Skjerdal in NOU 2005; Lid, 2012) and a holistic health strategy (Stensæth, 2012; Ruud, 2010). By this I mean that as a metaphor a *field of possibilities* illustrates how the CCTs create an open field that invites anyone to participate in society and in active co-creation, regardless of physical, social or mental function. Further, by being experienced as a *field of possibilities* by the users, the co-creation with the CCTs can be understood within a holistic health strategy that emphasizes health as a subjective experience, independent of factors that threaten the health state of the co-creators.

Four dualities

Based on my master thesis (Eide, 2013), I will now present four dualities that further derive from and elaborate upon the *open work* and *field of possibilities* aspects of the RHYME project's CCTs. Quotations from the close-other interviews will illuminate how these dualities arose during the act of co-creation that occurred among the close others, the children and the tangibles. Interestingly, it became clear from the interview analysis that some of the experiences of the CCTs were contradictory in nature, and when I sought to accommodate rather than undermine this fact, new depths of possibility emerged, which I have captured in these dualities.

Object and agent

On one hand, the interviewees describe the CCTs as objects with certain characteristics and functions (light, sound, camera, projector, fabric and so on). On the other hand, perhaps because of their pointedly interactive qualities, they also described them as agents – their interactivity, then, more than simply functional, was also *animating*. The CCTs were almost described as 'beings' with their own intentionality:

She acted towards the octopus (...) and probably believed that it was the octopus which made those...

That it was kind of alive?

Yes, I do think so...

Further on in the interview, the same interviewee said that she thought the child experienced the CCTs as having 'human characteristics':

So she did see, or have the experience, that it [the tangible] gave something back.

As an object, then, the CCT can be manipulated (by touching, pushing, bending). At the same time, it is an agent and an 'intelligent' responder in the co-creation. By this I mean that the CCT responds in its own way and takes its own initiatives without being manipulated. This duality makes users curious and holds their attention over time, even with children with disabilities who are described as not very curious in the first place.

Predictable and unpredictable

This predictable/unpredictable duality emerges from the object/agent duality, because the CCTs' objectness is relatively predictable, and its agentness emerges directly from its ability to be unpredictable. The CCTs surprise the user with each new interaction because they (are programmed to) 'make up' their own answers rather than simply respond in a certain way or imitate. On one hand, there are limited ways to manipulate them:

You learn that some inputs have this sound, and others have that sound, and then you just have to learn where the different sounds are located (...) then you just move them.

On the other hand, the user does not really know how they are going to respond:

You never know what will happen when you give them a push.

Structured and unstructured

Predictability, in turn, relates to structure. For some of the children participating in the RHYME project, structure (and a sense of an overview) in everyday situations allows them to feel like they are in control of their lives. It gives them a sense of self-agency (Eide, 2013). Given that the RHYME experiments occurred in a rather 'unstructured' fashion – the CCTs were initially unfamiliar and sometimes reacted unpredictably – it is especially compelling that even these children generally

responded to them in a positive and composed way. Was it the case, then, that the children experienced a sense of structure regardless? Did they see the CCTs as at once structured and unstructured, or at the very least capable of aspects of both qualities? The 'unstructured' would then relate to the unpredictable in the CCTs, which is a result of the programming and that what makes the CCTs improvise and behave 'intelligently'. The children learned and also accepted that the CCTs' responses were unpredictable and that there was no way to control the tangibles as such. The 'structured', however, would relate to the constants of the CCTs – that is, their physical characteristics, such as shape or functions. I find that one of the interviewees refers to the constants as structured when she refers to the pillows as a 'theme' and the functions of the buttons as controllable:

In a sense, it was the pillows that were the theme.

All the buttons had functions (...) and it gave a certain feeling of control when you first had tested out all of them.

By acting as both structured *and* unstructured, and predictable *and* unpredictable, the CCTs allow for acts of co-creation that appear to abide by unique laws and encompass the aforementioned dualities. Because there is no intersubjective element as such in the CCTs, they do not apply to what music therapist Holck (2004) labels *interaction themes*.¹⁰ Yet users *can* experience CCT-enabled co-creation as developing interaction themes, in the sense that certain predictable responses give rise to expectations. When the CCTs break with these expectations, however, they do not confuse or frustrate the users but instead surprise, amuse and engage them.

Field and agent

The field/agent duality, like the first, contrasts what the CCTs provide against what they *do*. It represents the physical environment in which the interaction takes place, and it participates in the interaction. This is an explicit part of the design: the CCTs a meant to be a hybrid of furniture, toy and instrument, in the interests of multiplying the possibilities inherent within (and *with*) it (Cappelen & Andersson, 2011b).

¹⁰ At the same time, one could argue that as long as there are several co-creators, there will be the potential for intersubjectivity in the co-creation process with the tangibles.

Discussion

I have now suggested four dualities as characteristic for the co-creative tangibles. We might then wonder: Do these dualities have implications for the way we understand co-creation itself? I would now like to explore the relationship between these observed dualities in the CCTs and the process of co-creation, which we defined earlier.

Active and passive

Revisiting the aforementioned dualities as characteristics of the CCTs, we see further that the CCTs play both a *passive* and an *active* role in the co-creation. First of all, as discussed, the CCTs are passive, in that they are *objects* that can be manipulated in several *predictable* ways so as to *structure* the interaction. Likewise, they create a *field* or physical environment that sets the scene for the interaction. Yet as *agents* that respond *unpredictably*, the tangibles are also active. This is a result of their *unstructured elements* (see before). Users are thus invited to interact meaningfully from both a passive and an active position, which expands the possibilities for co-creation and, in turn, for health promotion.

'Two-dimensional' role

As both passive and active, the CCTs fill a decidedly two-dimensional role. As opposed to a musical instrument, for example, which is only passive – as an *object*, the musical instrument require manipulation in order to produce the music that can then become part of its interaction with the user. Equally one-dimensional, the close other can only be an *agent* – as a human being, he/she can be manipulated to a certain degree, but never as an object.

From a dialogical perspective, the interaction between the music therapist, the client and the music is often graphically represented as a triangle, whereby each person or element mediates between the two others (Garred, 2008, 2001; Stensæth, 2010). Given the inherent dualities of the CCTs, we find that we must significantly extend such a diagram to encompass this kind of co-creation, in light of its *openness* as a work and the *field of possibilities* cultivated by the RHYME design group (Diagram 2):

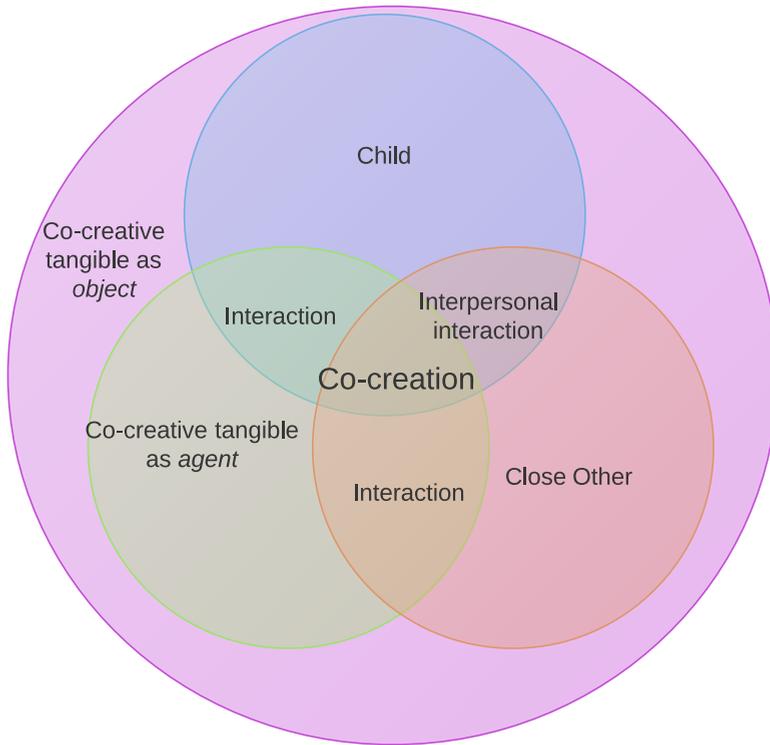


Diagram 2: *The field of co-creation.*

In this diagram, I have tried to illustrate the two-dimensional position of the CCTs, so we see that ‘the co-creative tangible as *object*’ (purple) surrounds the ‘child’, the ‘close other’ and the ‘co-creative tangible as *agent*’, supplying a generous field for interaction and co-creation. Additionally, the ‘co-creative tangible as *agent*’ (green) overlaps with both ‘child’ and ‘close other’ to create more specific fields for interaction and co-creation.¹¹

One interesting implication of the two-dimensional position of the CCTs in co-creation is that the close other and the child can have an interpersonal interaction without interpreting and experiencing the tangible as an agent. However, because of the position of the CCT as an object/field, the CCT will still play an important

¹¹ This recalls Stensæth’s (2013) illustration of the health-musicking perspective upon co-creation as located in a field between the child with disabilities, the close other and the CCTs.

part in the interaction. In the same way, I would argue that the child could have a meaningful interaction with a CCT as an agent, independent from the close other. The child is therefore presented with a field of several possible relations (as according to Cappelen & Andersson, 2011b, c), which returns us to Eco (1989) and his exploration of the terms *field* and *possibilities*.

Co-creative tangibles and music therapy

So far, I have concentrated on the relevance of co-creation in the context of RHYME. I will now extend these insights to my work as a music therapist with clients.¹² Rather than any particular expectation from music in relation to the therapist-client interaction, might we see music therapy as a configuration of *possible* events or interacting forces of structure. Also, rather than music *as* therapy or music *in* therapy (see Bruscia, 1998), we could frame music as *one of many possible media* in music therapy and place the client instead 'at the focal point of a network of limitless interrelations' (Eco, 1989, p. 4) with the therapist and the musical work that could ultimately act to promote health. This allows for the experience of *the third* (see before), which anticipates that the community co-creates and interrelates too. Also, by expanding the possibilities for who and what is active in the co-creation, we add new perspectives to music therapy. In fact, I believe that the perspectives revealed by the ways the CCTs vitalize the children and strengthen their feeling of mastery, becomes another way to reinforce the empowerment- and resource-oriented thinking that already informs music therapy (Ruud, 2010). RHYME shows that there could be many ways in which a client can be health promoted through music therapy. To interact with media like the CCTs creates challenges for the therapist too, because with increased possibilities of tools in therapy, comes increased risks for failing too. An active and responsive attitude must at all times be shared through co-experiencing and producing meaning (Stensæth, 2010). From this perspective, music therapy as a *field* of possibilities could represent a therapeutic ideal, which suggests many possible ways to deal with a therapeutic problem.

Secondly, given the inherent rejection of authority that resides in the field of *possibilities*, music therapy can no longer be considered a *systematic process of intervention* (Bruscia, 1998), because it is less the therapist than the interaction (and the CCTs or the music as an agent) that produces meaning and client insight. However, I would argue that the benefits outweigh the risks and potential costs in this regard.

¹² Music therapy is here understood as a 'systematic process of intervention wherein the therapist helps the client to promote health, using music experiences and the relationships that develop through them as dynamic forces of change' (Bruscia, 1998, p.20).

Conclusion

In this text, I looked at how Eco's concept of a field of possibilities might shed light upon the dualities found in the CCTs developed for the RHYME project. I have also described how my exploration of the dualities could affect our understanding of the crucial concept of co-creation. By identifying four possible dualities in the CCTs and discussed their relevance to co-creation and Eco's thinking, I found that the dualities both express the open ideal *and* are created as a result of the open ideal that inspired the design of the CCTs.

By putting the dualities mentioned earlier into play in the CCTs, the designers realize Eco's concepts of *openness* and a *field of possibilities* in the co-creation. This understanding correlates with the way the users describe their experiences of the CCTs, which is as objects embedded with 'inherent dualities'. Also, as the users learn how the CCTs respond uniquely to their co-creation with them, they develop new ways of relating to each other and the CCTs. The RHYME designers have in this sense managed to facilitate the building of new relationships between (musical and interactive) things and people, which I think has the potential to change the way the users see themselves in relation to themselves, to one another and to the community of which they are a part (e.g. Stensæth, 2010). Such an experience could be health promoting too, whether it happens outside or inside a music therapy setting. Eventually, I will refer to one of the interviewees who responded like this when I asked her if she thought that the CCTs could promote health:

I think so. I think they are so easy to manipulate. (...) This builds confidence. You are someone who makes things happen. You are someone who creates. Togetherness, in a way. And it brings joy – yes, a better quality of life.

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Health affordances of the RHYME artefacts

Even Ruud

The recent development within interactive music technology may provide the field of music and health with new opportunities to promote health and well-being. In order to test such possibilities, four generations of musical and interactive tangibles were developed through the RHYME project.¹ In this article, I will explore how the health consequences of this music technology as it operates within the testing of different generations of RHYME products may be understood in light of cultural psychology.

The RHYME products have been given many names: (musical) things, furniture, toys and instruments, and co-creative tangibles.² From the perspective of activity theory or cultural psychology, we might further label (and conceptualise) them as ‘artefacts’. Through this adherence to the principles of cultural-historical psychology, we also acknowledge “that the structure and development of human psychological processes emerge through culturally mediated, historically developing, practical activity” (Cole, 1996, p. 108).

As we know from the field of music therapy, musical instruments can serve as tools for communication and interaction in the service of health-promoting activity. Musical instruments, in general, we wrote earlier (Stensæth & Ruud, 2012, 2014 or elsewhere in this volume), represent *technologies*, and the use of actual digital music technology is nothing more than a continuation of the technological tradition that has long produced or reproduced music.³ Traditional instruments, electronic or digital music equipment and software, and the various generations of RHYME co-creative tangibles are also cultural artefacts, in the sense that they are human-made objects that in some way interact with individual development (Cole, 1996).

In the following, I will first introduce the RHYME project. Then I will explore how our understanding of the RHYME artefacts might benefit from being framed by the theory of cultural psychology. My main questions are the following: To

1 For a description of the RHYME project, see next page.

2 From now on I will call them co-creative tangibles. Learn more about the labeling of the RHYME artefacts in the other RHYME articles in this anthology (Stensæth, 2014) or see publication list on www.rhyme.no.

3 For an overview of music technology in music therapy, see Magee (2013).

what extent can the RHYME project be seen within a theoretical frame of cultural psychology? How might concepts like 'artefact' and 'affordance' prove helpful to our understanding of the health benefits of the musical co-creative tangibles?

The RHYME project:⁴

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical 'smart things' with multimedia capabilities. Within the project, these interactive and musical tangibles are called 'co-creative tangibles' (also sometimes shortened to CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the users and the families. Its user-oriented research incorporates the users' influence on the development of the prototypes in the project. The users include six - ten families who have volunteered to participate, and the children with disabilities in these families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children's mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

The co-creative tangibles (CCTs) as artefacts

I first suggested that musical instruments should be regarded as 'tools' that people may use to promote development over two decades ago (Ruud 1990, p. 141) with reference to Norwegian activity theorist Regi Enerstvedt (1982). I also suggested

⁴ The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology and Design by Stensæth.

that music should be regarded first as an *activity* rather than conceptualised as a work of art or an art object (Ruud, 1990, p. 220). Stige (2002) further elaborated upon the relevance of cultural psychology in his culture-centred, community-oriented approach to music therapy. He also categorised instruments as a type of artefact, which together with other artefacts such as technical equipment, songs and language, is important to the development of self and identity in relation to the community. He added: “How artefacts afford is again relative to both person and community, that is, to biography and to the cultural history of the community” (Stige, 2004, p. 107).

Such ideas have supplied much of the basis for a practice-oriented view of music therapy. Viewed in this light, music does not manifest any pre-existing content but instead makes possible or affords (see ‘affordance’ later) an interaction or communicative activity that acts in turn to define it: “It is practice that will determine the content of the concept of music”, I wrote (Ruud 1990, p. 220). Of course, this same inclination underpins Small’s powerful concept of ‘musicking’ (Small, 1998).⁵

This musical practice, in other words, can influence our cognition, our forms of thought and our modes of being in the world. Thought of as artefacts, instruments can be aligned with other material objects and tools that we have developed within a culture to realise certain goals. Cole (1996, p. 117) further underscores that artefacts, in their nature, are both *material* and *ideal*: “They are ideal in that their material form has been shaped by their participation in the interactions of which they were previously a part and which they mediate in the present”. Artefacts and actions are woven into one – material objects that carry with them ideas about how to be used.

Musical instruments as material objects are what Cole calls ‘primary’, but they are also secondary, in the sense that they imply prescriptions regarding their use that are governed by *schemas* and *scripts*. A schema represents our knowledge of the artefact – in this case, how the musical instrument (or RHYME artefact) can be applied. A schema can be more or less conscious or conventional – in the West, for example, we do not generally think about how to use a piano but rather take this for granted (at least, we did so until Bartok applied the piano as a percussion instrument). Context, of course, is important here – the relational aspects of our interpretation of the prescriptions associated with the object.

A script offers a more detailed notion of how to adapt the artefact to a certain situation (Cole, 1996, p. 124ff). It may specify the roles to be taken or the sequences of actions and causal relations within which the artefact exists. Music

5 Read about ‘Musicking Tangibles’ in Cappelen & Andersson (2014) or elsewhere in this volume.

therapists sometimes produce a new script that is adapted to the client and the instrument, thereby modifying and differentiating those existing cultural schemas (or knowledge) in order to further extend the actions that the artefact may afford.

In light of this approach, then, we must ask not only what kinds of material objects the RHYME artefacts are, and what actions they afford through their design, materiality or functionality, but also what their characteristics are as secondary artefacts with a “role in preserving and transmitting modes of action and beliefs” (Cole 1996, p. 121). Moreover, since “they include recipes, traditional beliefs, norms, constitutions, and the like”, Cole continues, new artefacts like the CCTs must be evaluated in terms of these secondary characteristics. Do they carry with them scripts that afford new possibilities for interaction and co-action that, in their particular case, might have implications for both health and quality of life?

Interactive music technology

Behind the *musical* design of the RHYME artefacts is the principle of interactive music. The ORFI, for example, is programmed in a unique way:

When one or many persons interact with the wings and microphones attached to the module, they then send signals to the computer, which memorises them and invites the person to respond and co-create music and graphics by playing, sitting, chilling out, socialising and making music together. An important feature of ORFI is that it is active, acting on its own as an actor. This means that ORFI is not simply an instrument or a neutral tool, giving the same response to the same stimuli. Instead, because of the computer program, it acts with a will of its own, enters into dialogue, imitates and answers the person interacting with the musical variations (Andersson, 2010, p. 4–5).

As Andersson explicates further (Ibid., p. 6), through interactive composing, he may transform the musical artefacts from simple intermediaries into ‘smart’ technical and musical actors. Through creating dynamically changeable algorithms in computer programmes, he may open the possibility for individuals to interact with the artefacts.

The ways in which the interaction with the musical CCTs motivate participants to explore and interact with the artefact, and also the way in which these algorithms are built into the programming, inform us about essential characteristics of the (musical) script. Thanks to its programming, the computer here has the ability

to learn and respond in an ‘intelligent’ way, in the sense that it adapts and changes in relation to the actions of the participant. This, in turn, motivates the participant to continue to engage, as the computer responds, waits, memorises and learns (Andersson, 2012).

Affordance

The notion of ‘affordance’ sheds light on the health aspects of the use of interactive music technology in the RHYME project, thanks to its conceptual history within both the field of design and musical aesthetics. Gibson (1979) developed it ‘to account for the fact that our perceptual experiences include not only awareness of the structure of objects and events in the environment, but also, and perhaps more fundamentally, an awareness of their functional significance, that is their functional meaning’, as Heft (1988, p. 29) writes. The affordances in our environment, for example, are its functionally significant properties considered in relation to an individual, Heft continues. We may use some common examples to illustrate this: a ball affords the possibility of being rolled; a small object, of being grasped. The wings of the CCTs in ORFI, then, afford the possibility of being bent, moved around, rested on, and so forth.⁶ The idiosyncratic features of each generation of the CCTs in the RHYME family could be described through reference to their affordances for participants, particularly in terms of any potential health benefit or improvement in life quality.

However, the participant must appropriate what is afforded if the artefact is to realise its full functional value. As demonstrated in the present project, affordances are determined by not only attributes of the artefacts but also attributes and abilities (e.g. perception, cognition, movement) of a given participant. This project was carried out with a mixed group of children and their siblings, parents or assistants in order to correct for the variation in affordance in this regard.

In the literature, *affordance* prompts a range of definitions. Wikipedia notes that the original definition encompasses all of the actions that are physically possible with a given object, and that this was later adapted to describe action possibilities of which the actor is aware. The term has further evolved in the context of human-computer interaction (HCI) to address the easy discoverability of possible actions.

According to Gibson (1979), affordances encompassed all of the ‘action possibilities’ that were latent in the environment and objectively measurable. Affordances could exist outside of the individual’s ability to recognise them but

⁶ Read about the design and the use of ORFI in Cappelen & Andersson (2014), Eide (2014), Stensæth & Ruud (2014) or elsewhere in this volume.

always existed in relation to agents and were therefore dependent on those agents' capabilities. They were not to be viewed as dependent upon culture, prior knowledge or individual expectations, Gibson insisted, thereby positioning himself within the philosophical tradition of 'direct realism'. This positioning has caused a lot of controversy within the field of cognitive psychology, where ideas of 'representational realism' prevail – that is, the conviction that we perceive the world *only* through our assumptions and interpretations.⁷

Within the field of design, Norman introduced the notion in his book *The Psychology of Everyday Things*, later re-released as *The Design of Everyday Things*: "The term *affordance* refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how things could possibly be used" [. . .] Affordances provide strong clues to the operation of things. "When affordances are taken advantage of, the user knows what to do just by looking: no picture, label, or instruction is required" (Norman, 1989, p. 9).

Commenting upon Norman's co-optation of Gibson's term, Sjøgaard (2008) observes that Norman's inclusion of an object's *perceived* properties – that is, the information that specifies how the object can be used – differs from Gibson's insistence that affordances are independent of the actor's ability to perceive them. From the perspective of representational realism, direct perception refers to the conviction that the information supplied to our sensory receptors is sufficient to the perception of anything, and that higher-level cognitive mediation between our sensory experience and our perception is unnecessary. Norman later made clear that he should have said 'perceived affordance' rather than simply 'affordance' from the start (Norman, 1999, quoted in Hartson, 2003).⁸

Hartson discusses Norman's take on the term:

7 I will not go into this rather complex discussion, as discussed within ecological psychology; see Katz (1987), Marková (1987).

8 Wikipedia states: 'Norman's adaptation of the concept has seen a further shift of meaning, in which the term *affordance* is used as an uncountable noun, referring to the property of an object or system's action possibilities being easily discoverable, as in "this web page has good affordance", or "this button needs more affordance". This in turn has given rise to a use of the verb *afford*—from which Gibson's original term was derived – in a way that is not consistent with its dictionary definition. Rather than "to provide" or "to make available", designers and those in the field of HCI often use *afford* as meaning "to suggest" or "to invite"' (<http://en.wikipedia.org/wiki/Affordance>; accessed Sept. 13, 2013).

In simple terms, much of the difficulty stems from the confusion between what Norman calls real affordance and perceived affordance. To Norman, the unqualified term affordance refers to real affordance, which is about physical characteristics of a device or interface that allow its operation, as described by Gibson (Hartson, 2003, p. 316).

Hartson, in turn, distinguishes among *four* types of affordances. Norman's perceived affordance now becomes *cognitive* affordance, which addresses the user's cognitive actions. Norman's real affordance (that is, Gibson's physical properties) becomes *physical* affordance, which addresses the user's physical actions. Hartson's third type is *sensory* affordance, which addresses the user's sensory actions. In the present context, this applies to how the design, and in particular the choice of surfaces and fabrics, of the RHYME artefacts invites participants to touch or interact with it. Hartson's fourth type is *functional* affordance, which ties usage to usefulness.

While these types certainly enhance one's ability to describe an artefact's affordances, the RHYME artefacts respond best to a functional design perspective, whether it derives from Norman's everyday design or Hartson's HCI perspective. It seems like this functional perspective centres around developing a design, which has a goal-directed program – i.e. to make us perform a certain task as straightforwardly as possible, based on the information given in the design of the product. The RHYME artefacts, however, have a more open and interactive design, where the functions are many and unspecified, and where their goals and intentionality emerge in a process whereby the user defines and influences the ways in which the artefact can be put to use.

This, more processual perspective is also stated clearly by Cappelen and Andersson who are inspired by, among other things, Eco's poetics of the open work, as well as Latour's theory of actants, mediation and shifting roles. Cappelen and Andersson are also critical of the HCI-based, Heideggerian, functionalistic engineering ideals that have long advocated for the opposite of ambiguity and openness. They characterise this trend as follows:

Good has been a synonym for disappearing, 'natural', intuitive and reduction of ambiguity. But lately, when people with an artistic background have entered the HCI and Interaction Design field, the engaging and interpretative potentiality of ambiguity has been introduced to the field (Cappelen & Andersson, 2011, p. 2).

Or, as Andersson states in another article:

The main shortcoming is the field's (HCI) too heavy focus on functionality, and that it still doesn't understand aesthetic experience very well.

The notion of variation and ambiguity as aesthetically and musically interesting and relevant qualities, still has to stand back for transparency and effectiveness. It has to do with interaction design's background in engineering and ergonomics (Andersson, 2010, p. 7).⁹

Ackermann (2007, p. 6) refers to French philosopher Gaston Bachelard (1964), who notes that humans can be deeply moved by what he calls 'felicitous places' (i.e. things able to transport us), and that such objects cannot and should not be characterised according to their functionality alone. Such objects instead might be said to reverberate with atmosphere or ambience in ways that capture the human imagination, Ackermann writes (Ackermann, 2007, p. 6): "They attract us because they have become topographies of our intimate being". Even a doorknob could become a felicitous object if it did not just call up our urge to "push or pull to enter", she adds (Loc. cit.)

"Everyday objects could speak a language much more un-tangible and rich, in resonance with our being and aspirations. Ideally, designers could endow objects with the ability to speak such language", Ackermann comments in her essay on affordances (Loc. cit.). In the present context, it is clear that the RHYME artefacts have those qualities that attract our attention, make us hold our breath or slow down – they speak to us.

However, to maintain this artefact's open, ambiguous, play-like design, we might ask which *functional characteristics* we can observe in the different generations of the RHYME artefacts. On the basis of the observations we have conducted of children's use and interaction with these artefacts, it is possible to produce a functional taxonomy. We could then ask if there is anything in this taxonomy which points in the direction of health benefits.

Such functional characteristics were exactly what Gibson's notion of affordance sought out, as mentioned earlier. As Heft describes (1988, p. 29),

⁹ Andersson & Cappelen (2014, or elsewhere in this volume) also write about openness and ambiguity in the design and use of the CCTs in RHYME.

Gibson developed this concept to account for the fact that our perceptual experience includes not only the structure of objects and events in the environment, but also, and perhaps more fundamentally, an awareness of their functional meaning.

Heft, however, underscores the fact that a distinctive characteristic of affordances is that they are relationally specified. In that sense, the affordances of the RHYME artefacts are determined both by the attributes of the things themselves and by the attributes of the particular children, assistants, parents and other participants. It also seems as though Heft is modifying Gibson's 'representational realism' when he states that affordances are 'more primary, in an experiential sense, than is an awareness of form-based classifications'.

Affordance categories in the RHYME artifacts

Among the affordance categories that have emerged in the studies of children's interactions with the CCTs in ORFI, WAVE and REFLECT, we may list the following.¹⁰ In an article about ORFI (Stensæth & Ruud, 2012, 2014), we can see how Ulla:

- bends the wings
- accompanies sounds with dancing movements
- turns her head downwards
- focuses on what she hears
- listens intently

– and Frode:

- is attentive and wandering
- explores
- bend-points with the wings
- explores his body and balance

In the article about the WAVE by Stensæth (2014a) in this anthology, Petronella:

- grabs the arms of the WAVE carpet
- talks and laughs into the microphone on the WAVE carpet
- pushes the 'bubbles' on the WAVE carpet

¹⁰ Read about the use of the various RHYME artefacts in Eide (2014), Stensæth (2014a, b), Stensæth & Ruud (2014) or elsewhere in this volume.

While exploring the WAVE camera, Dylan:

- watches the wall and holds the camera arm of the WAVE
- shows small movements, as if preparing to take action

Dylan also:

- leans his body over the WAVE carpet
- picks up a WAVE 'arm' and lets it fall back onto the floor

In the article about the REFLECT by Stensæth (2014b) in this anthology, Petronella:

- choreographs a dance together with her mother while holding REFLECT
- sings into the REFLECT 'tale' (as if it were a microphone)
- plays 'guitar' with the REFLECT 'whale' (as she calls it)
- cuddles and relaxes with one of the small CCTs in REFLECT

A more complete list of all of the affordances inherent to the different generations of RHYME artefacts could be organized according to, for example, developmental needs, relational and emotional aspects, fun and recreational affordances or (in the present context) health and quality of life.¹¹

Affordances of musicking

Over the past decade or two, Christopher Small's concept of 'musicking' (Small, 1998), like the concepts of 'affordance' and 'appropriation' (DeNora, 2000; Clarke, 2003, 2005), has gained wide acceptance in the literature. Small emphasises that 'music' must be understood as a practice and a process – as something we *do* – rather than as an object. This has profound implications for any understanding of the ways in which meanings are produced while one is engaged with music, and it leads Small to nuance the catch-all noun 'music' as the verb 'musicking'. This, in turn, seems uniquely applicable to a description of the use of music in health practice as 'health musicking' (Stige, 2012).¹²

According to Krueger (2011), music can also be seen as an 'affordance-laden structure'. In other words,

11 In a review of this article, Gary Ansdell also suggests a more categorical summary of the affordances, such as orientations, explores, acts on... etc.

12 Stensæth (2014b) also relates 'health musicking' to the a family's interaction with the REFLECT.

[...] musical experience is fundamentally a temporally extended, exploratory activity: a perception, manipulation and appropriation of different sonic affordances offered up by different pieces of music (Krueger, 2011, p. 2).

To Krueger, music also represents a nested acoustic environment ‘that affords possibilities for, among other things, (1) emotion regulation and (2) social coordination’:

A consequence of this view is that music ought to be thought of as a tool that we appropriate and use to construct different forms of self-experience and social relatedness. When we do things with music, we are very often engaged in the work of creating and cultivating the self, as well as creating and cultivating a shared world that we inhabit with others. As active perceivers, we are in many ways perceptual composers. Music invites this kind of dynamic engagement (Loc. cit.).

If this is true in relation to simply listening to music, it is even truer when it comes to the context of RHYME artefacts, which are designed for music-related interactivity and co-creation. As mentioned earlier, one’s interaction with the musical CCTs was always intended to spur further interaction – this was, in fact, a principle that was built into their programming. This means that the music, in this case, is an actor on equal terms with the user, “mediating co-creation, as creative activities of play, music creation and many-to-many communication” (Andersson, 2010, p. 13).

Health and life quality

If the RHYME artefacts set up a situation, which allows for interaction and co-creation, then they may clearly stimulate ‘communicative musicality’. Based on existing research within this tradition (Malloch & Trevarthen, 2009), Krueger argues that music affords emotion regulation and social coordination, among many other things. He draws on research from music therapy with prematurely born babies as well as phenomenological investigations of group listening to live music.

In order to relate such processes of communicative musicality to health, we must first define the sprawling concepts of health (Blaxter, 2004) and well-being. In general, researchers place these concepts somewhere on the continuum between the strictly objectivist position, whereby health is seen as subject to empirical investigation, and the strictly interpretivist position, whereby health is seen as subject to interpretation (Duncan, 2007).

When actual people are asked about their own notion of health, it is often regarded pragmatically, as a relative phenomenon, alongside expectations about aging, the burden of illness and the individual's social situation. Health, then, is at the end of a road that appears to be different from person to person. What is more, notions of 'good health' tend to encompass a sense of well-being, effective functioning, high spirits, a feeling of empowerment and a surplus of energy (Fugelli, 1998). Blaxter (2004) also refers to research that shows that one's view of one's health also depends on one's profession and social class.

From an interpretivist perspective, health is an experience, not a thing – in a sense, then, it is equivalent to the experience of well-being and meaning in life. Health is a resource or means of achieving the goals we have set for ourselves in our lives. Such a notion of health, of course, does not allow it to be regarded as a fixed state; it is something in flux and it can be influenced. Ultimately, then, it is a product of the relation between the individual, his or her actions and the environment (Medin & Alexandersson, 2000, see also DeNora, 2013).

This interpretivist definition sees music as a way to *mobilise* oneself towards a better quality of life. Swedish philosopher Lennart Nordenfelt points to the fact that most 'holistic' theories of health have been concerned with health as a feeling of well-being and even as a *capacity for action* (or, in the case of poor health, as a state of suffering or a lack of ability to act). In these cases, there is a strong conceptual connection between the state of well-being and the ability to act (Nordenfelt, 1991, p. 83).

Again from an interpretivist perspective, health as equated with quality of life relates to a number of other conditions as well: the state of our emotional life, our self-efficacy skills, our social relations and our experience of meaning in life (Ruud, 1998, 2001, 2011, 2013). Quality of life, then, derives from musicking as a . . .

- provider of vitality – that is, emotional stimulation, regulation and expression
- tool for developing agency and empowerment
- resource for creating a sense of belonging
- means of achieving meaning and coherence in life (see Ruud, 1997)

To the extent that musicking addresses these particular needs, we might argue that it offers a better quality of life, and thus better health. Yet we must not neglect the important physical aspects of health, lest we narrow the concept of health too much with regard to music's role within it.

As we have observed in the RHYME project, the children involved in the study, to varying degrees, responded with expressions of vitality and mastery. Through

the co-creative activities, they interacted with their parents and assistants in meaningful ways, and they reacted to the artefacts through moments of both recognition and anticipation. It certainly appears, then, that the artefacts as perceived within this particular ecological situation, afforded experiences of health and increased life quality, and further that the children were able to appropriate some of these possibilities for health-increasing activity.

Conclusion

In this article, I have framed the RHYME project according to certain tenets of cultural psychology. By regarding the different generations of the CCTs in RHYME as artefacts, whether material or ideal, we can come to appreciate the ways in which the aesthetic aspects of their design features, as well as the programming code of the interactive music, are novel scripts that inform our existing schemas for these 'musical objects'. Introducing these new cultural scripts into the discussion of health-related musicking may suggest new possibilities for understanding its impact.

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PARTICIPATION: A combined perspective on the concept from the fields of informatics and music and health

Karette Stensæth, Harald Holone, and Jo Herstad

‘Participation’, as it is commonly defined, appears to be a relatively trivial notion. In its everyday usage, it simply labels our interest in taking part in something. The word might derive from the Latin *participare*, to share, impart, partake of, but it might also derive from the Latin *partem carpere* – that is, specifically to take something from someone (www.myetymology.com/latin/participare.html). The latter derivation connotes a certain dimension of power and might explain the political applications of participation – for example, as a motivating force for democracy. As a noun, participation points to the act of sharing in the activities of a group, and/or the condition of having something in common with others (as fellows, partners, etc.). Participation has also become a central construct in modern social and health science, and in ‘participatory research’, which implies that all stakeholders are actively involved in the research assumptions and processes.

The point of departure for this article is the interdisciplinary research project RHYME (rhyme.no), which involves computing and musical components embedded in everyday objects, with the aim of improving the quality of life for children with special needs, their families and caretakers (Cappelen & Andersson, 2011). In RHYME, participation is apparent in many respects, including but not limited to the project’s political assignment, its theoretical foundation, and the practical implementation of user participation in the action research.

The authors of this article are three researchers in the RHYME project – two represent the discipline of informatics and one represents music and health. Before we explore the phenomenon of participation within the RHYME project over the course of this chapter, the informatics researchers Herstad and Holone and the music and health researcher Stensæth will outline the concept of participation within their respective fields. We will however begin with a short presentation of RHYME. The last part of this article derives directly from empirical data generated through RHYME, and in the concluding discussion we will suggest future possibilities for exchange between informatics and the field of music and health.

Because our fields seldom cooperate in research, we hope that our comments will be relevant to other interdisciplinary projects. We will specifically address the following research questions: *How is participation described in the disciplines of informatics and music and health, and what does participation imply in the RHYME project?* To proceed from a common ground of understanding, we will be guided by the following working questions: How does the focus on user participation in the RHYME prototype evaluations differ for informatics and health and music researchers? With regard to participation, what can the fields of music and health and informatics learn from one another?

The RHYME project:¹

RHYME is a five-year interdisciplinary research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. Its aim is to develop Internet-based, tangible interactions and multimedia resources that have a potential for promoting health and life quality. The project specifically addresses the lack of health-promoting interactive and musical information and communications technology (ICT) for families with children with severe disabilities. RHYME explores a new treatment paradigm based on collaborative, tangible, interactive Internet-based musical ‘smart things’ with multimedia capabilities. Within the project, these interactive and musical tangibles are called ‘co-creative tangibles’ (CCTs). The goal of RHYME is twofold: (1) to reduce isolation and passivity, and (2) to promote health and well-being. The RHYME research team represents a collaboration among the fields of interaction design, tangible interaction, industrial design, universal design and music and health that involves the Department of Design at the Oslo School of Architecture and Design, the Department of Informatics at the University of Oslo and the Centre for Music and Health at the Norwegian Academy of Music. The project encompasses four empirical studies and three successive and iterative generations of CCTs. The media is developed in collaboration with the Haug School and Resource Centre, the children and the families. Its user-oriented research incorporates the users’ influence on the development of the prototypes in the project. The users involve from six to ten families who have volunteered to participate, and the children with disabilities in the families range from seven to fifteen years old. The children vary considerably in terms of behavioural style, from very quiet and anxious to cheerful and rather active, but all of them become engaged in enjoyable activities when these activities are well facilitated for them. The most extreme outcomes of the variation in behavioural style relate to disability conditions, and mostly those within the autistic spectrum, which applies to four of the children. These conditions include poor (or absent) verbal language and rigidity of movement. Also, the children’s mental ages range from six months to seven years, and their physical handicaps range from being wheelchair dependent to being very mobile. The Norwegian Social Science Data Services approved the RHYME project in February 2011, provided it would gather, secure and store data according to the standards of ethics in Norwegian law.

1 The section inside the frame below is similar in all of the RHYME articles in this anthology, Music, Health, Technology and Design by Stensæth (Ed.).

For this article it is worth noticing that one motivation for the RHYME project derives from the development of 'An Information Society for All':

The penetration of ICT in all areas of society enables many groups to gain easier access to public and private services, which paves the way for solutions, which empower many people to live more independent lives and raise quality of life. (Min. of Government Administration and Reform, 2006, p. 19).

The ideal here expressed by the state demands a process towards a more inclusive society with equal rights for all citizens (Imrie & Hall, 2001; Iwarsson, 2003; Lid, 2009).² Understood as a democratic issue, obviously, such a society would allow for *more* participation for *more* people (Ibid.).

Participation within the field of informatics

In this section, we will present some of the history from the field of informatics with respect to participation. This will be used as background for investigating the role of participation in the RHYME project, in terms of both the children and the researchers. In particular, we will address participation within participatory design (PD), as well as computer-supported collaborative work (CSCW) and human-computer interaction (HCI).

Computer science in the early days

Computer science is a research and development field that dates back to the 1940s. In the early days, it was informed by branches of the natural sciences such as mathematics, physics and electrical engineering. As the number of users of computing systems grew, and the computer was applied to purposes other than calculations, new disciplines such as ergonomics and psychology started to study and inform computer science as well. Alan Perlis, Allen Newell, and Herbert Simon founded the Computer Science Department at Carnegie Mellon University in the 1950s, and they defined computer science as the study of computers and the phenomena that surrounds them (Knuth, 2001). To this day, it remains true that the use of

² In Norway, there is already a Minister of Inclusion.

computers, the users themselves, and the contexts of their use are all phenomena that concern computer science. In other words, computer science has always been a broad field, particularly given how sweeping the computer's impact has been on society and culture since its invention.

More specifically, computer science addresses areas as diverse as designing and studying electrical circuitry, programming languages and software engineering; among its principal paradigm shifts has been the cultural move away from stand-alone, isolated computers to networked computers, and the ubiquity of computing with which we currently live is often called the third wave of human-computer interaction, or HCI (Bødker, 2006). This particular shift will be examined below, specifically in the context of music.

The networked computer is everywhere

Networking technology, of course, has a long history. The telephone dates back to 1876, and from the very beginning, people tried to share musical concerts using it. The telegraph is even older, and its usefulness for distributing and sharing sheet music is evident. Over the past century, rapid technological advances have come to include the development of mainframes, mini-computers, desktop computers and the now-common mobile computers (Grudin, 1994). Parallel to this line of development of computing and networking technology, the use of these technologies has become ubiquitous.

Nowadays, the development of personal, mobile technologies for making, sharing and listening to music is ongoing and addressed by various subfields of computer science, such as the 'Internet of things', 'ubiquitous computing', 'tangible and physical computing' and 'wearable computing'. Computers are remarkably capable and various in their application (Greenfield, 2006), and any user is a potential participant in the development and refinement of the technology in question, explicitly or implicitly (Carr, 2009).

With the ongoing spread of computing and communications technology, social media has arisen to accommodate yet more participation as well. In his book *Here Comes Everybody*, Clay Shirky (2009) studies user-generated content and the grassroots participation enabled by new technology, finding that users themselves are now more than ever in a position to participate, communicate and generate information from 'the wild', in this way affecting and, in some ways, changing the way our society works.

The areas within computer science that study this use of computing systems have various names, such as *interaction design* and the previously mentioned *HCI*,

as well as *user-centred design* and *PD*. In the next section, we will address some of these subfields.

Human-computer interaction, computer-supported collaborative work, and human-centred design

Human-computer interaction (HCI) is concerned with the relationship between users and the technology they use, and, by extension, the development of interfaces and interaction mechanisms with computers (Carroll, 2003). Traditionally, this field of research has studied the *individual* user on a single computer – in the very early days, in fact, it was known simply as ergonomics. When computers were networked and began to facilitate mechanisms for communication and collaboration among more users, the subfields of computer-mediated communication (CMC) and computer-supported collaborative work (CSCW) emerged. The ‘W’ in CSCW indicates that the setting generally in question here was the work environment, though later on, non-work settings were also studied. At the European Conference on CSCW in 2013, there was, for example, a workshop on ‘boundaries between work and life’, which certainly implies contexts outside of the office.

There are many definitions of ‘collaboration’ and ‘cooperation’ within CSCW, a common theme of which is that negotiation must be part of all activities directed towards some common goal for a given group of people. Participation in this negotiation is therefore one of the conditions for the possibility of collaboration and cooperation. Yet what does ‘participation’ really mean? Various actors, users, systems developers, support personnel and others are stakeholders that ‘take part’ or participate in the development and deployment of new technologies. One subfield of computer science that focuses on various aspects of participation within systems development is participatory design (PD), and through its assumptions we might arrive at a clearer understanding of the notion itself.

Participatory Design (PD)

In Scandinavia, computer science is sometimes known as ‘informatics’. Kristen Nygaard, one of the founders of the Department of Informatics at the University of Oslo, was involved in large-scale systems development processes when the computer was introduced to workplaces in Norway. When developers engaged with those computing systems, they tried to involve both existing and future end-users in the process, for two reasons: (1) to allow users to be part of describing, defining and deciding what the issues were; and (2) to encourage the users be part of the

design of the solutions or systems that would address those issues. The participation of various stakeholders is particularly valued in the informatics areas of PD (Schuler & Namioka, 1993) and user-centred design (Norman & Draper, 1986). One idea in PD is to involve users as co-designers rather than simply evaluators of products or services. This represents a challenge, however, because different stakeholders have different needs and priorities, as well as different backgrounds and vocabularies for describing themselves and their interests. This situation is exacerbated when one works with small children and people with special needs, as is the case with the RHYME project. Methods within PD for working with children include those described by Allsop (2010), whereas Frauenberger, Good & Keay-Bright (2011) provide a helpful review of a PD project involving children with disabilities. Druin (2002) proposes the following four roles for the children who become part of a development process: user, tester, informant and designer.

Stakeholder participation has often been accommodated through workshops that bring together systems developers and users, in the interests of strengthening workplace democracy (Bjerknes, Bratteteig & Stage, 1995). This is often called the Scandinavian School of Systems Development, and the technologies in question here are traditionally systems that, in some way, support work. Out of this context, PD arose as an alternative to technology-driven development, one that places people and activities ahead of the technology they might need. There are three main issues that dominate PD literature: (1) the politics of design; (2) the nature of participation; and (3) the methods, tools and techniques for carrying out design projects (Kensing & Blomberg, 1998).

As mentioned above, the arena for PD has traditionally been the workplace, not settings from everyday life:

The epistemological stand of PD is that these types of knowledge are developed most effectively through active cooperation between workers (and increasingly other organizational members) and designers within specific design projects (Kensing & Blomberg, 1998, p. 172).

In this case, then, PD is about engaging workers and other stakeholders in systems development, ideally by enabling them to serve as co-designers.

Ultimately, there is no straightforward way to define 'participation' in PD projects, though Greenbaum and Kyng (1991) suggest four PD ideals nevertheless: (1) mutual sharing between users and designers about their respective fields; (2) the use of tools in the design process that are familiar to users in particular; (3) the envisioning of future work situations specifically so as to allow the user to

experience how emerging technologies might affect practice (as opposed to relying on the seemingly esoteric language of systems developers); and (4) the importance of embedding the design process from the start in the practice of the user.

Summing up

With this introduction, we have shown that participation is a central concept in the design and implementation of information systems. The Scandinavian informatics community, in particular, has a long history of participation from multiple stakeholders as a central methodological component of its work. Participation is at the very heart of user-centred design, and PD researchers and practitioners study it directly.

Participation in the field of music and health

In this section, we will present some of the history of the field of music and health with respect to participation.³ As in the previous section, we will look to the historical past to establish a context for investigating the role of participation in the RHYME project. First, however, we need to compare the (scientific) approaches of these two respective fields of interest.

Whereas the field of informatics addresses the interaction between humans and information systems in relation to the construction of computer interfaces, the field of music and health keeps computers themselves well in the background, or even out of sight altogether.⁴ This is perhaps surprising, given the ubiquity of music in everyday technology and social media as well as the historical dominance of Musical Instrument Digital Interface (MIDI) technology, which made it possible already in 1982 for digital musical instruments to ‘talk’ to one another, and to interact with small computers.

3 In this article, we use notions like ‘music and health’ and ‘music therapy’ almost synonymously, but there are basic differences between them, one being that music and health describes only a field of knowledge, whereas music therapy constitutes a field, a discipline and a profession. Stige points out, “Music therapy as a discipline is defined as “the study and learning of the relationship between music and health”. As professional practice it has “situated health musicking in a planned process of collaboration between client and therapist” (Stige, 2002, p.198-200). Because the RHYME artifacts are meant for home settings, not professional settings, we have positioned the project within the field of music and health and everyday life. We draw upon theory from music therapy to deepen our understanding of project results, however.

4 Magee (2013) provides a useful overview of the technology and computer programs that are being used in the field.

In part, this tendency to exclude things like computers stems from the field's origins in the humanities and the social sciences (Ruud, 2010),⁵ where people, not technology, are thought to dictate the relevant aspects (and impacts) of participation. This conviction does not necessarily prohibit an interest in computers or ICT, but it does privilege philosophical practices that clarify and deepen our understanding of these things as refracted through our human engagement with them. Rather than the causes and effects of our relations to things, the field of music and health aims to understand humans and their experiences through their interactions with things. This recalls Dilthey (1976), who said, 'We *explain* nature, but human life we must *understand*'. Dilthey argues that human experience encompasses a dual orientation: towards the surrounding natural world, in which 'objective necessity' rules, and towards inner experience, which is characterised by sovereignty of the will, responsibility for actions, a capacity to subject everything to thinking and to resist everything within the fortress of freedom of his/her own person (Ibid.). As we shall see later on, the music and health perspective on participation in RHYME adopts this humanistic and hermeneutic view as its basis for its empirical investigations. Next, we will look at the ways in which participation is described in areas related to music and health.

Looking back

As a concept, participation has become a central construct in health care, rehabilitation and various forms of therapy, often as a means of describing involvement in various life areas (Berg, 2009; Imrie & Hall, 2001; Law, 2002). Participation in these areas is assumed to be a vital part of the human condition that produces life satisfaction and a sense of competence in relation to psychological, emotional and skill development. From a humanities perspective, participation is also seen as important, specifically in the sense that it has positive influence on health and well-being. The increasing emphasis on participation from the WHO, various national governments, and other health and social systems makes it all the more important to understand participation – what it means, how we measure it and what it facilitates. To help us approach the RHYME project in this regard, we will try to narrow this focus a little more by positioning participation in relation to health and disability.

⁵ Here, we refer to the Norwegian situation in particular.

Participation, health and disability

Although the UN defines participation as a human right, it remains unclear what impact this determination has on the reality faced by people with disabilities. The International Classification of Functioning, Disability and Health (ICFDH) is categorised according to the following domains: learning and applying knowledge, general tasks and demands, and communication, social, and civic life (WHO, 2007/2001/1948). Here, participation is defined as ‘involvement in a life situation’, because, since 1999, the 1980 terms ‘impairment’, ‘disability’ and ‘handicap’ have been (mostly) updated to ‘impairment’, ‘activity’ and ‘participation’. Disability, that is, has become the unavoidable result of modified participation due to a ‘defect’ and an ‘activity limitation’.

Current research from the CanChild Centre for Childhood Disability Research distinguishes between two types of participation: (1) formal activities – that is, structured activities involving rules or goals that have a formally designated coach, leader or instructor (e.g. music or art lessons, organised sports), and (2) informal activities – that is, activities with little or no planning that are often initiated by the person herself (reading, hanging out with friends, playing).⁶ In either case, participation is assigned several aspects: a person’s preferences and interests; what he or she does, where, and with whom; and how much enjoyment and satisfaction he or she finds. Data measurement takes place at the various intersections between person, environment and occupation. For this kind of participation to be meaningful, as well, there must be a sense of choice or control over the activity, a supportive environment to facilitate the person’s attention, a focus on the task at hand rather than the long-term consequences, a sense of challenge from the activity, and a sense of mastery over it. Therapists often refer to this as the ‘just right challenge’.

Research shows that children with disabilities tend to engage in less varied leisure activities and in quieter recreational activities (Berg, 2009). In general, they participate in fewer social interactions, especially those of a spontaneous character. In a comparative study of youth with and without disabilities, Henry (1998) found many similarities in the interests of these two groups, whose top four pastimes were listening to music, hanging out with friends, watching TV, and talking on the phone. Studies also indicate that participation level changes as children with disabilities move into adolescence, in that there are fewer activities that occur outside the home (Ibid.; Berg, 2009). This suggests a significant correlation between the

⁶ See www.canchild.ca/en/ourresearch/participation.asp.

severity of one's disability and one's social isolation, which is a potential hazard for the children participating in RHYME.

In 2001, as introduced above, the WHO emphasised the rights of citizens with disabilities to participate fully in society. Along with their 'new' perspective on participation, ICFDH also changed their view on health, from considering it a 'consequences of disease' classification (1980 version) to considering it a 'component of health' classification (WHO, 2001, p. 4). This more integrated understanding of health in turn became a central component in participation, fuelling a social model which included more environmental factors, organised in sequence from the individual's most immediate environment to the larger communal environment (encompassing both social and institutional structures) (Ibid.).

Critical voices claim that dimensions like autonomy and subjectivity are lacking in the ICFDH reports. Wade and Halligan (2003), for example, observe that people with disabilities are often inhibited from directing their own daily lives or making their own decisions about personal questions. Of course, autonomy has both an objective (societal) and a subjective (personal) side, and Wade and Halligan insist that the best judge of successful participation must remain the respondent him/herself rather than the professional. They acknowledge however that the inner world is hard to observe.

Music and health

The use of participation in music and health is generally similar to its use in the humanities and social sciences, though it is clearly also treated as a component of health. This salutogenetic perspective, inspired by Antonovsky (1987), sees health as a personal experience (and an ongoing process) rather than a biomedical state. Factors that support and promote well-being are seen as essential from this perspective – for example, a sense of confidence in the fundamental coherence of the world. Participation thus becomes a means of experiencing (good) health. The 'opposite' view is the pathogenic perspective on health, which focuses on the factors that cause disease. This perspective, which is common in many medical settings, is important in order to understand the link between illness/disease/disabilities and life conditions, but it does not say anything about how to increase quality of life, for example.

Ruud (2014) takes the salutogenetic health perspective further. He calls the experiential focus on health an interpretivist perspective and asserts that such a notion of health does not allow it to be regarded as a fixed state but rather as a fluid state that can be influenced, for example, by regular participation in

meaningful musical activities. In this case, there is a strong conceptual connection between the state of well-being and the ability to act (Nordenfelt, 1991). Music as participation comes to represent a way to *experience* the feeling of being part of something meaningful and larger (such as one's community). In the context of the present study, then, music is positioned as a capacity for action and a practice that engages subjective feelings and the experience of participation.

Following these lines of thoughts, we see that the doing becomes crucial. In RHYME, we have found Small's (1998) notion of 'musicking' to be particularly evocative in this regard, precisely because it emphasises music as *doing*:

To music is to take part, in any capacity, in a musical performance, whether by performing, by listening, by rehearsing or practicing, by providing material for performance (what is called composing), or by dancing (Small, 1998, p. 8).

For Small, musicking is an active means of relating to – and participating in – the rest of the world: The act of musicking establishes, in the place where it is happening, a set of relationships, and it is in those relationships that the meaning of the act lies. They are to be found not only between those organized sounds which are conventionally thought of as being the stuff of musical meaning but also between the people who are taking part, in whatever capacity, in the performance; and they model, or stand as metaphor for, ideal relationships as the participants in the performance imagine them to be: relationships between person and person, between individual and society, between humanity and the natural world and even perhaps the supernatural world (Ibid.; Small, 1977).

Stige's notion of 'health musicking' combines Small's musicking as a social model with our salutogenetic or interpretivist perspectives on health (see Stige, 2012, 2006). Ultimately, health musicking sees participation as a resource or form of social capital – it is about building social networks and providing meaning and 'coherence in life' (e.g. Antonovsky, 1987).

We see here how a music and health perspective on participation moves among notions like integration, inclusion and exclusion/marginalisation, and empowerment. Matell, in her master's thesis on the notion of participation in music therapy, finds that inclusion, participation and empowerment are used synonymously, and often without any critical reflection (Matell, 2011). Empowerment, Matell responds, should be seen as a *source for* social participation, whereas inclusion describes the *preconditions that enable* participation. Rolvsjord (2004) links empowerment to a resource-oriented perspective on music therapy, which likewise

focuses upon the client's personal resource and strengths or potential, rather than his or her limitations (such as disabilities). The collaboration (and implied equality) in the relationship between the client and the music and health worker becomes important here and could even be positioned as a first step in the process towards social participation.⁷

Ultimately, the most comprehensive treatment of the notion of participation in the field of music and health is found in the work of Stige (2012; 2006; 2005; 2002 Stige, Ansdell, Elefant, & Pavlicevic, 2010). In the article 'The notion of participation in music therapy' (2006), Stige reviews the literature on learning, music and health and develops the following definition as a platform for further discussion:

Participation is a process of *communal experience and mutual recognition* where individuals *collaborate* in a socially and culturally organized structure (a community), *create goods* indigenous to this structure, *develop relationships* to the activities, artefacts, agents, arenas and agendas involved, and *negotiate our values* that may reproduce or transform the community (Stige, 2006, p. 134).

Stige here explores a notion of participation that takes context into account and is not limited to the act of 'joining in', which is a prominent aspect of the societal dimension of music and health practices. He further distinguishes between participation as 'individual activity' and 'collaborative activity', the latter of which encompasses both 'communal experience' and 'political action' (Loc. cit.). Stige (2003) argues that community music therapy, a theory that focuses on the collaboration of music therapists with the community in the interests of common goals for individuals, is promising in light of its promotion of sociocultural and communal change through a participatory approach.

Summing up part 2

We have seen that the notion of participation has become a central construct in music and health and other related areas. Participation is described as ecological and empowering – that is, as something active, processual, personal, subjective, relational, experiential and potentially health promoting. Stige's elaboration of the notion makes it possible to distinguish participation as an individual activity from

7 The idea that empowerment is intrinsic to (and a consequence of) music and health practice is also implied: see <https://normt.uib.no/index.php/voices/article/view/283/208>.

participation as a collaborative activity. As an individual activity, participation is the act of 'joining in', which is the most prominent action within most music and health practices. However, the societal dimension, and participation as a collaborative activity (as described by the community music therapy theory), expands our means of reflecting upon participation, especially as political action.

Participation in RHYME

We have seen that the fields of informatics and music and health approach the notion of participation differently. In the former, participation is described as experiences between humans and the objective and 'natural' world (of things and computer technology and science). In the field of music and health, participation is an end in itself, and the primary value of technology is to promote health. The question, then, now becomes as follows: *What does participation imply in RHYME?*

In general, all concerned readily derive a sense of community or partnership from the concept of RHYME, and we recognise that participation in RHYME resonates with the social intention of a health outcome for all. This intention encompasses an active taking part and/or sharing in the testing, the development of the CCTs, and the research process by everyone. The hope is that the children and their 'close others', the research group, *and* the CCTs are all 'involved' in this participatory work,⁸ so that the final product incorporates the intended function of the CCTs, the researchers' observations about the data, and the participating users' personal experience of the actions. In the following, we will look at how these ideals of RHYME participation were dealt with in the design and use of the CCTs, and in the research work that came before and after. To ground the discussion, we will sometimes refer to empirical data derived from the project.

Participation in design and use

The RHYME prototypes were tested at the school of the children who took part during the spring of 2011, 2012 and 2013. Stensæth and Ruud (2014) and Stensæth (2014a, b) provide detailed descriptions of the testing of three generations of the RHYME prototypes: ORFI, WAVE and REFLECT. At these test sessions,

⁸ A child with disabilities is generally accompanied by a family member or helper (in this case, from the special education school where some of the research actions were carried out) who will be referred to as a 'close other'.

researchers from the project were present and carried out or oversaw direct observation, video recordings, questionnaires and interviews with the children, their families and expert professionals at the school. Later, the session notes, interview transcriptions and video recordings were analysed by the researchers.

We will now describe and analyse two ways of understanding participation in design and use. We will look at the participation of the children according to the three aspects of participation identified by Kensing and Blomberg (1998) and Stige (2006): the politics of design, the nature of participation, and the methods and tools.

Politics of design

Participatory design (PD) is inherently concerned with levelling out power structures, ideally enabling all stakeholders to contribute equally to the design of new artefacts and services. In projects such as RHYME, however, this is a challenging ideal, and certain shortcuts and adaptations were required. For example, expectations regarding what the children can and cannot (or will not) do can influence the design process. Given that many of the children have difficulty grasping abstract concepts or verbally expressing their own needs, the preconceptions of others tend to fill these voids. Of course, the use of close others as interpreters, gateways or proxies for the children in the design process can partly address the problem. In this case, the child's voice is heard through the close other, which is better than nothing, though it submits the child's reactions to the close other's interpretation. Thankfully, because the close other knows the child and his or her complex needs and desires very well, the close other can generally produce good descriptions of useful solutions regarding the development of the CCTs for the particular child.

The use of a close other does not entirely eliminate the imbalance of power in terms of PD in RHYME, though, because what the close other says must necessarily derive from his or her own subjective impressions about the child's desires and opinions. The voice of the close other is *mediated* communication (Holone & Herstad, 2013) and must therefore be treated as an interpretation or representation, not a firsthand account.⁹

Another issue with respect to the politics of design relates to the families' participation in the testing process. The shift from passive end user to co-designer is not easy to accomplish (Ibid.), and it is by no means a given that either the children

⁹ The challenges regarding the use of communication through a third party are discussed in an earlier paper by Holone & Herstad (2013).

or their families are prepared for the informatics ideal of democratisation of everyday activities and decisions. They first and foremost concentrated on their exploring of the CCTs and participated in this sense as equals during the testing. Still, we could say that the participating families in RHYME were more mentally prepared for this dynamic in some ways, because they were already accustomed to fighting for the rights of their children with disabilities. In the interviews some of them were also quite articulate and comfortable with speaking up.

The nature of participation

According to Kensing & Blomberg (1998, p. 172), it is of central importance in PD to develop 'meaningful and productive relations between those charged with technology design and those who must live with its consequences'. Developing those relations among stakeholders in a PD project is always challenging, and perhaps especially so when the central stakeholder group is composed of children with severe disabilities (Holone & Herstad, 2013). For example, the PD ideal of rapid prototyping is undermined by the additional amount of time that is required to properly understand and communicate with this group. In addition, the use of close others to facilitate communication can introduce misunderstandings and even promote stereotypes of the needs and desires of these children. In the RHYME project, the participating families did not spend much time with the researchers and the CCTs before the testing sessions. It helped, however, that some of the participating children and their parents knew one of the RHYME researchers from her work as a music therapist at the school where the testing took place. Thanks to this level of familiarity, they 'trusted' the other researchers and their implementation of the RHYME actions, and more was accomplished as a result. It is perhaps also true that if we had allowed the users to spend more time with the CCTs, we might have derived other results.

In RHYME, in general, the children have not been an explicit part of the design process as such. However, through their interactions with the prototypes during the test actions, they have provided valuable input into the revision process.¹⁰ Also, the microanalyses of the RHYME testing-session video recordings (Stensæth & Ruud, 2014; Stensæth, 2014a, b) of the children and their close others interacting with the CCTs have supplied project researchers with detailed information about the requirements attendant upon individual programming. They showed, for

¹⁰ A similar but quicker approach was recently articulated by Larsen & Hedvall (2012), who used basic yet interactive design artifacts to enable children to provide input to the design through their actions.

example, the lag time of the temporally shifted response in the CCTs that was right for each child. This was important to adjust in order to suit those children with disabilities who have unusual perceptions of time, for example (Stensæth, 2013).

Methods, tools and techniques for carrying out design projects

In RHYME, the children have mostly been involved in the testing phase of each design cycle, and interviews with family members and caretakers have helped inform the design process as well. Further follow-up interviews provide useful perspective on revised prototypes. The design process in RHYME is iterative, comprising a yearly cycle of prototype design and development with corresponding tests, and participation in design among the researchers has, to a great extent, consisted of discussions before, during and after the test sessions. MusicalFieldsForever, the design team that designed the first prototype, ORFI, has continued to work on revisions in the context of stakeholder participation throughout the RHYME project.

Research participation

During the test activities, RHYME researchers were primarily interested in the interaction between the children and the prototypes, but the interaction between the children and close others (including parents or siblings) has also been important.

In the family interviews, these close others have offered valuable suggestions, generally based upon what they feel would improve the experience for their own children. After the first RHYME actions, for example, they pointed to the need for the CCTs to feature strong or marked sensory responses (see Stensæth, 2014a). The parents of two children with poorly developed sensory capacities proposed that the design of the CCTs should incorporate powerful vibration to physically arouse them and help them to become mentally 'accessible' to the outside world's impulses, impressions and interactions. Vibration was therefore introduced into the WAVE prototype (see Stensæth, 2014a), but it was not strong enough and had a limited effect.

Another family request was to develop a prototype that would engage the (hyper) active children's gross motor skills, not just their fine motor skills. In order to allow the child to use his or her whole body – climbing, rolling, dancing, and jumping and so on – the CCTs would have to be very solid and able to tolerate rough treatment, the parents admitted. Parents applauded the student product called COVE as especially successful in this respect (see picture and video of COVE

at http://rhyme.no/?page_id=2808). COVE was one of several added student products that families could explore after they had tested the REFLECT prototype during the third RHYME actions in 2013.¹¹ Also, Stensæth and Ruud (2014) found that ORFI engaged the children at a gross motor level but that it needed to be sturdier to tolerate drooling and 'wild' play.

Families were also contacted directly for comments on the CCTs. Before the development of the prototype called REFLECT (see Stensæth, 2014b), designers asked families what kind of music they would prefer to be programmed into it. Some parents suggested that it would be good to include favorite (children's) songs; others suggested classical music, to help children and close others relax together (see Stensæth, 2014b).

Families did not seek changes or improvements in the prototypes specifically to enhance participation as a collaborative activity (e.g. Stige 2006) but rather out of a general interest in the developments of 'such media' (their words). They were grateful for the opportunity to participate in a project like RHYME. As long as their children were attending school, the parents said, they were in good hands in terms of activity and stimulation (a reference to structured activities involving rules or goals that are led by professionals). But it was harder to provide proper stimulation during informal everyday activities in the home setting (activities involving little or no planning that are initiated by the child or the family member, such as reading, hanging out with friends, playing). Outside of school, then, there seemed to be very little for the family to do together that was meaningful for all at the same time. One mother of a girl with severe physical and mental handicaps said: 'At home we need things to do – together – things that are easily enjoyable and meaningful!' (Stensæth, 2013).

Another mother sought meaningful solo activities for her daughter with Down Syndrome and mental retardation. In an interview, she said that her daughter took little initiative to involve herself in leisure activities (Stensæth, 2014b) except for play that the mother saw as just repetitive actions without any value for 'learning and development' (Ibid.). Their need as a family was 'for her to be active on her own, over a longer time', the mother said (Stensæth, 2014b). If RHYME could improve the quality of co-activity in these situations, she would be grateful.

Of course, it is difficult to devise design solutions during RHYME prototype development that would accommodate every family technically, musically and

¹¹ Students participated in a course titled Sensorial and Musical Interaction that was given by RHYME designers at the Department of Design at the Oslo School of Architecture and Design in 2012.

Among the results of this course was COVE, an interactive musical rocking chair for the whole family designed by the students Luciene and Berit.

materially. Yet these concerns and interests are nevertheless extremely valid in terms of the politics of design, and we continue to ask ourselves the same question as time goes on: How can the subjective voices of the families (including the voice of the child with disabilities) become more influential in the design process? By engaging families, RHYME researchers have, to some degree, ensured subjectivity and autonomy (which, we remember, the ICF were criticised for leaving out of their reports). Importantly, this participation emphasises the need for making the RHYME artefacts as *flexible* as possible to accommodate a range of unique needs.

Discussion

RHYME as a research project has allowed for rich interdisciplinary interaction, and scholars from different areas have taken on roles as developers, program designers, observers, interviewers and facilitators. All of the material, including video footage, interviews and observations, has been shared among the researchers. During data collection, ideas from different fields are introduced, observations are discussed from various perspectives, and associations across disciplines emerge. This interaction during the preparation and implementation of the test activities has impacted the way we think and write about the project, as the present article attests.

In the following, we will look closely at how participation has been encouraged within RHYME from the perspectives of both music and health and informatics. To reconnect with the empirical material, we have assembled clips from the video analyses done by Stensæth & Ruud (2014) from a music and health perspective. The situations described below derive from a setting where two children ('Ulla' and 'Frode') and their close others interact with the prototype called ORFI. Both children have severe disabilities to varying degrees; they are enthusiastic and physically active but have no words.

Ulla, Clip 1:

'Conscious action when she bends the wings on the pillows, as if she knows that there will be a sound response. Addresses A (her close other) and expects that A will "play" with her. Becomes bodily and mentally stimulated, senses a surplus, and seems like she at times dances to the sound and with the pillows'.

Frode, Clip 1:

'Is attentive and wandering while he explores the pillows, the screen and the interrelation between them. He tries out several ways to handle the pillows. Are they heavy? He seems to think that this is exciting and wants to communicate this to A (his close other). He wants A to share this experience with him – he both wants and needs validation from A? Speaks and gesticulates through the pillow (when he "bends-points" with it). Is excited and wants to share feelings with A.'

In the empirical material, Stensæth & Ruud (2014) describe the selection criteria for the video clips with Frode and Ulla as follows: 'We ultimately chose the video clips based upon the inclusion of those glimpses and camera angles which most clearly demonstrated varied activity, including actions and both physical and emotional reactions'. The informatics researcher, who is also interested in the interaction with technology and the reactions of the children as they engage with the CCTs, could have applied the same criteria, but the focus of the interpretations, however, would be quite different. We will briefly review the analysis from a music and health perspective, then do the same from an informatics perspective, and finally look at how they complement one another.

Interestingly, the above analysis sees the CCTs as 'given' – that is, they exist as is. The focus, then, is on the people and their interactions, and particularly on the relationship between the child with disabilities and a close other. Their participation is interpreted as communicative sharing. In another study, Stensæth & Ruud (2012; see also 2014) predict that the greatest potential of the CCTs is as a means of communication and a social tool intended to enhance well-being and life quality. This interest, in turn, aligns the design of the CCTs to the promotion of interpersonal interaction and the sharing of meaningful experiences, primarily between subjects, and secondarily between the subjects and the objects. From a music and health perspective, two aspects are more prominent than others in the RHYME actions – the role of the close other and the degree of intersubjectivity (which relates to the first). We will discuss these aspects shortly.

The child, who is vulnerable or even helpless, is to some degree dependent upon the close other, who must be well qualified. A 'good' close other becomes so through kinship, interest, education, experience and the relational history with the child. Horgen (2010) says that a close other is there for the child with disabilities to share his or her experiences, engage in his or her world and *meet* the child by encouraging communication, self-expression, development, and empowerment. The task for the close other is 'to put him/herself into play for the child' (Horgen, 2010). In a sense,

the close other becomes an instrument of the child's self – a premise for the child's very ability to respond to the CCTs. The close other is needed for direct support, as a pivotal link between the children and the objects, and helps the child with a disability become *response-able*, in the most literal sense, by ensuring that the child with disabilities can share and participate in the activity.¹² The role of the close other in professional contexts is even characterised as a 'prosthesis', a 'co-experiencer' (Lorentzen, 2010) or a therapist – ultimately, as one who accompanies the child in life through empathic 'co-travelling' (Yalom, 2001/2002).

The relation between the child and the close other is also understood as fundamental to the promotion of health musicking. This finding does not surprise the music and health researcher, because it has been shown that we are all born to be sociable – to both communicate and share meaning (on Trevarthen and Bråten in Stensæth & Trondalen, 2012). This aspect is sometimes also referred to as intersubjectivity, or the sharing of subjective states by two or more individuals. It encompasses shared emotion (attunement), shared attention and shared intention (Stern, 2000). In the field of music and health, it is sometimes called 'communicative musicality' (after Malloch & Trevarthen, 2008), and it encompasses the earliest relational communication, such as the 'dialogue' between newborn and parent via musical parameters such as rhythm, melody, intonation, timbre and intensity. This theory demonstrates that the need to communicate is inherent to people regardless of the presence of a disability, but that it must be accommodated. If this form of participation is denied, people tend to develop other strategies (such as aggressive or destructive behaviour) to compensate for their isolation (see Matell, 2011). A human being is born to *seek* intersubjectivity and engage in cultural learning through companionship (Stensæth & Trondalen, 2012; Stern, 2010). In fact, the intersubjective relation is seen to have health potential in itself (see Johns, 2012; Trondalen, 2008).

Methodologically, and with respect to the users such as Ulla and Frode, who lack words, it is difficult when the distance between the children's inner experiences and the researchers' interpretations is passed through interpretations a third party. In order to strengthen the validation of the close others' interpretations, however, the music and health researchers in RHYME have used method triangulation. In Stensæth (2014b) and Eide (2013), for example, the close others' interpretations were compared

12 In her dissertation, Stensæth (2008) discusses 'musical answerability' in the context of defining music therapy improvisation (which encompasses all of the relations among therapist, client and music). Music therapy improvisation is a means through which to transform isolated human utterances into intentional communicative expressions.

to comments from experts and peers. Units of meaning were derived from a technique called 'systematic text condensation' (Malterud, 2011; see also Eide, 2013).¹³

The focus on the subject–subject relationship relegates the objects to the background from the music and health perspective. The role of the CCTs is simply to offer a space, or field, for the primary participation. From the perspective of informatics, technology is seen as more present, and as highly adaptable. The CCTs are not just tools but active participants that are engaging in a dialogue with the child (see Cappelen & Andersson, 2011).

In HCI, one locates the interaction between the computer system and the user at an interface, like a terminal with a screen and a keyboard. This interface accepts input from the user, through, for example, the pressing of a key; the computer program processes that input and produces its output through the interface as well, on a screen or through a loudspeaker (Winograd, 1997).

In RHYME, the CCTs are deliberately designed to be flexible, both in terms of the physical appearance of the artefact and the behaviour of the system (Gaver, Beaver & Benford, 2003). In a classic computer system, one expects a predictable, consistent relationship between user input and computer system output. In the RHYME prototypes, a certain amount of unpredictability (and computer agency) is built into the system, which is very different from what one would tolerate from, say, an accounting system. Nevertheless, when evaluating the interaction between the user and the computer system, the informatics researcher will look at the system as a computer with an interface. A well-known method for evaluating human computer interaction is Fitt's Law (see Accot & Zhai, 1997), where the precision and efficiency of pointing devices, such as the computer mouse, are measured in milliseconds and millimetres.

With the emergence of the third wave of HCI (Bødker, 2006), as described above, the focus of the informatics researcher moved beyond the direct interaction between the user and technology to the effects of the use upon the user – the emotions it evokes, for example, and the ways in which the technology fits into the use situation as a whole. In summary, the informatics researcher will look at the technology as something *malleable*, and the purpose of prototype evaluation is to identify possible changes and improvements to the technology to better fit the use situation.

We could say, then, that the RHYME project is useful in that it generates insight into participation on the individual level. Sometimes this insight resonates with broader theories, such as theories like the already mentioned 'community music therapy' and 'communicative musicality'. Participation in RHYME can therefore be viewed as a social model that encompasses environmental factors ranging from the

¹³ This is a method whereby data points are coded into units of meaning. For more, see Eide (2013).

individual's immediate environment to the general environment (including both social and institutional structures).

Combined perspectives on participation

The model of participation that we have described so far highlights the complementary qualities of the two perspectives in play here. Our interest in the relevance of both perspectives to the pursuit of an improved quality of life for the children and their close others through the introduction of new music technology foregrounds the ethical commitment that we all share to recognise other people's needs, whether they have disabilities or not. Despite HCI research encompassing the human qualities of our interaction with computers, there are obvious limitations to what the informatics researcher is able to see in terms of the role that technology has in the use situation, such as in the clips with Frode and Ulla described before.

Conversely, the music and health researcher has an in-depth understanding of the child and his or her relation to self and world but less awareness of the possibilities residing in the malleability of the technology.

The RHYME project's strength and distinctiveness derives from its combination of these two perspectives – it is only through a shared understanding of the child's participation in the use situation that we can best understand the complex interaction between the child and the environment (including the CCTs). The music and health researcher's in-depth understanding of the child's actions, coupled with the informatics researcher's view of technology as malleable, make it possible to achieve a better quality of life for children and their close others through the introduction of this new technology.

The two fields have overlapping areas of interest and expertise, as seen in the following table:

Informatics	Shared	Music and health
Participatory design Information technology Development Human-computer interaction (HCI)	Participation Use Affect Natural settings/everyday life Professional settings/workplace settings	Subjectivity Intersubjectivity Relation Health musicking

Figure 1: Areas of interest and expertise in the fields of informatics and music and health

In the next section, we will propose possible further interactions between the research fields of informatics and health and music. This list is not meant to be complete or exhaustive.

Possible contributions from informatics:

- Learning from the history of informatics: The study of the development and use of computers has a history dating back to the 1950s. By getting to know a bit of this history, we might uncover further common areas of concern, such as participation in relation to ethical and democratic reasons (i.e., the politics of design).
- Current technology development: New areas within informatics, such as wearable computing, change the pragmatics of participation – that is, they suggest new means of participation and collaboration. RHYME is an example of a project through which we can investigate novel ways of interaction with computers and participation through new technologies.
- A deeper understanding of technological development. By better understanding the possibilities and limitations of the technology in question, music and health researchers will be better equipped to actively contribute to the system design of the CCTs.
- The integration of musical and interactive technological objects through participation: A better understanding of the potential use of this technology in the artefacts surrounding us daily would allow music and health researchers to broaden their ways of engaging users regarding health musicking.

Possible contributions from music and health:

- The implementation of the notion of musicking: The understanding of music as *doing* (as well as a powerful way to promote positive group dynamics on all levels) may have direct implications for participation in the design of informatics systems.
- Awareness of health perspectives: The salutogenetic perspective applied in RHYME, which views health as a personal experience and an ongoing process rather than a biomedical state, might complement the pathogenic health perspective that still dominates the informatics

in the development of information systems and infrastructures, such as patient journals, minimal invasive technology.

- The perspective of health musicking: Combining musicking and a salutogenetic health approach, health musicking might help the informatics researcher to design informatics systems that provide social capital and create coherence in the life of the users.
- Workplace studies and everyday life settings: When one moves from workplace design to the design of technologies for natural settings, the everyday home use of music might provide further perspective on the informatics involved. In RHYME, for example, we have seen that musicking with objects like CCTs can regulate users' moods and quicken them to act (as was the case with Frode and Ulla).
- The awareness of relation and intersubjectivity: The relation philosophy, especially between a vulnerable participant and a guiding participant, can help the informatics researcher to account for the former in the design process. RHYME, as a research case, shows how listening to the children with no words and limited communication capacity becomes possible through the interpretation of the close others' empathic understanding of the children's needs and interests.

These suggested contributions indicate that there are areas where more exchange between the two fields could be beneficial to both.

Conclusion

This article addressed the following research questions: *How is participation described in the disciplines of informatics and music and health, and what does participation imply in the RHYME project?* We have described some issues regarding participation that have emerged through the RHYME project. First, we presented some history and an overview from the disciplines of informatics and music and health concerning participation. Then we presented possibilities for these disciplines' combined perspectives on participation. We have also listed what the fields contribute to each other with respect to participation.

The collaboration between professions is challenging and important to any multidisciplinary research project. In order to reach the goals set in the RHYME project – to improve health and well-being – we must rely on the core competencies of

various disciplines. This study describes both participation between children and their close others, who are the primary users, and participation among researchers. With fruitful exchange across disciplines, we can understand more about the relationships among the children, the technology, the family and close others, and the environment. The music and health professionals' in-depth understanding of and interest in the activities of the children, and the informatics professionals' understanding of the malleability of the technology, together comprise a better foundation for shaping an improved quality of life and health for these children and their families. It is also clear that the participating families' individual needs provide a broad spectrum for further development of the RHYME artefacts that could address needs for agency, mastery and life quality in the future. In this way RHYME could contribute to the promotion of participation in a very important life area – the home setting.

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From experimental music technology to clinical tool

Alexander Refsum Jensenius

Human body motion is integral to all parts of musical experience, from performance to perception. But how is it possible to study body motion in a systematic manner? This article presents a set of video-based visualisation techniques developed for the analysis of music-related body motion, including motion images, motion-history images and motiongrams. It includes examples of how these techniques have been used in studies of music and dance performances, and how they, quite unexpectedly, have become useful in laboratory experiments on attention-deficit/hyperactivity disorder (ADHD) and clinical studies of cerebral palsy (CP). Finally, it includes reflections regarding what music researchers can contribute to the study of human motion and behaviour in general.

Introduction

In the early 2000s, I started experimenting with live video in interactive music/dance performances. At that time, laptop computers were barely fast enough to handle the simple manipulation of live video feeds and were nowhere near the advanced realtime analysis that is possible today. Never would I have imagined that the video analysis tools I originally developed for these experimental music performances would be tested in clinical practice at hospitals on three continents a decade later. In this article, I will tell the story about how my software moved from the stage to the hospital, how this has shaped its related methods and tools, and how the experience has helped me as a music researcher and as a research musician.

It was during my PhD research on music-related body motion that the *Musical Gestures Toolbox* came to life (Jensenius, 2007; Jensenius et al., 2005). The main goal of my research at this stage was to understand more about the body motion of both *performers* (such as musicians and dancers) and *perceivers* (people experiencing music), and specifically about the ways in which such motion was related to the sound of the music to which they moved or which they created. The human

body has always been integral to all aspects of *musicking*, from performance to perception. The concept of musicking is used here to denote that music is seen as a process rather than a product (Small, 1998), and should be studied accordingly. It is only in recent decades, however, that larger groups of music researchers have started to investigate music-related body motion more systematically (Gritten & King, 2011, 2006; Godøy & Leman, 2010).

One core challenge when it comes to studying music-related body motion is the need for methods and tools to record and analyse the motion itself. Here, we must differentiate between two principal methodological directions: a) Qualitatively based observation techniques from visual inspection and/or video recordings, and b) Quantitatively based analyses from various types of motion capture data. More and more researchers are also combining these two directions in order to study larger sets of recordings and data, while at the same time looking more closely into certain specific parts of the data sets. This is the approach I have taken over the years.

Due to rapid technological development, the availability and accessibility of various types of *motion capture* systems have improved enormously. I use 'motion capture' in a broad sense to encompass all of the technological systems that in some way track and record the body and its motion in space over time. Several different motion capture techniques exist, falling broadly into two main categories: sensor-based systems and camera-based systems. One example of the former is *inertial sensors*, such as accelerometers, which measure the gravitational pull on the object and output information about its orientation and acceleration. Their flexibility and usability, combined with their decreasing size and cost, have allowed inertial sensors to appear in all sorts of electronic devices, including computers, mobile phones and motion capture systems intended for research. Inertial sensors do have some drawbacks, however. First of all, the data coming from the sensors is not always immediately useful. For example, accelerometers, despite the name, do not output the acceleration of the object but rather the gravitational pull on it. While this information can be used to estimate the true acceleration, and possibly even position, of the object, it requires a considerable amount of analysis and interpretation to do so. Another drawback with sensor-based systems is that the sensors must be placed directly on the body of the subjects being studied. My own experience with studying musicians, dancers and people moving spontaneously to music is that they often feel uncomfortable wearing the sensor system. In some cases, a musician may even experience difficulties playing his or her instrument due to the sensors and cables that are attached to the body.

Working with a camera-based system, on the other hand, allows for a sensor-less setup and still allows the researcher to track motion, even if only from a single,

two-dimensional recording. Using multiple cameras and reflective markers, in addition, it is even possible to get a fully three-dimensional motion tracking with a high resolution (at the millimetre level, or lower) and very high speeds (at 500 frames per second, or faster). For many situations, however, a single ordinary video camera provides the researcher with a cheap, flexible, and reliable tool for studying body motion. While such a setup may not offer the tracking precision and speed of sensor-based or multicamera-based systems, it is perfectly capable of allowing for both quantitative and qualitative analyses of the same type of source material.

Exactly these qualities of simplicity, accessibility and flexibility are what led to my initial interest in exploring the possibilities of video-based analyses techniques. This article begins with a brief introduction to some of the video-analysis methods I have developed and includes descriptions of *motion images*, *motion-history images* and *motiongrams*. Next, it includes an overview of how these tools have proven useful in analytical studies of music-related motion, in experimental studies of ADHD and in clinical studies of CP. Finally it presents some thoughts on the further development and artistic use of these methods.

Video-based visualisation

A main challenge when one works with video recordings as source material for various types of analyses is to create proper representations of the motion being studied. One such representation is *visualisation* – that is, a visual display that in various ways illuminates certain aspects of the motion. From a musical point of view, one must further create visualisation techniques that can capture different types of temporal levels. In cognition in general, and in music cognition in particular, it may be useful to distinguish between three different temporal levels, each related to the three main memory levels: the *sensory memory*, the *short-term memory*, and the *long-term memory* (Snyder, 2000). Based on such a tripartite division, Godøy (2008) has suggested three levels of grouping, or what is often referred to as *chunking* in psychology:

- Sub-chunk level: perceiving continuous sound and motion features, up to 0.5 seconds (sensory memory)
- Chunk level: fragments of sound and motion perceived holistically – that is, sound objects and goal-directed actions that are typically between 0.5 to 5 seconds (short-term memory)
- Supra-chunk level: several chunks concatenated into larger structures (long-term memory)

Human beings have the ability to handle these levels effortlessly and in parallel. For example, we may observe the instantaneous unfolding of sound and motion while at the same time preserving an internal memory of the trajectories of a sequence as well as an overall image of its longer patterns. A video recording, however, is only a series of individual frames at the sub-chunk level, typically recorded at a rate of 25 to 60 frames per second. An interesting question, then, is how to create visualisations of the other two levels (chunk and supra-chunk) which can then be used for further analysis, or as illustrations in, say, a research paper. The following sections will present some of the techniques I have developed for representing body motion at these three levels.¹

Motion images

When one works with motion analysis from video files one of the most common techniques is to start by creating a *motion image*. The motion image is found by calculating the absolute pixel difference between subsequent frames in a video file, as illustrated in figure 1. The end result is an image in which only the pixels that have changed between the frames are displayed.



Figure 1: A motion image from a performance of a piano piece, recorded from the front: The motion image is created by subtracting subsequent frames in a video file (that is, looking at the difference between each individual pixel in two adjacent frames) looking at the difference between each individual pixel in two adjacent frames

The quality of the raw motion image depends on the quality of the original video stream. Small changes in lighting, camera motion, compression artefacts, and so on can influence the final image. Such visual interference can be eliminated using a simple low-pass filter to remove pixels below a certain threshold, or a more

¹ All of the examples presented in the following sections are created with software that is freely available from <http://www.fourms.uio.no/software>. Readers interested in the technical implementation can find details in Jensenius 2007 and in the source code that accompanies the software.

advanced ‘noise reduction’ filter, as illustrated in figure 2. Either tool cleans up the image, leaving only the most salient parts of the activity in the motion.



Figure 2: The motion image is improved by applying either a simple low-pass filter or a more advanced noise reduction filter.

The video of the filtered motion image is usually the starting point for further processing and analysis of the video material.

Motion-history images

A motion image represents the motion that takes place between two frames but does not represent a motion sequence that takes place over more frames (the chunk level). To visualise the motion itself over time, then, it is necessary to create a *motion-history image* – a display that keeps track of the history of what has happened over the course of some number of recent frames. There have been numerous implementations of this idea over the years (summarised in Ahad et al., 2012), most of which have been based on averaging the results of a certain number of frames of motion images. One of my approaches, in fact, is to simply average over the frames of an entire recording. This produces what could be called an *average image* or a *motion-average image*, such as that shown in figure 3. These images may or may not be interesting to look at, depending on the duration of the recording and the content of the motion. The examples in figure 3 are made from a short recording that includes only one short passage and a raising of the right hand. The lift is very clearly represented in the motion-average image, whereas the average image mainly indicates that the main part of the body itself stayed more or less in the same place throughout the recording. For longer recordings, in which there is more activity in larger parts of the image, the average images tend to be more ‘blurred’ – in itself an indication of how the motion is distributed in space.

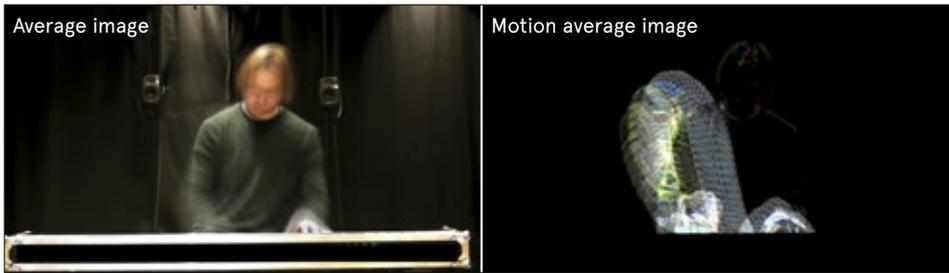


Figure 3: The average image (left) shows a 'blurred' version of the performer as it transpires over the entire recording. The motion-average image (right) more clearly shows the trajectories of the motion in the recording.

To clarify the motion-history image, I often prefer to combine the average image and the motion-average image, or possibly incorporate one frame (for example, the last frame) into the motion-average image. The latter alternative makes it possible to combine a clear image of the person in the frame with traces of the motion-history, as illustrated in figure 4:

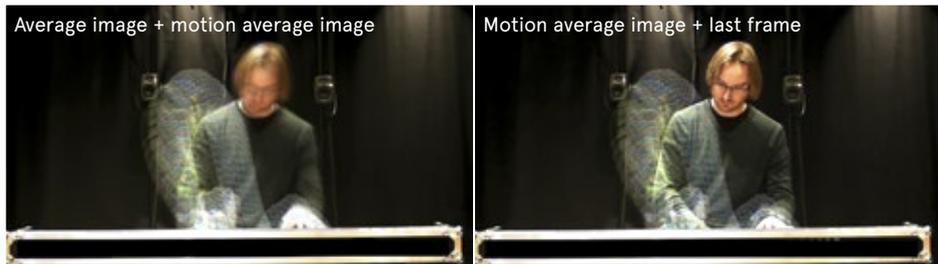


Figure 4: A motion-history image becomes more informative when it incorporates either the average image (left) or a single frame from the recording (right)

Motiongrams

The motion-history images above reveal information about the spatial aspects of a motion sequence, but there is no information about the *temporal* unfolding of the motion. Inspired by the chronophotographies of Etienne-Jules Marey from the late nineteenth century (Marey, 1884), as well as slit-scan photography (Levin, 2005), I have developed a technique for displaying motion over time that I have called a *motiongram*. Averaging over a motion image, as illustrated in figure 5, creates

a motiongram. The tandem of horizontal and vertical motiongrams makes it possible to see both the location and the quantity of motion in a video sequence over time:

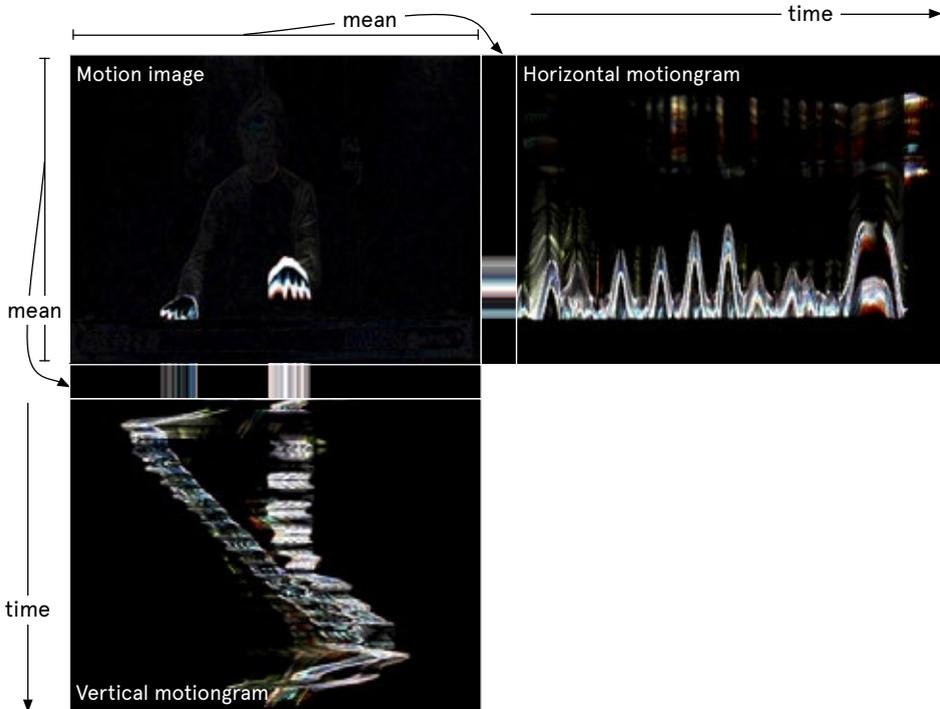


Figure 5: A schematic overview of the creation of motiongrams, based on a short recording of a piano performance. The horizontal motiongram clearly reveals the lifting of the hands, as well as some swaying in the upper part of the body. The vertical motiongram reveals the motion of the hands along the keyboard, here seen from the front, as in the previous figures

One of the fascinating aspects of a motiongram is that there is no analysis involved in its creation – the process is based solely on a simple reduction algorithm. This also makes the technique very flexible, because no a priori knowledge about the content of the video recording is necessary for creating a motiongram. The most important choice that is made during the creation process is the level of filtering that is applied to the motion image used to create the motiongram. It does not change the overall shape of the motiongram, but it is important with regard to determining the level of detail (or noise) to be included in the final visualisation.

Towards clinical applications

Music research

The above-mentioned motion-visualisation techniques have been used in the analysis of various types of music-related motion, including the performance motion of pianists (Godøy et al., 2010), clarinetists (Jensenius, 2007) and violinists (Schoonderwaldt & Jensenius, 2011). They have also been used in studies of people moving spontaneously to (musical) sound – for example, when dancing freely (Casciato et al., 2005), playing ‘air instruments’ (Godøy et al., 2006b) or carrying out so-called sound tracing (Godøy et al. 2006a; Nymoen et al., 2013).

Figure 6 presents one example of the usefulness of motion-history images in the study of performance technique. Here, each image represents an individual stroke on the drum pad, and the image series serves as a compact and efficient visualisation of a total of fourteen different strokes by the percussionist:

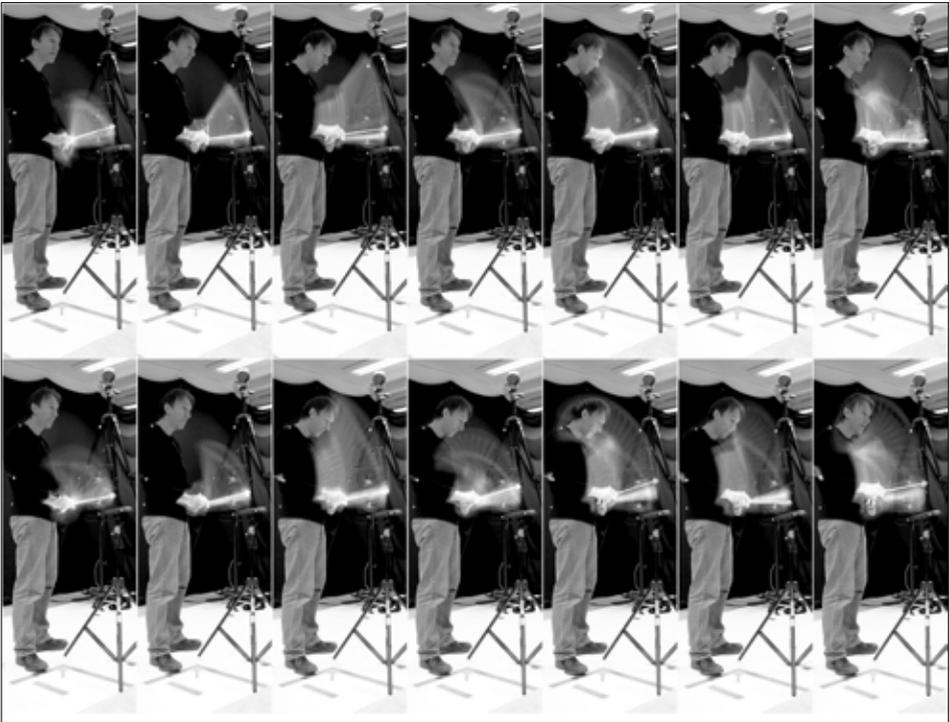


Figure 6: Motion-average images overlaid upon the last frame of fourteen video recordings of a percussionist performing the same drumming pattern in different ways. Each display represents around fifteen seconds of video material

One example of the ways in which motiongrams can be used to study dance performance can be seen in figure 7. This display shows motion-average images and motiongrams of forty seconds of dance improvisation by three different dancers who are moving to the same musical material. The motiongrams reveal spatiotemporal information that is not possible to convey using keyframe images, and they facilitate the researcher's ability to follow the trajectories of the hands and heads of the dancers throughout the sequences. For example, the first dancer used quite similar motions for the three repeated excerpts in the sequence: a large, slow upward motion in the arms, followed by a bounce. The third dancer, on the other hand, had more varied motions and covered the whole vertical plane with the arms. Such structural differences and similarities can be identified in the motiongrams, and then studied in more detail in the original video files. As shown in figure 7, motiongrams can also be used together with spectrograms of the sound to reveal and explain relationships between motion and sound.

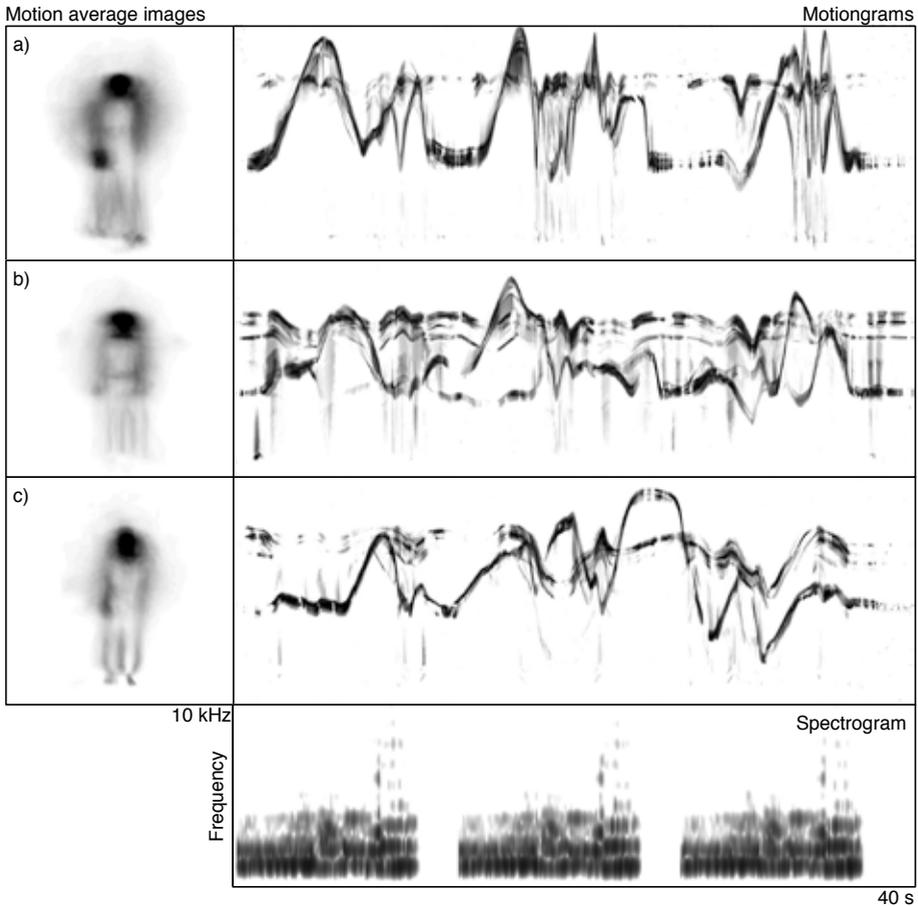


Figure 7: Motion-average images and motiograms of recordings of three dancers improvising to the same musical material (approx. forty seconds). A spectrogram of the musical sound is displayed below the motiograms

Animal experiments on ADHD

A very different type of motion patterns can be observed in figure 8. These motion-grams are created from videos of rats with different symptoms of attention deficit hyperactivity disorder (ADHD), recorded in the lab of Professor Terje Sagvolden at Department of Physiology at the University of Oslo. What is popularly known as ADHD, is actually an apparently heterogeneous group of behavioural disorders affecting between 2 and 12 percent of young children (Swanson et al., 1998; Taylor

et al., 1998). There are, in fact, three subtypes of ADHD diagnosis and two behavioural dimensions (American Psychiatric Association, 1994):

- *ADHD (attention deficit hyperactivity disorder)* is a predominantly hyperactive and impulsive subtype that is typically more common among boys
- *ADD (attention deficit disorder)* is a predominantly inattentive subtype that is typically more common among girls
- A combination of ADHD and ADD

ADHD usually manifests itself before the child is seven years old and is characterised by inattentiveness, hyperactivity and impulsiveness (Applegate et al., 1997). Around 50 to 70 percent of the children diagnosed with ADHD will have problems relating to social adjustment and functioning, and they are also more likely to have psychiatric problems as adolescents and young adults (Cantwell, 1985). It is therefore important to identify children with ADHD at an early age so that they can receive the necessary treatment and support (Sagvolden et al., 2005).

Sagvolden's group carried out experiments using genetically engineered rats with symptoms equal to those of clinical cases of ADHD and ADD. The experiments were based on tasking the rats with pressing one of two levers inside a cage (Sagvolden, 2006). If the assignment was carried out correctly, the rat received a drop of water as a reward. The experiments were run daily for several hours, and the aim was to study patterns of overactivity, impulsiveness and inattentiveness over sustained periods of time, and to see whether various types of medical treatment would change the behaviour of the rats. The challenge, however, was that only lever presses were recorded in the original design of the experiment, which resulted in very discrete and time-gapped measurements and no information about how the rats behaved when they were not pressing levers. My part in the project was to provide a tool to analyse the motion of the rats *throughout* the experiments. Figure 8 shows motiongrams of recordings of three different rats: one with ADHD symptoms, one with ADD symptoms, and one with no symptoms.

The motiongrams reveal that the ADD rat moved the least of the three rats, showing typical signs of inattentiveness. Both the ADHD rat and the normal rat moved more than the ADD rat, although only the ADHD rat moved continuously throughout the sequence. The normal rat showed generally superior focus on the task, moving up and down and following the light, while the ADHD rat showed signs of whimsical behaviour as well.

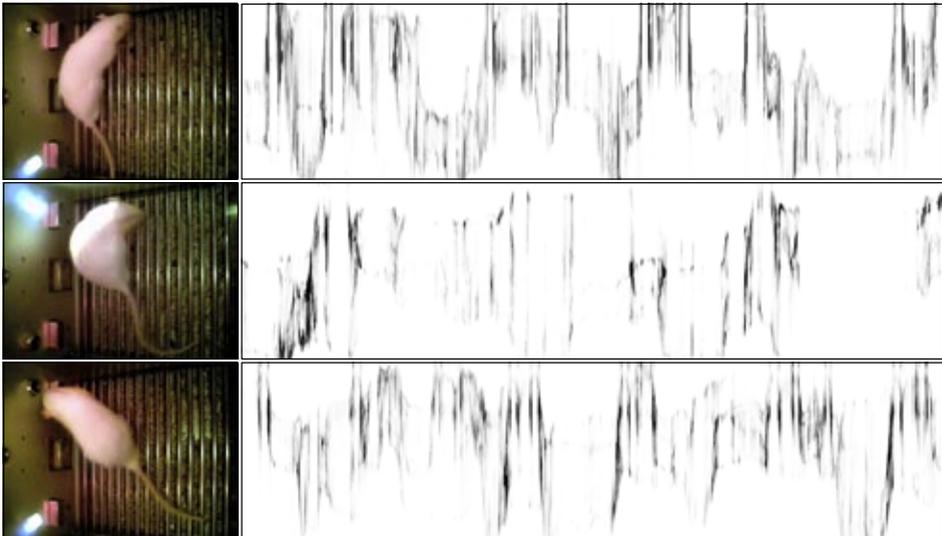


Figure 8: Motiongrams of rats in the experiment cages: ADHD rat (top), ADD rat (middle) and normal rat (bottom). The motiongrams show a little more than one minute of activity

Based on the positive findings from the pilot study, we set up video cameras in all of the rat cages and recorded a full season of experiments. We also piloted a similar system in a clinical experiment at Ullevål University Hospital in Oslo that was aimed at screening a large number of school children. Due to sheer extent of the recorded material, we promptly developed a method of extracting statistics from it, including the *quantity* and *centroid* of motion in the image. Based on these data, we started analysis using auto-correlation techniques and produced some very promising results in terms of understanding more about the behaviour of the different groups of rats (Johansen et al., 2010). Unfortunately, the collaboration abruptly ceased due to the passing away of the project leader in early 2011.

Studying infants with cerebral palsy

In 2008 I started collaborating with physiotherapist Lars Adde from NTNU in Trondheim in 2008. His group carries out longitudinal studies of infants and children with CP. Cerebral Palsy is a permanent disorder in the development of motion and posture in the developing fetal or infant brain and is one of the major disabilities that result from extremely premature birth (Adde et al., 2010). As the most

serious chronic motor disability that can occur in infants, early identification of CP might be beneficial for early treatment, while the plasticity of the brain is at its peak. Identifying children in the risk group that do not have CP is also important, as it can prevent unnecessary worry in the families of the children.

Diagnosing CP, however, is difficult, and it is most commonly conducted by an expert clinician, who visually assesses what are known as the *general movements* (GMs) of the child. This can be done using a regular video recording, from which the expert seeks signs of spontaneous motor activity. Absence of so-called *fidgety movements* in infants at nine to twenty weeks of post-term age has been shown to be a strong indicator of later CP (Prechtl et al., 1997), so researchers are mainly focused on trying to improve the identification method regarding these types of movements. The General Movement Assessment (GMA) method, which is based on the systematic observation of infants' spontaneous movements in video recordings, has been shown to predict CP with a high degree of accuracy (Einspieler et al., 1997). More particularly, the absence of fidgety movements in the general movements of infants at two to four months of corrected age (that is, expected date of birth) may identify infants who will develop CP with more than 90 percent sensitivity.

Because there are so few expert clinicians who are trained to identify CP in infants, researchers are eager to develop a computer-based video-analysis system that can assist in the selection of infants that are in the risk group. So the aim of the CIMA project (computer-assisted infant movement assessment) is to develop a video-based analysis tool that can match the prediction rate of an expert clinician, and that is so easy to handle that it can be used in clinical practice in hospitals. If successful, such a system could allow for the screening of a much larger group of infants in the risk group than is currently possible.

Fortunately, CP researchers had already been filming infants for several years before I met them, so it was possible to start testing a large data set with my software right away. It immediately became apparent that the motiongrams could reveal differences in the motion patterns of infants with and without fidgety movements, as can be seen in figure 9.

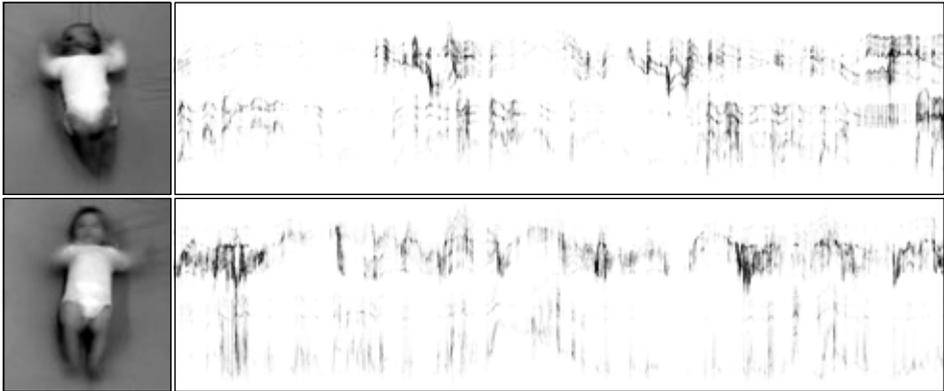


Figure 9: These examples show average images and motiongrams of motion sequences of infants without fidgety movement (top) and with fidgety movement (bottom).

Based on these initial studies, we have continued to develop the technique with a focus on extracting some relevant quantitative features based on the centroid of motion (Adde et al., 2009, 2010, 2013). The project is currently piloting a hardware solution at several hospitals in Norway, USA, India, China and Italy. Here, preterm infants are video recorded while lying on a mattress, and the video analysis tool is used to study some general movement features. The priority now is to validate the system and the analysis methods, and to work towards a clinical tool for more widespread use.

Discussion

One question I have asked myself over this whole period of collaboration is why my approach to studying music-related body motion is attractive to psychologists, physiotherapists and people working in medical science. After all, there has been an abundance of research on various types of motion tracking over the years, most of which is much more technically sophisticated than what I have been working on. But perhaps that is part of the answer – a lot of the motion-capture solutions that exist are either too advanced or targeted at specific applications. Coming from a background in music technology, I am used to working with technology in creative ways, trying to push the borders of what is possible with the technology in

question. This has also helped in giving advice and helping researchers in widely different fields than my own.

Choosing the right technology

During my years as a doctoral and post-doctoral researcher, I have been fortunate to have access to many different types of motion-capture systems, ranging from accessible and affordable to absolutely state-of-the-art. Therefore I have had the opportunity to work with different systems, depending upon the needs of the project with which I was involved. Once, we used a video-based markerless tracking solution in an experimental violin performance (Jensenius & Johnson, 2012). Another time, we used a full-body motion-capture suit for a piece of electronic dance music (de Quay et al., 2011). This experimentation with different types of recording and tracking solutions has given me a broad understanding of the possibilities and limitations of these different systems – knowledge that is valuable when approaching entirely new fields of study.

The ADHD and CP researchers with whom I have worked are experts in (human) behaviour and motion but not in motion capture or analysis. The ADHD researchers had mainly been working with quantitative data that was based on discrete measurements of when the rats pushed the levers in the cages. Thus the data sets were very limited and did not contain any information about the actual motion of the rats otherwise. The CP researchers had mainly been working with qualitative observation but had also experimented a little with electromagnetic trackers attached to the limbs of the infants. This required expensive equipment and a cumbersome process of attaching the sensors to the infant, neither of which is ideal when one is working towards clinical application.

An advice to both groups was to use affordable video cameras, mounted above the infant's mattress, respectively. Recording from above gives a clean and accurate overview with little visual interruption or noise. In addition, regular, off-the-shelf video cameras provide technology that is sturdy, replaceable and easily operable by lab technicians or clinicians who are not motion-capture experts. If there is anything I have learned after more than ten years of working with musical performances, dance pieces and interactive installations, it is that the researcher's technology must be easy to use for anyone involved. This is not as trivial as it sounds – much research technology is costly, highly specialised and difficult to operate. Such equipment certainly has some advantages, but they reveal themselves mainly in a controlled laboratory setting in which there are people that know the system. In a hectic hospital setting, all the tools must be as easy to use as

possible, and a simple, video-based system may be preferable, if only because no sensors or cables are needed.

A broad perspective

Both the ADHD and the CP groups called for a broad perspective to motion analysis. As mentioned in the introduction, most motion-capture solutions are based on trying to identify and track a certain part of the body – say, a hand or the head. This leads to very detailed analyses of the motion of these specific body points. While such an approach can produce interesting and relevant findings, it can be limiting for those researchers who are, in fact, mainly interested in global motion characteristics. The approach to motion analysis that is presented in this article, is intended to accommodate the study of the *entire* body as one moving object. A broad perspective is useful when one is studying general motion features in large datasets, and it turns out that its methods and tools work as well with video recordings of musicians and dancers as with those of infants and rats.

Temporality

The temporal unfolding of events is one of the core elements of music, and is an important part of any type of music analysis. Thus knowledge of time is one thing that music researchers can contribute to other fields of study. This is not to say that researchers in other fields do not accommodate time as such, but rather that the music researchers' focus on time and temporal development is utterly ingrained in how we think about both the performance and the perception of music. This awareness is also the reason why I began creating visual displays that represent motion at different temporal levels: motion images represent the sub-chunk level, motion-history images represent the chunk level and motiongrams represent the supra-chunk level. Such displays can be used very efficiently to say something about spatiotemporal motion features, which has proven to be particularly important when one is studying the behavioural patterns of ADHD or CP, both of which deviate from regular motion patterns.

Detecting differences in temporal patterns and ordering is only the first part of the problem, however. In my continued collaboration with the CP researchers, we are now working towards extracting more advanced temporal motion features. Here, it will be particularly interesting to see whether and how different types of methods developed within the field of *music information retrieval* (MIR) can also be used to study motion features. The MIR community employs statistical and

machine-learning methods to extract information about music from scores and sound files (Downie, 2003). This makes it possible to study music from large collections, and to extract information that is not possible with only close studies of individual songs and pieces. Many of these tools are also based on advanced models of time and temporality, which, again, could be very relevant to use on recordings of human body motion. The challenge, again, remains the development of an easy-to-use and stable solution that it is possible to apply in a clinical setting.

Limitations of the computer

We must always remember that a computer-based system is never better than its theoretical and methodological foundations. For example, in my collaboration with the CP researchers, we are trying to build a computer system that replicates the years of knowledge and experience possessed by expert physiotherapists. The main problem with my approach to motion analysis, however, is that there is no a priori knowledge in the system – it is mainly based on simple image-manipulation and reduction techniques. How, then, do we build more specific knowledge into the process of analysis? One way to approach this issue is to leverage the expert knowledge of the clinicians at the right points in the process.

Feeding back to music research

Even though I have spent quite a lot of time on non-music-related topics over the last few years, these collaborative activities have had a very constructive impact on my music-related research projects as well. Working towards the realisation of an effective and accessible clinical tool has greatly improved my underlying analytical methods and made the software much more stable and reliable. As a music researcher, I have aimed to maintain an open and exploratory approach to my research questions, and I have often applied a range of methods in order to look at the questions from different angles. It has been exciting to be part of larger teams that are working with a high level of detail and rigour when it comes to planning experiments and analyses. This is, of course, necessary when the subjects in question are children with health problems. The ethical dilemmas that arise are far from those to which we are typically exposed in music research.

Working in an interdisciplinary group, I have also benefited from the lively discussions about terminology, theoretical foundations and methodological directions. While such discussions can take time and energy away from other activities, they are also important when it comes to sharpening one's argument and posing

new research questions. Since I have no formal training in human-movement science, biomechanics or physiotherapy, it has been rewarding to learn more about these fields. It has been particularly interesting to see how the body and its motion is treated from a much more biomechanical perspective than that of the music researcher. Exactly this interplay between the different disciplines is the most stimulating part of working interdisciplinary.

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Technology and clinical improvisation – from production and playback to analysis and interpretation

Jaakko Erkkilä, Esa Ala-Ruona, and Olivier Lartillot

Introduction

This article illustrates some of the ways in which music technology can be utilised in everyday clinical practice. Presently, digital devices work relatively well together regardless of manufacturer, and there are useful and generally shared standards for digital formats and memory solutions as well. Thus music technology has introduced new possibilities to both clinical practice and music therapy research. Computational improvisation analysis, a key concept in this chapter, is one such relatively new approach in music therapy, and we will present the principles and possibilities of the music therapy toolbox, a computational tool for music therapy improvisation analysis. The chief benefits of computational tools are precision, effectiveness and objectivity. Still, computers cannot produce interpretations, and human-centred qualitative analysis remains an essential part of any successful improvisation-analysis process. The last part of the chapter, then, focuses on the clinical model perspective. The effective exploitation of computational improvisation analysis requires relatively consistent data and large sample sizes, which can represent more of a challenge than the securing of appropriate technology for data analysis.

Music technology in everyday music therapy practice

Digital music instruments, recording equipment and software are increasingly present in music therapy clinicians' everyday work. Thanks to the standardisation of digital formats and the ever-increasing capacity of computers, it is now possible to both store and analyse a large amount of data cheaply and quickly.

Music therapy improvisations, for example, are now simple to record digitally on between one and four different channels, depending on the model of recorder, in most audio formats, including *wav* and *mp3*. A *wav* file is not compressed and thus takes more space to store, whereas the *mp3* format represents some form of compression, depending upon the user's preferences and tolerance for poorer sound quality. Digital recorders typically store data on memory cards, such as SD cards, that are based on industry standards and can be removed and used in computers and other digital devices as well. When determining the desired capacity of a memory card, one rule of thumb rule is that a single gigabyte (1,024 megabytes) represents about three hours of mono recording and about half that amount of time of stereo recording (often the preset setting) in *wav* format. The *mp3* format increases those timeframes by a factor of up to ten, depending on the amount of compression. It is therefore a good idea to acquire a memory card with a capacity of thirty-two gigabytes or more to avoid a sudden stop to one's recording. Digital recorders allow for immediate playback and also include a mini-stereo-plug output, through which one's recording can be listened to using headphones or an external sound system. Music therapy clinicians are therefore able to review and discuss shared improvisations promptly, combining both active and receptive music therapy techniques in the process (see Bruscia, 1998).

Many digital music instruments also include MIDI (Musical Instrument Digital Interface) input and output jacks. The MIDI protocol presents key elements of musical information as numbers. It is important to note that MIDI data is not actually based on real music at all but on variables, which *describe* the music. For example, MIDI information will encompass what key on the keyboard was pressed (number 68 out of 128, say), how long it was held down, and so on. This information can then be used to instruct any compatible device about what to play using its own sounds. The benefit of MIDI information is that it is very 'light' and does not occupy much memory. A computer can process it quickly as well. Furthermore, MIDI information lends itself well to various mathematical, algorithmic operations that can be utilised, for example, in the computational analysis of music-therapy improvisations.

In music-therapy clinics outfitted with musical instruments and equipment, the therapist can take advantage of the more elaborate environment for recording, saving and editing musical material. Musical instruments can be connected directly to computers running digital recording software, some of which can handle both MIDI-based musical information and digital audio. Perhaps the cheapest and most straightforward option for digital music-making is the tablet-based application, but Apple's computer-based Garage Band is also relatively popular among music hobbyists because it enables, among other things, the use of a sample collection for creating accompaniments. There are plenty of other music software makers on the

market as well, and their products range from freeware to professional recording software such as Pro Tools and Logic Studio. A workable clinic setup would include a computer and recording software but also an audiocard to accommodate the connection of musical instruments or microphones to the computer. Various makes and models of audiocards range from inexpensive options with only one or two inputs to professional devices with multiple inputs and high class AD (analogue to digital) converters. Audiocards typically incorporate MIDI input and output in addition to analogue inputs and outputs. There are two basic versions of analogue inputs: the so-called line level input (for instruments such as electric guitars and keyboards with quarter-inch jacks) and the XLR input for devices with pre-amplification, so that the audiocard can act to amplify a microphone, for example.

The type and number of instruments to be recorded in a typical music therapy session will determine the type of audiocard needed. If, for example, therapist and client each use an acoustic drum, the audiocard must have two separate analogue input channels to accommodate the two microphones that will be used with the drums. If there are additional instruments or improvisers, there will need to be more input channels. Today's computers, and even laptops, are powerful enough to handle dozens of simultaneous input signals.

Digital recordings of music therapy improvisations offer the following possibilities:

- 1) Therapist and client can create and edit an entire composition using the available instrumental and vocal performances. In therapy with children and adolescents, in particular, this kind of working method is useful and specifically evokes the therapeutic songwriting method (Baker & Wigram, 2005).
- 2) Anyone can replay the musical material at any time for any therapeutic reason, with good sound quality.
- 3) The performances of the improvisers can be separated digitally to accommodate analysis of the features of interaction or for specific attempts at therapeutic microanalysis (Wosch & Wigram, 2007).
- 4) The sound files can be exported to other applications, such as music therapy-specific computational-analysis applications, in order to create a detailed feature analysis. Musical features, when described as numerical values with specific meanings (see below), can be exported in a data matrix to statistical software for further analysis. In this fashion, a large number of performances from several improvisers can be analysed at once (a so-called batch analysis).

- 5) The reproduction of recorded clinical improvisations might suggest a shift in the process-oriented work of music therapy. Spontaneous clinical improvisations represent an important tool for achieving unprecedented levels of non-verbal processing of underlying therapeutic themes. Even initially rather primitive material can be processed, and new creative elements can be introduced to round out the end product. This reproduction can be based on both multitrack recording and sound processing. New tones and nuances might appear, to say nothing of new areas and themes for therapeutic processing (Ala-Ruona, 2014).

Music Therapy Toolbox

The music therapy toolbox (MTTB) was created at the University of Jyväskylä, Finland, for the purpose of computational music therapy improvisation analysis. The development work started in 2004 in the context of a research project called 'Intelligent Music Systems in Music Therapy' that was funded by the Academy of Finland. MTTB was designed and developed by Olivier Lartillot and Petri Toiviainen as a set of algorithms and a graphical user interface; it was written in Matlab using the MIDI toolbox (Eerola & Toiviainen, 2004) for the processing of MIDI data. Team members reflected significant experience in music therapy, music psychology, cognitive music research and the computational modelling of music. Whereas their research was initially focused on MIDI data, they broadened their scope to digital audio analysis in the context of a subsequent project using a music information retrieval (MIR) toolbox (see Lartillot, 2007). In the current version of MTTB, both MIDI data and digital audio can be processed.

MTTB was first applied to improvisations created by people with mental retardation and their therapists. The idea was to detect whether the musical features of the given improvisation predict the level of retardation. This study represented the first time a computational analysis was applied to music therapy improvisations to this extent. The large group of features made available through the MTTB demonstrated that the severity of mental retardation affects the client's freedom of musical expression (Luck et al., 2006; Luck, Erkkilä, Toiviainen, Lartillot & Riikkilä, 2007; Luck et al., 2008).

According to the article 'Steps in Researching the Music in Therapy' (Bonde, 2007), the MTTB approach answers many of the needs of music analysis in therapy. Bonde lists five basic categories with which a researcher must grapple: the *trace*,

the *scope*, *focus* and *purpose*, the *representation* and the *presentation*. In terms of the *trace*, which refers to the format in which the music exists, MTTB requires music being in MIDI or digital audio format depending on the purpose of the analysis. MIDI format allows doing various precise feature extractions and analyses based on them but it does not enable timber related analyses, for instance. This is due to the nature of MIDI data, which is actually a representation of music, not real music at all. In digital audio, all the aspects of music, such as timbre and dynamics, are included. When these are in the focus of the analysis, digital audio instead of MIDI data is needed. Thus, they are mutually complementary formats, both having their unique qualities. MTTB analysis benefits greatly from verbal comments (therapist's notes and session recordings that include verbal dialogue between therapist and client) as well. In terms of *scope*, MTTB allows the researcher to choose whether to employ a micro-analytical approach (involving the detailed analysis of a short segment of a given improvisation, for example) or to analyse a certain number of improvisations by a single client or many clients (a batch analysis). The advantage of computational methods such as MTTB is that the computer does the work and the computation will always be quick, regardless of the total number of improvisations.

In terms of *focus* and *purpose*, the researcher is free to choose his/her theoretical standpoint in relation to the music analysis enabled by the MTTB. Of course, MTTB does not read the music in a 'human' way and is therefore limited. It cannot easily, if at all, extract musical aspects such as melody and phrasing, for example. If one wants to go beyond those features that MTTB *can* extract from the music, one must turn to traditional music analysis methods. In terms of *representation*, MTTB offers the possibility of graphic notation (see figure 2). A sequence within an improvisation, or an entire improvisation, can be readily visualised, and furthermore the user can specify the musical features to be captured there. This is a convenient way to look at the interaction patterns between the client and the therapist, trace meaningful moments from an improvisation, or simply prepare an overview of the improvisation itself. The rendering of several improvisations across different therapy sessions allows for an overview of changes or evolution in the music as well. This kind of visualisation serves clinicians in their everyday clinical practice as well as qualitative researchers who want to look at the improvisation second by second and possibly connect their findings to other data sources. Quantitative researchers, in turn, are generally more interested in the data matrixes created by MTTB for further statistical operations.

In terms of *presentation*, MTTB encompasses certain extra-musical possibilities for interpretation which enhance its applicability to other professions. Specifically, MTTB features are not always related to purely musical considerations. Features

such as density, velocity and pulse clarity, for example, are more or less interdisciplinary and have various connotations. This characteristic of MTTB may help in the conversion of certain findings into general language for health care professionals.

How MTTB helps in improvisation analysis – a micro-analytical perspective

MTTB is based on mathematical algorithms that compute statistical and musicological analyses based on the raw symbolic data provided by MIDI files, as well as raw audio data. There are algorithms for various music-related aspects such as time, register, dynamics, tonality, dissonance, timbre and pulse (for more information, see Luck et al., 2006; Erkkilä, 2007). For the purpose of microanalysis, the clinician can arrange a closer look at any excerpted portion of the improvisation, investigating the rhythmic synchronicity between the improvisers, for example (see figure 1):

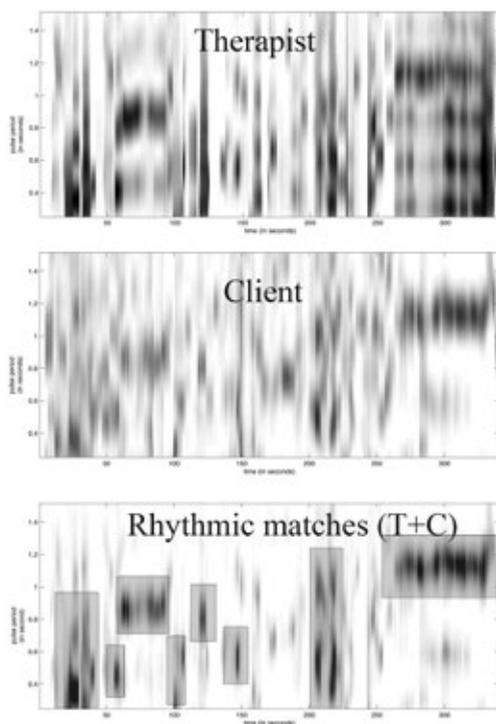


Figure 1(a,b,c): An example of a pulse diagram created by MTTB. The temporal evolution of the improvisation is spread along the horizontal axis. Detected pulsations are shown in black, vertically ordered according to their periods: fast pulsations are at the bottom, slow pulsations at the top. Figure 1c shows the pulsations that are common to both client and therapist.)

In figure 1, the darker spots signal greater rhythmic clarity – that is, more rhythmically precise playing – and the lighter colours or spots signal the opposite. The lower box indicates the points of greatest rhythmic synchronicity between the therapist and the client, a young boy with Asperger syndrome who also suffers from delayed development and resides in an institution for disabled individuals. Rhythm and even basic pulse have an important role in music therapy for individuals with these kinds of problems, because they are seen as basic and primitive elements of music, which do not presuppose high level of cognitive skills for understanding (Wigram, 2007). In general, then, this excerpt shows that the therapist's rhythmic clarity is greater than the client's. With some clients, it may be clinically relevant to focus on rhythm-related aspects of ordinary improvisation, so as to work to improve rhythmic expression via selected techniques and interventions and then track the progress via the MTTB. By using the toolbox to analyse several improvisations representing different phases in the music therapy process, one quickly gains an objective overview of rhythmic development in terms of synchronicity and preciseness point of views, for instance – if these phenomena are under specific interest and relate to the goals of the therapy. MTTB visualizations on couple of the early improvisations and couple of the later ones allow comparing them and finding out whether any lasting improvement has happened.

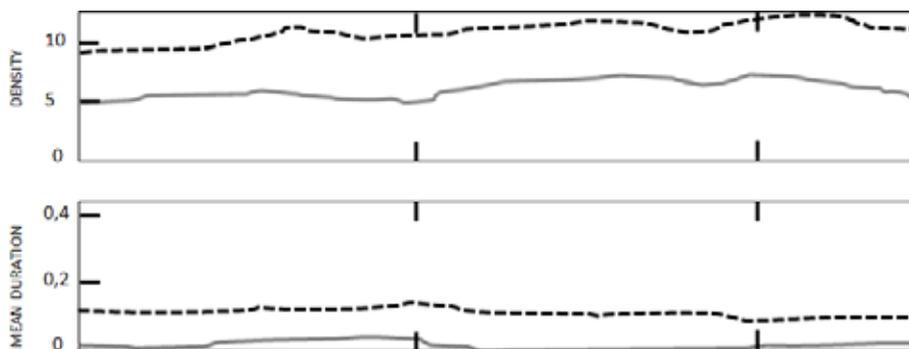


Figure 2: An example of density and mean duration graphs from the MTTB showing improvisations of client (dashed line) and therapist (solid line).

Another example (see figure 2) demonstrates how MTTB can be used to explore two improvisers' musical behaviour according to a specific musical feature. Regarding density (above), the upper dashed line reflects the client's play, which is obviously very busy, and the lower solid line reflects the therapist's play. In MTTB,

one can adjust the moving time window within which the calculations are made. In figure 2, for example, the time window is a duration of six seconds, and it is moved every half second: the first window starts at time $t = 0$ seconds, the second window at $t = .5$ seconds, and so on. The shape of the line thus shows how the improviser's musical behaviour regarding a given musical feature changes over time. Likewise, one can use the MTTB to explore potential interactions between the improvisers in terms of any musical feature. In figure 2, the client is a young boy with Asperger syndrome who played the therapist's electric piano by using both hands and pressing down on many keys at once, which produced a clustered, chordlike improvisation. This is why the density of the client's music is greater than the therapist's music, most of the time.

The two examples above depict a microanalytical perspective, which is valuable to everyday clinical needs when a music therapist wants a quick overview of what is going on in the music. It also supports single or multiple case-study research where there is an interest in emphasising microanalytical or process-related musical aspects.

How MTTB helps in improvisation analysis – a process-analytic perspective

In a recent case study (Erkkilä, 2014), fifteen music-therapy improvisations involving a depressed client and her music therapist were initially analysed using MTTB to produce a data matrix of their musical features. All of the improvisations were played on a pair of digital xylophones, which allowed for easy comparison, and they were created during a therapy process, which lasted for about three months. With this much data, a microanalytical approach was deemed to be less useful than statistical methods for processing. One way to compress the MTTB data that accompanies multiple sessions and/or musical features is to run a principal-component analysis (PCA). This statistical method determines what kinds of components, which consist of several individual musical features that have something in common, explain changes in the data. In other words, a component is an independent entity consisting of several factors, in this case of musical features, which vary concurrently and are thus like relatives to each other. It is the task of a researcher then to try to conclude why certain factors (musical features) seem to belong together and to form an independent component. If many of the factors (musical features) of a component seem to have something to do with rhythm, we could conclude that rhythm related phenomena seem to be in the core of expression and (one of) the main source of musical variation. The therapist's, or the

researcher's, task is also try to understand why rhythm has this kind of salient role in a client's musical expression, how rhythm related expression has been used for different expressional needs, and what it might represent symbolically in relation to the illness, for instance. After running the PCA in the aforementioned case study, the first three components turned out to explain 75 per cent of the change. When there are three salient components, as in the example here, the question becomes how the components differ from one another – that is, how they explain different aspects of the data. A challenging task now is to try to understand what is common with the factors of a component and is it possible to name the component in a way that is relevant to clinical music therapy.

When each of the components consists of musical features that correlate with each other (either positively or negatively) it is helpful to name the component based on a musical aspect which best describes it. This is the so-called interpretative part of PCA, and it demands questions such as the following: 'What does it mean from a musical-behavioural point of view when these musical features appear to interact in this way?' In our example, the first component with the highest loading was named 'Activation-Harmony', the second, 'Variation-Static', and the third, 'Tonality', based on the musical features of the components and their interaction. High loading refers to the amount of explanatory power, i.e., how much a component explains the change in data in percents. If one knows each of the musical features of a component, it is possible to see whether and how each of the components is or is not present in individual sessions. This is done by creating a graph consisting of the values of the component factors (musical features) for each of the fifteen improvisations, for example, the Activation-Harmony component (AHC) as is shown below (see figure 3):

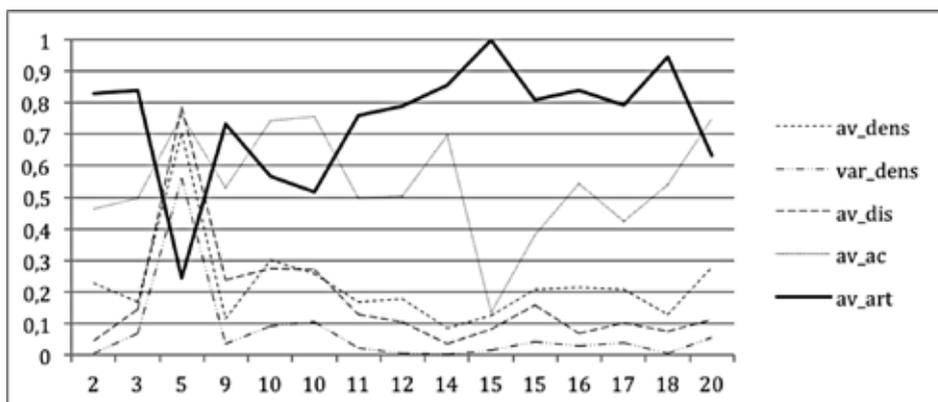


Figure 3: Activation-Harmony component as it appears in the therapy process of a client with depression. The scale of the Y axis is based on normalised values (0–1) of each of the musical factors in the component. A high value means a more dominant role for the musical feature, such as average dissonance. In the X axis, the session numbers are presented. For example, in sessions 10 and 15, two improvisations which were included in the analysis were created. The figure 3 is based on both improvisers' playing (client + therapist).

AHC consists of five musical features: average density (av_dens), variation in density (var_dens), average dissonance (av_dis), average pulse clarity (av_ac), and average articulation (av_art). We can see that in most of the sessions, musical density, variance of density and average dissonance is rather low. This tells us that the improvisations were generally rather 'peaceful', with little drama and few dissonant outbursts. This resonates with the character of the client, who was a rather calm and peaceful person with no tendency to dramatic behaviour. The high articulation values indicate that the improvisations were typically based on staccato rather than legato expression. In most of the improvisations, the pulse clarity is high, which suggests a rather stable rhythmic progression.

The exception to the typical state of affairs is the session 5 peak in the component, but there is an explanation. The client was working on her inability to be spontaneous and throw herself into life situations. It was also difficult for her to show negative emotions, such as anger or aggression – she typically kept these feelings inside, which caused a kind of repressed negativism. It also led to situations where some of her close relatives and friends were very dominating in relation to her, because she could not show her real feelings. In session 5, the therapist took

on the role of a dominating friend and symbolically dominated her musically. He later wrote in his journal:

I took the role of the annoying relative in the improvisation. I intentionally disturbed the patient's play by playing in a loud, dissonant way (i.e., trying to be annoying in a symbolic way). However, this did not affect the patient's play, which was a picture of her life. This was exactly her problem: not being able to react in a spontaneous, authentic way.

One way to utilise computational improvisation analysis methods in psychiatric context is to look at the graphical outliers in relation to the human context of the therapy.

For larger quantitative studies, the MTTB offers another perspective as well: a batch analysis – a statistical analysis of a large number of improvisations at once – can encompass many clients with a large number of sessions. Instead of graphic, visual representation of the improvisations, MTTB can create a data matrix. Each of the relevant musical features is depicted as single numeric value, which may be the mean, standard deviation or variation, for example. If the improvisation is not divided into sections, there will be only one numerical value per musical feature per improvisation; mean of musical density concerning whole improvisation, for instance. In this kind of representation, unfortunately, precision of micro-analytical analysis is sacrificed and the data are reduced and compressed, but it remains useful when one is dealing with big samples and trying to locate general trends across the musical features and client population under consideration.

Pros and cons of computational improvisation analysis

While computational improvisation analysis methods such as MTTB enable the analysis of a large amount of data, and the result of the analysis is clearly objective, the work is still being done by a machine with obvious limitations. The MTTB, for example, cannot interpret its findings. If musical density, one of the many features that the MTTB can extract from improvisational data, is high in the client's play, as was the case in figure 2 for the client with Asperger syndrome, it might indicate high energy and much activity in general; strong feelings about something, based on positive or negative emotional loading; or simply a physical limitation that forces the client to improvise using clustered voices. Thus the clinician or

researcher will always require additional information to attempt an adequate interpretation, such as the known effects of a disorder in a certain client group (e.g., physical limitations or emotional problems), a particular individual's unique ways of expressing her/himself musically, and even a specific awareness of the context and issues involved in the work of improvising. Together, qualitative data from clinical observation and quantitative data from computational analysis will supply the necessary information for proper clinical assessment and evaluation.

When data exists for several clients representing the same diagnostic populations, commonalities in their musical behaviour across the sample can provide valuable hints for interpretation. Luck et al. (2006) found, for example, that severe mental retardation correlates with a staccato style of musical expression. This finding probably can be associated with a lower developmental age, where cognitive competencies such as the idea of phrasing, the creation of a melody line, or the general ability to deal with notes sequentially (all of which lead to legato rather than staccato style) are underdeveloped.

Another issue is that many aspects of musical behaviour cannot be extracted by computational methods in a trustworthy way. It is hard to teach a computer to recognise and distinguish melody, phrasing or accompaniment, for example, within a busy musical texture consisting of various overlapping aspects and events. Though research in this field is progressing quickly, computational improvisation analysis at the present time is based on a more global extraction of features.

Clearly, precision and reliability come with a price. On the other hand, traditional improvisation-analysis methods, such as the Improvisation Assessment Profile, or IAP (Bruscia, 1987) are generally unable to handle a large amount of data. They are very time-consuming and interpretative approaches with low inter-rater¹ reliability, and they are useful mostly for small-scale case studies and certain clinical applications. It is furthermore unlikely that different analysts, when employing manual analysis method, will end up with the same numeral ratings on highly abstract/interpretative musical phenomena. The consequence of this is that the analysis does not provide with reliable results. Overlapping musical features easily lead to a loss of focus and therefore reliability, in particular when employing manual methods with the computer. In the end, quantifying a highly qualitative phenomenon remains a challenging task. Whereas computational analysis methods only quantify objective facts (average pitch, for instance), one can always trust the numbers. Due to their effectiveness and precision, computational improvisation

1 Inter-rater is a basic statistical term that refers to consistency of assessments made by several independent assessors who evaluate the same event by using the same analysis method.

analysis methods will probably become more common in music-therapy research in the future, but we believe that qualitative methods will still have an important role in gaining a better understanding of the real-life implications of these findings.

Towards the standards

Computational methods develop quickly within various areas of human behaviour research, and continuously smarter and more sophisticated analysis techniques accompany them. Sometimes, however, there is a mismatch between these technology-driven measures and the actual needs of a practical profession such as music therapy. Additionally, clinical improvisation varies in popularity among cultures and nations, and there are various improvisational models with different theoretical and practical principles, first listed by Bruscia (1987). These principles may require different types of applications in terms of improvisation analysis. Free improvisation raises different challenges for analysis than other improvisation methods, which are based more closely on musical grammar, for instance.

Computational improvisation analysis is useful when it accommodates the theoretical and practical principles of an improvisational model. After successfully completing the randomized controlled trial (RCT) on depression based on improvisational music therapy (Erkkilä et al., 2011), we drew upon earlier writings, practices and our tacit knowledge to propose the model we currently call Improvisational Psychodynamic Music Therapy (IPMT). Though this work continues, we have published the outlines of the model already (Erkkilä, Ala-Ruona, Punkanen & Fachner, 2012). In IPMT, clinical improvisation is seen to represent a form of pre-conscious, nonverbal expression and interaction where thoughts and feelings that are not yet possible to verbalise or even consciously recognise are expressed in symbolic, musical form. These cerebral 'contents' are emotionally loaded and typically reflect highly personal, sometimes traumatic experiences which are otherwise repressed in everyday life. After improvising, clients often describe particularly strong sensations, images and memories that they experienced during the interaction with the instrument and the therapist. An essential part of the IPMT process is to then verbalise these (pre-conscious) experiences in a dialogue with the music therapist so as to gain a better understanding of the forces behind one's pathological behaviour. We believe that clinical improvisation stimulates the client in a therapeutically relevant way, boosts the therapeutic process, and enables a productive and appropriate expression and interaction even if the client is not yet able to verbally open up in

therapy. Strong transference (and counter-transference) experiences are typical for an IPMT process and represent an essential therapeutic tool (see Bruscia, 1998b).

Improvising in IPMT is always based on the free, unstructured and spontaneous production of sounds, and improvisations are never alike in musical features or feature combinations. Sometimes, potentially meaningful shifts during the process are so subtle that only careful analysis will reveal them. In addition, a long-term music therapy process may comprise numerous improvisations, so a different set of specific analytical tools will be needed in order to reveal the overall evolution of the client expression. This kind of improvisation analysis helps music therapists to better understand this clinical tool and its function and implications for different diagnostic groups and individuals. Perhaps the most important potential of IPMT is to generate new insights into how clinical themes (e.g., aspects of pathology or recovery) affect improvisation; this knowledge might then be turned around to improve IPMT practice as well.

Our aim is to make our model, or approach, both useful and transferable nationally as well as internationally, to develop training around it, and to continue research activities by introducing new clinical target groups. To label IPMT a treatment model is, of course, rather ambitious at this stage – according to Bruscia (1998a), who has creditably defined music therapy in general, a model is the highest concept in a hierarchy also consisting of the technique, method and approach. Time will tell whether IPMT is unique enough to deserve this status, so for now we will think of it as an approach, one that in fact owes much to existing improvisational models and definitions as well. Our aim has always been to include all aspects of a treatment model in our plans, and to make IPMT as consistent as possible. A full-blown treatment model requires coherent theory, clear clinical procedures, a training system and outcome research, all of which presently exist with IPMT, even though more elaboration is required.

If a large enough group of clinicians and scholars takes up the gauntlet and participates in the development of clinical applications and research regarding IPMT, it might be possible to standardise the approach relatively quickly. Because computational improvisation analysis is fundamental to IPMT, this approach would allow for a better understanding of the implications of clinical improvisation for therapeutic work as well. Large samples representing different diagnostic populations, possibly based on international, multi-site studies, would contribute significantly to the preparation of the relevant standards.

Conclusion

In this chapter we have looked at the possible impacts of modern technology on music therapy clinical practice and research, focussing primarily on clinical improvisation. Certainly the computational analysis of clinical improvisations demands compromise and flexibility from the clinician, who, first of all, must sometimes accept the fact that his or her favourite instrument or clinical setting is not ideal (or even possible) from a data-collection point of view. Sometimes, one has to accept poorer sound quality as well, in the interests of obtaining a more optimal analysis. The clinician also has to acquire a basic knowledge of different digital-music data formats and the transfer of this data between applications. Thankfully, technology is now omnipresent and generally based on shared standards and functionality; it is also more affordable all the time, which allows for unprecedented improvements. For example, a mid-range digital piano is now fully able to compete with or supersede a traditional acoustic piano in terms of purchase price and service costs, convenience and sometimes even sound quality.

Computational improvisation analysis, such as MTTB, provides a precise and highly objective picture of the musical features of the process. Still, a human being is needed to interpret the results. In addition, purely musical analysis is seldom a sufficient basis upon which to construct relevant clinical interpretations. Additional data, such as the therapist's journals, video recordings, existing knowledge of the client's condition, and so forth, are also needed for successful interpretations during assessment and evaluation. It might be possible to connect MTTB analysis to other visualisation methods, such as traditional musical notation. For example, MIDI-based musical representation can be automatically converted into musical notation. Traditional notation, in turn, might expose certain musical phenomena, such as rhythmic patterns and melodic phrases, which are not possible to detect through MTTB, which produces a rather coarser representation of musical events.

Though computational analysis as such is a speedy process that allows one to deal with a huge amount of data at once, the clinical work that follows is not. A real challenge in terms of improving modern analysis possibilities is perhaps not the technology in question but the availability of coherent (and sufficiently large) samples to be analysed. Consensus is therefore needed regarding clinical models and procedures, so that this data can be acquired. Happily, IPMT, which combines all of the core elements of a treatment model, matches well with a computational improvisation analysis method. This is because in IPMT the musical expression and interaction are seen as an important source of information concerning the aspects of illness and recovery. An important element of the IPMT is also to put attention

to, and to investigate the relationship between identifiable musical features and their symbolic meanings. This challenging task greatly benefits from the computational methods, which allow dealing with big amount of data in a systematic manner. It will not be long before we know much more about the clinically relevant implications of musical behaviour in improvisational music therapy.

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Using electronic and digital technologies in music therapy: the implications of gender and age for therapists and the people with whom they work

Wendy L. Magee

Introduction

This article is going to explore two important themes that have emerged in recent practice, theory and research relating to the use of digital and electronic music technologies in music therapy. Gender and age are of specific importance when introducing technology into both clinical settings involving music therapist and client, and training settings involving music therapy trainees and trainers. This chapter will explore each of these factors and the impact for music therapists and the people with whom they work in clinical settings, before making recommendations for music therapy practitioners and trainers. Given the limited published research and clinical description on this topic from music therapy literature, the discussion presented in this article draws from related fields such as music education and music production. It also considers the small body of research on music technology in music therapy practice. First, the relationship between age (or generation) and technology is examined drawing from informatics epistemology. Then, considering literature from informatics, music education and music production, I will examine gender /technology/music technology relations. Lastly, I explore all of this in the context of music therapy practice and education. As most of the inquiry to date is descriptive, qualitative or hypothetical, I have used a narrative style that compliments the existing style of inquiry and helps to illustrate some of the issues raised.

Background: gender and age as topics of importance in music therapy practice with technology

We are living in an interesting age where technology, and digital or electronic technologies primarily, have become a part of our 24-hour daily existence within a relatively short period of time over the very late 1990s until the present time. The race to keep up with the latest technology contributes to one's social identity, evidenced through preferential branding of devices such as Apple media over android media in phone, tablet and music listening devices indicate. The phenomenon of social networking using platforms such as Facebook, Twitter, Pinterest, LinkedIn, Instagram and blogging illustrate the power of this medium for one's social identity. Parallel to one's professional world, as therapists we are interested in how our clients can benefit from technologies that enable music engagement, production and performance, as well as those that expand social horizons.

As therapists, we need to keep up with these trends in order to best meet the needs of the people with whom we work, including staying informed through means such as information networking. There is a dilemma, however, for many professionals who may not be drawn to these technological tools. As positioned in the previous paragraph, staying up to date with the latest devices and technology platforms contributes to one's social identity. Inherent in this idea is that *not* staying current with developments can result in being excluded from particular social identities. This chapter is going to examine some of these issues with particular reference to gender and age. These two factors are relevant when considering the therapist, the client and also the professionals teaching trainee music therapists. Gender and age are only two of the factors that may contribute to one's comfort factor with technology. Other socio-cultural factors also contribute, such as race, economic wealth, technology infrastructures in geographical region (urban, rural, country), and familiarity from cultural perspectives. All of these are important to consider, although with little research on these topics it is difficult to make meaningful recommendations. Any one of these factors can influence one's inclination to use technological tools.

At this point, I would like to clarify that 'age' might be better considered as 'generation' in relation to the topic of technology. 'Generation' refers to a collective body of individuals born at around the same time who, within a particular culture, will be exposed to similar life experiences. At the time of writing this piece, the Internet and the ensuing technologies to use it are relatively new phenomena. As will be discussed later, this means that a certain *generation* may be disadvantaged when it comes to technology as its use in everyday life requires making conscious

decisions and changes to adopt it into everyday life. In ten years' time, the situation for people who are 40 years and above will be different. For this reason, this article will also refer to 'generation' as this is a more specific way of examining how professionals and the clients with we work might be excluded or disadvantaged.

Anecdotal conversations with peers and colleagues from diverse backgrounds about technology are weighted with references to gender differences. That is, men and women use technology differently. Examining theory that stems from the epistemology of informatics and education, it emerges that females "distance" themselves from technology, whilst males tend to "appropriate" technology (Kelan, 2007). This difference between genders is important for the music therapy profession for a number of reasons. First, we need to think about therapists working with clients: we work with female clients, and so we need to be aware of what it might mean to introduce technology into the therapeutic space from a gender perspective. Second, as a profession that has a greater number of female to male professionals, we need to think about how the therapeutic applications of music technology is being taught to trainee therapists, whether the professor is female or male, and given that the majority of students are likely to be female. Lastly, it is worth thinking about clinical supervision offered to both clinical trainees/interns as they learn to work in clinical settings, and also supervision offered to professional music therapists. We need to keep in mind how gender technology relations might be playing out in these different forums so that we can ensure the clients with whom we work are optimally enabled and empowered in music therapy.

Situating myself in this inquiry

Before I discuss why considering gender is a significant issue when technology is used in music therapy, I need to situate myself and explain my motivations. In doing so, I hope that this will provide some concrete illustrations to a topic that has received little interest in the research or clinical literature to date, and which has proven difficult to research (see Magee & Wimberly, 2013). As a feminist, my perspective of the world is one that understands women's voices as a minority. I am interested in exploring women's perspectives and understand that these are generally underrepresented in mainstream media, academia and world views generally. At the same time, I also understand topics and issues that are of interest to women may not be considered of interest or significance in mainstream thinking.

I also want to challenge the idea of gender being a binary concept of merely 'male/female'. Personally, I am deeply committed to challenging societal norms

around gender and strongly encourage all of my colleagues and students to do the same in their clinical and research practices. Best professional practice demands that music therapists be aware of the needs of people who have nonconforming gender identities, pertaining to both the clients with whom we work and the colleagues alongside whom we work (Whitehead-Pleaux et al., 2013). People with non-conforming gender identities may not identify as either female or male, or may identify with a gender other than their physical gender or their assigned sex at birth. These thoughts bear relevance when introducing technology into the therapy space, as we will see that males and females are socialized differently with technology. Thus, we should keep gender in mind when introducing these tools as the socialization of transgendered clients around technology is not likely to follow traditional norms.

Further to both these points, I have a particular perspective on this topic having been born in the 1960's, and thus of a generation that did not grow up with digital technologies or computers. As such, I feel disadvantaged every day as I am challenged by 'keeping up' with technology, learning about new platforms, updating apps on the latest devices to make my life (supposedly) easier or more manageable. This position is explored more in the section that follows, where I examine the notion of 'digital natives' versus 'digital immigrants'.

An examination of age and technology: Digital native; digital immigrant

As a child of the 1960's, I could be classed as what has been termed a 'digital immigrant'. This term has suggested to describe the generation who grew up before the digital age (Prensky, 2001). The opposite side of this is the generation who are described as 'digital natives'; that is, the generation who group up well-versed in the language of video games, computers, mobile phones and smart phones in particular, iPods and other MP3 players, and tablets with the encyclopedic 'apps' that accompany those. Previously, I have suggested that digital natives and immigrants might be classed by age, with a loose suggestion of those being born before 1970 being the immigrants (Knight et al., 2012). Although I position this discussion through the lens of age, it should also be kept in mind that this perspective is provided from a position of privilege, being that of people who live in developed countries rather than developing countries where socio-economic factors may be another barrier for accessing and mastering technologies.

Let me paint a picture of the digital immigrant's world. I remember when television remote controls became a part of most people's homes; but as my parents

were older, we did not have this technology in my family home as it was too technological for people of my parents' age. Because of this, I did not become familiar with using a remote control until at university. At the all-girls' school that I attended, the elective computer class (offered only in the final year) was poorly attended as it was not an attractive option. Instead, I chose to do typing, that was taught on manual typewriters. My assignments at university in the mid 1980's were typed on a (borrowed) manual typewriter. Although electric typewriters were a recent technology at that time, these were expensive luxuries for students and required learning new skills to use them. Many people just chose to hand write assignments. In my final year at university I had access to one of the early Macintosh desktops through a friend, and so I learned to do word processing. None of my peers had this luxury and although there were computer 'labs' available on campus, these were not heavily subscribed to by students in the arts. Music-listening involved vinyl LPs until the invention of the CD around the early 1980's which brought digital music into the home for the first time. Near to the same time, the first portable personal stereos (or "Walkmans") appeared on the market, and revolutionized the way of listening to music 'on the go'. When one wanted to phone a friend, the only option was using a landline either in the home, workplace or public telephones. I offer these examples to illustrate the devices and music formats that were usual in my youth, and as a contrast to a later generation who might identify with the following illustration of the 'digital native'.

Let's look now at the world of the digital native. Again, I examine this from the perspective of a wealthy society in a developed country. Born (loosely) after 1970, digital natives have grown up in the world of computers and mobile phones, and the idea of a home without a television remote control would be unheard of. Digital natives were in their 20s when the iPod was released, and in their 30s when the first iPad was released. They have grown up being versatile in a language where digital and electronic technologies are an accepted part of everyday parlance. Younger digital natives (i.e. those born after 1990) are likely to have grown up carrying their own mobile phone. Music consumed by those born in the 1980's has most probably always largely been digitized. Music is consumed, shared and composed in entirely different ways by digital immigrants, using digitized files that are commonly shared by downloading and uploading online. Software for amateur music composition (e.g. Garageband) is widely accessible on everyday devices (e.g. Mac laptops; iPads) so that digital music composition is readily available and enables even people with no music training (in the traditional sense) to create beats, loops and songs.

For the digital native, music is now so easy to access that there is a risk of being overloaded with music. Social media dominates how people of this generation relate to music, connecting to and sharing music through applications like Spotify, Grooveshark and Soundcloud. Favorite musical artists are followed on forums such as Facebook, Instagram and Twitter. The result can be an inundation with music, with as many as 10,000 songs on a computer and personal MP3 player.¹ Creating, sharing and accessing music in these ways are completely alien for the digital immigrant, who may not even consider embracing music using any of these means, and will still consider buying CDs as the norm. Many will not even have iTunes accounts. Despite some seeming advantages for the digital native's perspective, I have recently heard students born as recently as 1990 discuss "the kids these days are so technologically able....". It helped me to understand that possibly the identity of 'digital native/digital immigrant' was not quite as straightforward as one's age. That is, the passport for immigrant / native status might require other criteria that just one's birth date. However, largely we can see that digital natives conceptualize music making and listening entirely differently from digital immigrants.

I will explore the issues of age and technology later in this chapter. However, at this point, I want to highlight that age and generation are important factors to consider when we introduce technology into music therapy settings, whether this be the clinical session, the supervision session, or the music therapy classroom. The age of the therapist, the client, the professor, the supervisor, the supervisee and the student all need to be considered if the use of technology is intended to enhance authentic relations between any of these players and if technology is to be a tool that helps the therapeutic process rather than hinders it.

An examination of gender and technology

I have already discussed gender being broader than simply the binary category used more widely in society. Gender is also more complex than merely the sex we are assigned at birth. It has been proposed that gender is an "asymmetrical social relation", in which "the masculine is more highly valued and ascribed with more power than the feminine...(varying) over time and according to place and culture" (Stepulevage, 2001, p. 326). In this statement we can start to understand that gender is socially constructed, that notions of power may be implicated, and that the gender-power dynamic is influenced by cultural influences. At this point, I want

¹ I would like to acknowledge Lena Wendt BM MT-BC for her input from a digital native's perspective.

to return to non-conforming gender identities and clarify how I will consider this group in this chapter. Given the limited research about technology and people of non-conforming gender identifies, the previous research I have done on this topic grouped 'female' and 'transgendered' identities together as non-dominant gender minorities in the culture of technology (Magee & Wimberly, 2013). This seems appropriate, particularly given women's place as a non-dominant gender minority in the culture of technology. From this point on, where I discuss 'female' or 'women', I am using this as an umbrella term that encompasses non-conforming gender identities too.

This seems to be a point to begin to think about the power dynamic between male and female identities in the technological environment. Emergent in the literature from the disciplines of informatics and education is the idea that *men and women use technology differently*. As already stated, we might see that females may avoid using technology whereas males seize the opportunity (Kelan, 2007). This is important for music therapists to remember as it means *introducing technology can cause one to feel unequal on the grounds of one's gender*. Women downplay their technological competence (Henwood, 2000), a phenomenon that I (as a female digital immigrant) struggle with every day in my experience as a professor of music therapy trainees. However, it seems that downplaying one's competence is not just for women of my generation: recent research in music education settings also found that girl students underestimate their computing ability and express greater incompetence, less confidence and assurance in using computers than boy students (Armstrong, 2011). Gender also creates differences when technology is used in educational settings (Armstrong, 2008). This seems to be because the culture surrounding technology produces differing socialized expectations of males than females when it comes to behaviors and attitudes towards technology. Males are positioned as more 'expert' users than females (Armstrong, 2008). More worryingly, because of the higher expectations of males and the authority given to them when technology is introduced, males have greater influence in shaping the culture of the classroom when technology is introduced. Although this has been observed in music education settings, we might ask whether this also occurs in the therapeutic settings.

Gender and the relevance for the musical genres that incorporate technology

Technology can be a highly versatile tool for the music therapist working in community, health and educational contexts with clients across the life span, from neonates right through to the elderly (Magee, 2013). It enables therapists to

provide genres, idioms and instrumental sounds that can enable an individual to explore expressions of ethnicity or national identity (Magee & Burland, 2008a, b). Technology provides a platform for clients to access alternative identities, reinforcing age-appropriate cultural and social roles and challenging less-preferred identities (Burland & Magee, 2014).

The prevalence of hip-hop as a preferred genre for children, adolescents and young adults from any number of racial or cultural backgrounds can challenge music therapists using solely acoustic instruments (Sadnovik, 2013). In these situations, techniques such as looping, cutting and pasting, and multitracking require technological tools in order to create music and experiences that are authentic to the client's sociocultural identity. Whilst the use of hip-hop in music therapy is now widely practiced (Hadley & Yancey, 2012), it is also acknowledged that these musical genres may carry gender associations with considerable discussion around misogynistic and/or homophobic lyrics (Stadler, 2010; Vazquez, 2010; Veltre & Hadley, 2011). Also, literature from sociology and feminist theory paints the picture of male role models dominating the electronic music recording studio, playing the role of "producer", the ultimate controller in electronic musical creation (Faulkner, 2001; Stadler, 2010).

So, in music therapy situations where hip-hop is used and generated by technology, we need to stay mindful of several things. This musical genre may risk alienating females; the technological tools used to create this music may create an environment where females feel unequal or even disempowered; and the roles available for female clients might be more limited than those available to males due to the role models played out in society. This is not to suggest that all female clients will feel alienated, or that when working with females one should avoid using technology or hip-hop. However, the therapist should stay mindful of gender-based social practices, role models and expectations to ensure that the therapy session is an enabling rather than limiting environment. The therapist is responsible for ensuring that gender non-conforming and female clients are enabled to take a range of roles, including that of producer that might more traditionally be held by males.

The implications for gender and age when using technology in music therapy

The gender differences in technology environments have a number of implications for the music therapy clinical session and educational settings where music therapy is taught. An international survey into how music therapists are engaging with music technology in practice found that male music therapists are

significantly more likely to use technology than female or transgendered music therapists (Hahna et al., 2012). Furthermore, the results indicated that almost 60% of music therapists using music technology in 2010 (when the survey was undertaken) were between the ages of 21 and 40 (born 1970 – 1989). Music therapists born before 1950 were much more likely not to know how to use music technology in clinical practice and those aged born between 1950-60 were more likely to say that they “do not like music technology” or to view it as “not appropriate/relevant for music therapy clinical work in general” (Hahna et al., 2012). Although this research did not look specifically at the interaction between gender and age concerning music therapists’ use of technology, we already know from wider theoretical epistemologies that females are disadvantaged when it comes to technology from a sociocultural perspective. Given the results from Hahna et al.’s survey, it would seem that age combined with longevity in the professional field might further disadvantage female music therapists.

Theoretical perspectives explain some of the disparity between genders on the grounds of “reductionism” versus “determinism”. Reductionists argue that it is only *access* to technology that inhibits people from engaging with it; determinists argue that *socialization* plays a key role, particularly in terms of how comfortable individuals feel with technology (Magee & Wimberly, 2013). This argument is pertinent for music therapy. Research exploring the music therapy profession’s engagement with technology indicate that *access to technology* and *knowledge about how to use technology in therapy* are two of the main barriers for bringing technology into music therapy practice (Hahna et al., 2012; Magee, 2006). Let’s now consider this in combination with the demographic of the music therapy profession, being a profession with a majority of female practitioners, with many of the professors and trainers in the profession falling into the category of ‘digital immigrant’ who may be less informed about technology and less inclined to use it. Thinking about the argument already positioned concerning gender and generation, we can start to think about the profession’s *comfort* with using technology in the therapy clinical situation or the therapy classroom. Current discourses on both gender and age suggest that much of the profession may not be well placed to feel comfortable with using technological tools.

Let us now turn our thoughts to the people who are engaged in music therapy as clients. We have so far discussed digital immigrants in the profession of music therapy who, having been born before 1960, may be less inclined to use technology in their practice. What might this mean for using technology in music therapy with older clients? Is technology an inappropriate tool, given its lack of familiarity and usefulness for older people? It is of note that many of the previously published case

studies about using music technologies in music therapy have been with children, teens and young adults (see Magee et al., 2011 for an overview). However, several detailed case studies have illustrated the multiple uses of technology with this age group (Magee et al., 2011; Weissberger, 2013). In particular, recording technologies seem particularly pertinent for enabling the immediate capturing of spontaneous music making with others. Greater inquiry is required about the relevance of music technologies with older populations, however. Although a number of studies from related health disciplines are exploring the application of Wii technologies to meet functional goals with older people (Benveniste et al., 2011; Jung et al., 2009), reports indicate that standard technologies may not be optimal motivators and require considerable adaptation in order to engage elders meaningfully and meet clinical goals (Gerling & Masuch, 2011).

Age and/or gender may therefore contribute to how comfortable a therapist feels introducing music technologies into his or her practice, and how comfortable a client feels with engaging in therapeutic activity. Feeling comfortable with the methods and tools used in therapy is one aspect of being able to build a safe and trusting relationship that are essential for the client to feel empowered within their personal interactions. This has implications when technology is introduced into the therapeutic setting. Age and/or gender are factors that can contribute to feelings of skill, ability and mastery when it comes to technology. The therapist should always ask "What benefits can technology bring to the client within this interaction?" before introducing it into therapy, particularly when working with older clients. Certainly research has suggested that music therapists believe that music technology can empower people living with complex physical needs (Burland & Magee, 2014; Magee & Burland, 2008a & b) through contributing to the development of new skills, feelings of mastery and thus feelings of identity. In cases where acoustic instruments or receptive methods do not empower a client, technology may be another instrument to consider. However, careful thought should be given to ensure that the client is not left feeling disempowered with an unfamiliar device for the purposes of making musical sounds, which might be an entirely abstract concept for that client. Successful cases where technology has been used with elders have tended to use it for recording spontaneous music making with loved ones (Magee et al., 2011; Weissberger, 2013). This helps to keep the activity more concrete with a familiar outcome (i.e. a recording to keep for legacy).

Lastly, the therapist also needs to have feelings of skill and mastery with the instruments they use. Lack of comfort, familiarity and skill can all risk the therapist feeling disempowered. These concepts may contribute to therapists who are either from older generations, or female, or both, being less likely to use technology

in practice (Hanha et al., 2012). Feeling disempowered through the introduction of music technologies can provide a challenge when therapists are working with younger generations (e.g. digital natives). In such cases, therapists are encouraged to think about how the client may feel empowered by being the skilled one in the relationship. This may feel challenging for therapists, however, engaging with a client's preferred means of making music enhances the client's motivation and engagement in therapy at times of distress. In this way, engaging with technology can help to enhance a therapeutic relationship: it situates the client in a place where she or he can teach the therapist about the things that meaningful within the client's life.

Recommendations for music therapy training and practice when technology is involved

There are a number of recommendations for music therapy professionals if we are to ensure that introducing technology into either the therapy clinic or the therapy training setting is to enable and empower clients, therapists and students rather than place a barrier. Gender needs to be kept in mind given the gender demographic of the profession and, in turn, the demographic of music therapy trainers and supervisors. These recommendations are made to ensure that female music therapists feel confident in their abilities to use technology in therapeutic contexts, that female clients feel empowered when technology is introduced into therapy, and that female students do not feel deskilled when technology is brought into the classroom. I believe that music therapists are already aware of many of the issues around using technology with elders. However, there may be less awareness around matching technology to the needs of people who fall between being 'young adults' and 'elders', a group that we might consider 'digital immigrants', for whom technology use might be less familiar, less meaningful and be less comfortable.

It is worth considering training aspects first of all. Training for using music technology therapeutically has long been identified as a priority in the profession (Crowe & Rio, 2004; Hanha et al., 2012; Magee, 2006). However, little thought has been given before now about the gender demographic of the profession and how this might be influencing our teaching of using technology in therapy. Research from music education suggests that differing learning styles and teaching strategies might suit male and female students (Armstrong, 2011). When teaching the use of technology in therapy, female students may respond better to step-by-step guided learning rather than freer self-study (which may suit male students more). Also, emphasize the ways that music technology can enhance human relationships in the therapy setting, as female students may engage more with learning that stresses meaningful

social relationships (Armstrong, 2011; Hahna et al. 2012). Clinical case vignettes are a recommended means for illustrating the value of technology in practice.

In both training and clinical settings, technological jargon should be avoided as it may exclude people who are less comfortable with technology, who have less familiarity with technology, and who do not engage readily with the technology culture. This thought holds for both training and clinical contexts. Skill and expertise should not be based on either gender or generation. Younger people may be more familiar with technology, and thus more comfortable with using it. However, ensure that people from older generations also have the possibility to lead activities where technology is introduced as this will help with confidence and learning. This holds as well for gender. Be consciously aware of enabling all students/clients/participants to lead regardless of gender identity.

Be aware too of the role models that are prominent on the grounds of age and gender, and think about how this might affect clients in therapy and students in training. More prominent female role models are needed when technology is introduced for students, clients, and professionals alike. In particular, female therapists and trainers should remain aware of how they model the ways they interact with technology. Notice if you are presenting as the 'non-expert' as this can serve to undermine both the students you teach and the clients with whom you work.

In following these recommendations, strive to achieve an environment where music therapy educational and therapy settings enables people of all gender identities and age to feel free to explore, fail, learn, achieve and grow.

Conclusions

Music technologies can be a valuable resource for meeting the needs of people with complex needs and clients who are hard to reach using more traditional resources in music therapy. However, technology should never be used 'for technology's sake': when technology is used, it should always be matched to the client's specific needs and abilities. Two factors to consider when deciding whether to incorporate technology into practice that have not been thought about adequately until recently are those of gender and age. The age and/or gender of the therapist and/or the client can impact upon the 'comfort' factor for both client and therapist, as may other factors that have not been considered in this article such as ethnicity, cultural background and socio-economic wealth.

Music therapy has historically given voice to marginalized groups and isolated individuals. New and emerging technologies can help to honor this tradition as they can empower people with the most complex needs. However, music therapists using new technologies should remain aware that technology also has the potential to disempower some individuals. Ultimately, music technology should only be used when it empowers the client.

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Natasha Barrett is a freelance composer and researcher at the University of Oslo, Department of Musicology. She holds a doctoral degree from England. Her research interests include sound's spatio-musical potential in 3D. Her compositional works include instrumental and electroacoustic music, sound-architecture installations, interactive projects and collaborations with scientists, designers and performers.

Olivier Lartillot is a researcher at the Department of Architecture, Design and Media Technology at Aalborg University, Denmark. He was previously an Academy of Finland research fellow at the Finnish Centre of Excellence in Interdisciplinary Music Research at the University of Jyväskylä. He developed several toolboxes in Matlab for music analysis, such as the Music Therapy ToolBox (MTTB), in collaboration with Jaakko Erkkilä and Petri Toiviainen, and the MIR toolbox, with Petri Toiviainen.

Wendy L. Magee is Associate Professor in the Music Therapy Program at Temple University, Philadelphia, USA. Having worked with neurological populations for 25 years, she has a particular interest in technological solutions to meet complex needs. She has published a number of studies on the therapeutic applications of electronic music technologies, including the book *Music Technology in Therapeutic and Health Settings*, published by Jessica Kingsley Publishers in 2013.

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Perspektiver på musikk og helse. 30 år med norsk musikkterapi [Perspectives on music and health. 30 years with music therapy]
NMH-publications 2008:3

Imagine that objects in your home environment – let us say a pillow, a carpet or a toy – became musical and interactive. Do you think that they could offer new ways of playing and being together? Could they even have the potential to reduce isolation and passivity and promote health and well-being for some of us?

This anthology, the eighth in the Series from the Centre for Music and Health, presents a compilation of articles that explore the many intersections of music, health, technology and design. The first and largest part of the book includes articles deriving from the multidisciplinary research project called RHYME (www.rhyme.no). They engage with the study of the design, development, and use of digital and musical ‘co-creative tangibles’ for the potential health benefit of families with a child having physical or mental needs.

Well-known international researchers broaden the picture on the book’s topic in the second part. They ask: How can video-based visualisation techniques of music-related body motion diagnose health problems? How can music therapy practice profit by digitalised improvisation analysis? What are the implications of gender and age in music technology for therapists and the people with whom they work? All together, this book supplies a broad perspective on its topic, which should be of interest to a wider audience.

The Centre for Music and Health at the Norwegian Academy of Music was established in 2008. The centre conducts research and dissemination. Its goal is to develop knowledge about the connections between music and health.

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