

Designing Empowering Vocal and Tangible Interaction

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ABSTRACT

Our voice and body are important parts of our self-experience, and our communication and relational possibilities. They gradually become more important for Interaction Design due to increased development of tangible interaction and mobile communication. In this paper we present and discuss our work with voice and tangible interaction in our ongoing research project RHYME. The goal is to improve health for families, adults and children with disabilities through use of collaborative, musical, tangible media. We build on the use of voice in Music Therapy and on a humanistic health approach. Our challenge is to design vocal and tangible interactive media that through use reduce isolation and passivity and increase empowerment for the users. We use sound recognition, generative sound synthesis, vibrations and cross-media techniques to create rhythms, melodies and harmonic chords to stimulate voice-body connections, positive emotions and structures for actions.

Keywords

Vocal Interaction, Tangible Interaction, Music & Health, Voice, Empowerment, Music Therapy, Resource-Oriented

1. INTRODUCTION

Interaction design has historically focused on visual interaction and graphical user interface design, and to a lesser degree on music and voice interaction [16]. However, due to the rapid development in mobile communication and social media, the interest for embodied and tangible interaction has grown. These technologies use body, touch, voice, music and computers that memorise and learn, making them accessible for large groups of people. People that were earlier excluded from interaction and everyday communication are now empowered to overcome social, economical, bodily and cognitive barriers.

In this paper we explore voice in tangible interaction design, its possibilities to empower people in everyday settings and what we see as their valuable design strategies. We do so by using Music Therapy as an approach for designing tangible interaction, exploring music and voice as input and output in two interactive, tangible and mobile cross-media installations.

Our method is research-by-design, with explorations that build on actions in cycles of design and user observations with families with children with severe disabilities. Our work builds

on observations in the research project RHYME for the last 2 years and on work with families with children and adults with severe disabilities prior to that.

Our approach is multidisciplinary and based on earlier studies of voice in resource-oriented *Music and Health* research and the work on voice by music therapists. Further, more studies and design methods in the fields of *Tangible Interaction in Interaction Design* [10], *voice recognition* and generative *sound synthesis* in Computer Music [22, 31], and *Interactive Music* [1] for interacting persons with layman expertise in everyday situations.

Our results point toward empowered participants, who interact with the vocal and tangible interactive designs [5]. Observations and interviews show increased communication abilities, social interaction and improved health [29]. Based on our results we discuss the possibilities for using what we call *empowering vocal and tangible interaction* in the *NIME* community and for *Music and Health*.

2. RELATED WORK, APPROACHES

2.1 Vocal and Tangible Interaction

Gestures have been used for navigation in non-tangible interfaces for work and gaming, like the gaming console *Microsoft Kinect* and *OpenKinect* community [20]. Tangible interaction where a user engages more physically and tactile by standing on an interactive board has been developed in the gaming console for *Nintendo Wii's Balance board* [18], with studies confirming improved strength and balance [19].

With increased use of *mobile communication* devices, such as the iPhone smartphone, vocal interaction, voice control and voice services have become well spread. Often the game designers have used principles from popular music and made games, interesting for a broader group, like *GuitarHero*, voice controlled karaoke game *SingStar* and *ReacTable* instrument [11, 15, 21].

In *Assistive Technologies* for the elderly and people with disabilities, voice control, vocal interaction and also hearing aids have been used for communication. There are popular commercial assistive music technologies like the switch based *Paletto* [12] and electronic instrument and ultrasound sensor *Soundbeam* [28]. *Sound Beam* is used in Music Therapy and physiotherapy as part of a rehabilitation centre's training programme.

Common for technologies like these are that they give *direct sound response* to movements with the goal to give users clear feedback. There are however mayor drawbacks. It can be hard for persons with severe disabilities to master. It is because the strong focus on direct feedback creates expectations that a person with severe physical disabilities might never be able to meet. As a result, the individual can experience defeat instead of mastering. The mechanical repetitiveness can lead to fatigue [17] with the risk to disempower [5] the person interacting. Perhaps the most popular electronic music technology used is a

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NIME'13, May 27-30, 2013, KAIST, Daejeon, Korea.

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microphone connected to an amplifier with effects like reverb and delay-echo. The users are strengthened as they hear their voices amplified and slightly changed spatially by reverb and temporarily, creating loops of delayed repeated echoes. It is used in collaboration while performing in community music settings [30]. However, the increased motivation felt is due to the social interaction between the players. An interaction where the person without disability tends to have the upper hand in the relation, with the power to decide what to do. Also, when the therapist is leaving the room, the devices in practice (instruments, amplifiers, switches) stop working, because they depend on the therapist's actions. The result is that the person with disability either becomes over-stimulated or isolated or never achieves the ability to decide for him or her self. Meanwhile, successful methods and practice are being used within traditional computer gaming, Assistive Technologies and Interactive Art. Very few, though, of the existing vocal computer-based games and interactive devices for health improvement consider the knowledge in the fields of Music Therapy and Music and Health. Our suggestion as designers of tangible interactive music technologies is to look for inspiration among these methods and practices and adapt them for the design of computer-based media.

2.2 Voice, Music and Health

Music and Health is a research field that for the last 10 years has expanded the music therapeutic situation into the everyday. From music for professional therapist treatment to amateurs' use of sound and music for work, leisure, wellbeing and creative processes.

Music and Health research complements biomedical, cognitive, psychological, methods with *humanist*, cultural and ecological approaches. Instead of only focusing on diagnosis and illness, *Music and Health* is *resource-oriented*, and no matter how weak or ill, it is always possible to motivate a person to use her resources with the purpose to *empower* all persons involved in a relation in a certain situation. An example is the Norwegian music therapist Randi Rolvsjord who uses a resource-oriented approach in psychiatric care with the result that she as a therapist is getting empowered as a co-musician and singer-and-songwriter, working with a patient to write, perform and publish songs. The patient's confidence and proudness of their shared accomplishments is strengthened and empowers her to find alternative routes out of her illness. To stress what is positive in a situation like this, instead of what is negative and wrong, has showed to give good results for a wide range of target groups from therapy to everyday situations [25]. The positive psychology and resource-oriented approach that we practise, that there are no wrong actions, is connected to musicologist Christopher Small's term *Musicking* [26]. Small sees music as an ongoing, everyday *relation building activity*, like the song writing activity above. Not as an Art object but as a verb – *to music*. The approach has in particular been used in *community musicking* [30, 25, 5], like playing in a rock band, dancing, singing and socialising with music. The approach involves everyone in an amateur community or family to interact and potentially get empowered. We believe that musicking everyday activities has the potential for computer-based vocal and tangible interaction.

2.2.1 Voice in Music Therapy

Music therapist Kenneth Bruscia has collected and commented on some 25 music therapeutic methods [4]. About the potentiality of vocal improvisation methods used in therapy he writes that: "Being an inner instrument of the body, the voice is at a unique and powerful vantage point for working with the self from within." [4:357]. The voice is powerful and yet

vulnerable since it is constantly in connection with our body through breathing and the bloodstream. The voice is something we always bring with us. It is also vulnerable because it reveals a person's emotions and expresses her identity [9, 25, 27, 4:359]. Music therapist Joanne Loewy brings forward four complementing models for working with voice throughout a person's life and in different situations. 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* [14].

2.2.1.1 The Musical Voice

The Music therapist uses rhythm, melody, harmony and speech as working tools. The music therapist tries to motivate a person to create *rhythms* to a repeated pulse with the purpose to enhance motoric and vocal play and strengthen the persons sense of self, stressing borders. The effects of rhythms in vocal interaction and singing increase when using sharp separated sounds such as the consonants "S", "K", "T", "P".

Melodies are based on tones, joining events together in sequences and can be used to localise and open up emotions and parts of the body [27].

Harmonizing is to simultaneously play two voices on separate notes. In Music Therapy it is used to explore situations of separations and relationship between voices [2:8] belonging to the same chord. The music is a safe environment and a "test-bench" for trying out difficult emotions.

Babies are constantly synthesizing the music of *speech* from their surroundings, even when they can't express words [14]. Morphemes and words come out of their explorations with consonants (e.g. B, J, S, K, T...) and vowels (A, E, I, O...) put together with rhythms and melodies before they become speech.

2.2.1.2 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*.

In therapy, 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 [2]. In therapy the body can extend to relations to other persons and their bodies, recognising voices belonging to a functional *family body* and even a *cultural body* as in music therapist Lisa Sokolov's *Embodied Voice Work* [27, 4]

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 community musicking [28] and Music Therapy [23, 24]. Music is important in *prelinguistic* stages. Before a child develops a verbal language she uses musical non-verbal communication to explore her own body and mirroring relations with her mother and others.

Rhythms, melodies and harmonizing are used to ground a person in her body and to evoke positive emotions. They are also used as *structures for actions*. These are structures that can facilitate actions for identifying difficult emotional and physical boundaries and breaking with those boundaries [27, 4]. Often the actions have as goal to empower people to make things by their own will, or to break with a negative behaviour. This is described as 4 phases from 1. *Exploring* the difficult boundary through use of one's voice, listening and trying to 2. *Release* emotions and *Strengthen* ones person, 3. *Integrating* the new knowledge and techniques into everyday actions, and finally seek 4. *Independence* and to break with the therapist [4:359].

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 another musical context then before and is therefore *recasted* and given a *different role* [27, 4:358]. It can empower the person, who the voice belongs to, to integrate emotional conflicts by overcoming them, acting out the emotions in a chord of two 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* [2], the therapist provides the means to explore sound, breathing and voice.

2.3 Tangible Interaction Possibilities

2.3.1 Interactive Possibilities with Voice

Computer-based tangible interaction offers new possibilities. Possibilities that analogue instruments and mechanical switches such as the assistive technologies Soundbeam and Paletto don't offer. The computer can *remember* and *learn* actions and musical rules for composition and improvisation among amateurs [1, 22, 31]. For example by *recording* and *playing* back sounds. These possibilities can also be used for strengthening *voice-body* relations, *positive emotions* and creating *structures for actions*.

2.3.1.1 Generative Sound Synthesis, Record, Play

With a computer the composer can create *generative sound* and real-time synthesis that can change the recorded or streaming voice dynamically with algorithms according to new actions and musical parameters. It can change amplitude, filters, and effects such as delays. It can make jumps, scroll, scrub and reverse effects in the recorded samples or loops and create new rhythms, melodies and sound events in the time domain. Or, it can zoom in on a few milliseconds creating granular synthesis effects in the frequency domain. It can combine recorded *samples* of concrete sounds or musical instruments with *live streaming* voice and *synthesis*, and build dynamically changeable composites, or montages [7]. Montages have the advantage of being recognizable due to the *culturally known* content of the recorded samples, a song, an instrument, a known animal, etc. At the same time it has the expressive possibilities for a person to use his *personal voice*, and the power of real-time manipulated *synthesized effects*.

2.3.1.2 Embodied and Cross-media Possibilities

Generative vocal sound effects can, with the help of the computer, be combined with cross-media in light, visual and tangible media. While multimedia happens simultaneously, cross-media is crossing in time as well as space. For example, can a vocal input lead to a tangible vibration starting a rhythm immediately and a gradual change in dynamic graphics 5 minutes later [7]? Tangible cross-media makes possible to sense on one's own body vibrations from small speakers and buzzers to heavy bass vibrations from transducers and "butt-kickers" used to "move" listeners in cars and dance halls.

2.3.1.3 Shifting - Temporal, Spatial, Actorial

The cross-media experience can potentially motivate a person to shift [13] out temporally to a melody he or she recognises from long ago. It can make him shift down spatially into the bodily vibrating experience. Similarly to how musical harmonic change can recast the music and create a new potential role for the listener to explore, cross-media can make the person interacting shift actorially, from not listening to the music to explore the direct sound feedback. Further, from singing and creating music, to collaborating by playing with other persons.

The embodied cross-media can make the experience more immersive and powerful than mere music.

2.3.1.4 Role of the Media – the Thing

The computer's abilities to remember and learn, respond and change over time, potentially makes the vocal and tangible interactive things into *actors*. As in theatre, sociologist and philosopher Bruno Latour [13] speaks about technical actors that take and change roles during interaction. From being a neutral object sitting quiet and doing nothing, it can turn into an ambient sound background-actor for the person that focuses on something else. It becomes a tool for the person that explores the direct sound, an instrument to the person that wants to create music and a "friend" to the person that wants to take turns and go in dialogue or make a fight.

These techniques, from vocal, music therapeutic, tangible, to interactive, computer-based and actorial, can be used in the design of vocal and tangible interactive media. In the following we will explore two design cases from the RHYME project, that we designed and tested with children with severe disabilities and their close others.

3. THE RHYME PROJECT

3.1 Goals, Methods and Approaches

The context for this paper is the RHYME project, funded by the VERDIKT programme and the Research Council of Norway. RHYME is a multidisciplinary collaboration between Institute of Design/Oslo School of Architecture and Design, Centre for Music and Health/National Academy of Music and Institute for Informatics/University of Oslo. The project goal is to improve health and life quality for persons with severe disabilities, through the use of *vocal and tangible interactive media*. In the project we develop new generations of prototypes every year, focusing on different user situations and user relations, from multimodal, mobile and distributed to social media. The new designs build on experiences from previous tests.

RHYME is based on a humanistic health approach [3, 25]. The goal is to reduce isolation and passivity through use of vocal and tangible interactive media. Through *multidisciplinary action-oriented empirical studies*, discussions and reflections, we develop new generations of musical-vocal and tangible interactive media and related knowledge. Our design research methodology is user-oriented and practice-based, where we develop knowledge through design of new generations. The first empirical study in the RHYME project was of the vocal and tangible interactive medium called *ORFI* (see Fig. 1). Prior to the RHYME project it had been tested and documented with video observations and interviews with adults and children at a multi sensory environment at the Rosenlund public hospital in Stockholm. The observations were made twice with each child-adult pair, as one-hour sessions over a period of two weeks.

Later in the RHYME project, *ORFI* was observed with 5 children, between 7 and 15 years old with special needs, in their school's music room with a closely related person, not with professional music therapists. We made 4 different actions over a period of 1 month. From one action to the other, we made changes based on the previous action, weekly user surveys, observations and multidisciplinary discussions. The second empirical study at the school was of *Wave* (see Fig. 2). We followed the same schedule for actions as in *ORFI*. All sessions were video recorded from several angles to capture as much as possible to be presented for a cross-disciplinary focus group of researchers for further analysis. The health aspects of the study have been described and analysed in a separate paper by researchers and music therapists Karette Stensæth and Even Ruud [29].

3.2 Design Voice and Tangible Interaction

3.2.1 *ORFI – First Generation*

ORFI (fig. 1) is the first generation prototype in the RHYME project, and a vocal and tangible interactive medium. It consists of 26 mobile soft triangular shaped and tangible cushions in three different sizes with speakers, microphones, LED-lights, generative graphics projection and sensors, reacting to touch, bend and throwing. *ORFI* is presented earlier to the *NIME* community [8].

ORFI's software, made with real-time audio-synthesis programming language SuperCollider [31] makes it possible to change the sound dynamically. It leads to greater flexibility to change the music and give relevant direct responses. *ORFI* has 8 different music genres, where one is VOXX. It has separate cushions with microphones that record and manipulate people's speech and singing with delay, time-stretch and cut-up algorithms. The possibility to record makes it possible to recognize ones own voice, while the audio-synthesis manipulation of the recordings create curiosity and motivate to play. The recording possibility therefore makes it possible to create and explore your own sounds, not only using predefined sounds. The computer's manipulating and "funny" pitch-changing effects, create structure for actions. Structures that the person recognise as his or her voice, the fathers voice, etc., as well as exiting effects, motivating the user to take initiative and act. We have designed *ORFI* so that a user can select any cushion at any time, and interact with it over a long time. So that a user can change and develop the musical variation as well as *shifting* [13] what role to play herself from exploring alone, to creating music and playing with others, or relaxing.

Voice can be used in *ORFI* to create *voice-body* relations [2, 4, 27] as described about *the therapeutic voice* above.



Figure 1. *ORFI*, vocal and tangible interaction.

Voice-body relations that can be achieved in *ORFI* by recording and listening to your individual voice, and by feeling the vibrations of the manipulated voice on the body, from sitting in a large cushion with speakers. Compared to other genres in *ORFI* the sounds in the VOXX genre can become

especially strengthening, since the user has been part of creating the sounds with his or her own voice. These are voice recordings which the same person later uses to create his or her own narrative, with beats, melodies and effects, that can be played on and shared with others.

3.2.2 *Wave Carpet – Second Generation*

Wave Carpet (fig. 2) is the second generation vocal and tangible interactive media. When designing it our objective was to make something that combined many more mediatypes, than in the first generation *ORFI*. The goal was to explore the potential for rich cross-media interaction and collaboration among several persons. We designed it as a seven-armed 300*350 centimetres thick carpet with stereo speakers, heavy vibrating transducer, LED-lights, generative graphics projection and small handheld laser projector, camera with microphone and separate microphone, sensors reacting to light touch, bending and shaking (accelerometer). We designed *Wave* with stronger stereo speakers and vibrating transducer or "butt-kicker", otherwise found in cars to create heavy bass vibrations. It made it possible to explore *voice-body* relations and positive emotions related to the vibrating effect of music, that wasn't possible in *ORFI* with weaker speakers.

Wave Carpet's software, made with SuperCollider [31], makes it possible to collaboratively record sound at one place and manipulate and add effects like pitch shift and play it back in another place with two of the seven arms, further away. One small arm used for pitching up and one large for pitching down the sound. The software and tangible design, with separate arms for record and play, provide *structures for actions* for two or more persons. Software and tangible design makes it easier and more motivating to record and play if you are two than one. Touch and bend sensors are spread out to make it more playful and motivating to get a feedback from any part of *Wave*.

Wave further 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. The dynamic projection gives feedback to movements in the different arms with one small graphical circle per arm. All user movements contribute to a collectively created, changing image. In this sense the change in graphics, rhythms and bass melodies create structures for actions.



Figure 2. Family musicking in vocal and tangible interactive *Wave Carpet*. Sister singing into the glowing microphone. Brother playing melodies and pitching up sister's voice. Father relaxing in the vibrating *Wave*.

3.2.3 *Vocal Changes From ORFI to Wave Carpet*

Based on observations and reflections on actions with users [29, 5, 6], we have made vocal and other changes between first

generation *ORFI* and second generation *Wave*. In *ORFI* the speakers and microphones are separated in different mobile modules, while in *Wave* they are put together in the same large and non-mobile object, with the advantage of getting sound response *close* to where interaction with a sensor takes place.

Wave overall has increased cross-media direct response, due to LED-lights in orange glowing microphones. With the heavy transducer and stronger stereo speakers inside, *Wave* has increased *tangible vibrations* inviting a more bodily interaction, like sitting, hugging and relaxing in the *Wave* carpet.

With accelerometers responding to shaking and the real-time synthesis algorithms, *Wave* has increased possibilities for individuals to create manipulations of the vocal input with pitch shift and ring modulation. The design with recording in one arm and playback in two other arms, create structures for two people to act. Similar actions are possible in *ORFI*, but with a weaker effect, since the different modules are separated. In *Wave* the arms are stringed together, but with enough distance to give room to two persons playing and communicating.

Due to the powerful real-time sound synthesis software SuperCollider [31], *Wave* mixes user-recorded voices with synthetic voices and beats with a tempo that follows user interaction. The program remembers previously recorded sounds and makes it possible to pitch and hold on to a particular recording as long as the user wants. Even if recording, manipulation and playback is possible in *ORFI VOXX*, the possibility for the user to dynamically change the sounds in real-time has increased in *Wave*. The one playing, is pitching up and down with analogue accelerometers in two of the arms, has possibility to control the amount of pitching, motivating more playful communication over time. Combined with the strong vibrator and larger stereo speakers *Wave* has expanded the possibilities to create *voice-body relations* and *structures for actions*, both positive relaxing and motor-enhancing activities [4, 27]. Other new cross-media features in *Wave* are a camera with built in microphone in one arm, effecting both sound and image, and a small handheld laser projector in another arm, creating a round shaped projection of the camera view, which is always in focus due to laser-based technology.

In the next part we show how some of these changes in tangible interaction design and voice software have affected the interactions and its potential for health and wellbeing.

4. TWO USER STORIES

4.1 Deaf David in ORFI

David uses a wheelchair, has impaired hearing and loves music. First it might seem as a contradiction but David listens through vibrations. Normally this can be hard for David since most speakers are too heavy for him to lift up and into his wheelchair. In *ORFI*, though, he plays sound, holding one of the small and light speaker cushions in his lap, and “listens to” the assistant’s voice, through the vibrations. According to his assistant, David likes to explore the relations between music and body [27, 4]. He is deaf since birth. In *ORFI*, though, he starts to imagine which of his own *music records* to bring with him the next time.

A defining moment is when David realises that he can not only play other peoples music, but *record his own voice*. He starts to cry. David tells in sign language that he has never heard his own voice. And even if he does not manage to create many sounds with his voice when he tries it the first time, he is determined to go home and practice. *ORFI* offers David structures for potential mastering.

4.2 Wendy in Wave

Wendy is a 15 year old girl with Down syndrome. She likes to sing but is shy in others people’s company. She records her voice, in one of *Wave*’s glowing arms and recites names of favourite dishes like “Taco” and Pizza”. The assistant interacts with the two arms that pitch the recording up and down. Wendy laughs at the parrot-like pitched up falsetto effect.

Wendy lies down, resting on top of the transducer with heavy vibrations and tangible responses. The vibrations from the beat in the synthesised rhythmic voices in *Wave* are making her calm and safe as she feels the bass rhythms on her body. In a safe and relaxing environment Wendy takes initiative. Instead of being shy and withdrawn, she and her assistant like to collaborate and create cross-media melodies in voice that they manipulate and that vibrate throughout *Wave* and make the both of them giggle.

As in traditional Music Therapy, *Wave* is programmed to make analysis and separate between melodic events built up from structures of binding vowels and separating consonants as described above in *the musical voice* [4:358, 27]. On increased and repeating interaction, the timbre of the sound attacks change towards sharp percussion sounds and FM-synthesis and high-pass filtering effects. Wendy focuses on holding on to certain sounds, where the binding vowels are supporting her actions. She also reacts to sharp consonants and timbre changes that help her separate between sounds and increase her sense of mastering [4:358, 27].

Wendy and her assistant develop a social dialogue where the assistant toggles between the last three sounds as she plays with the arms. Wendy communicates with voice and body what she likes and dislikes, by being more or less positive in her next recording.

4.3 Discussion

In two user stories we have tried to show how Music Therapy has inspired us to find design solutions for a demanding target group with adults and children with severe disabilities. We have observed and documented actions on video and through interviews of all actors including music therapists [29] and music psychologists, composers, interaction designers, and musicologists.

4.3.1 Positive Stories

We have observed deaf David putting *ORFI* modules in his lap, using melodies and rhythms to feel the musical vibrations on the body. As we have written above, it is similar to how traditional music therapists use *vocal holding techniques* [2, 14, 27, 4:357]. In *ORFI*, though, the motivating effect is stronger, because whatever David does, no matter how weak, *ORFI* strengthens the response. One thing is that it is easier for David to lift up and handle the cushions compared to traditional speakers. The most positive effect, though, is that he can do it by himself and at his own pace. The computer waits until he is ready, stimulating positive emotions as David increasingly masters *ORFI* by himself.

According to the assistant, Wendy is normally to shy to use her voice, but already after a few minutes in *Wave*, she is laughing. She records and repeats phrases like “Taco” and “Pizza” that she learns in school but seldom dares to say. The positive atmosphere and the dynamic changeable sounds make her and her assistant relax and enjoy the situation. They develop and negotiate structures for social play just by interacting and fooling around with the voice (Wendy) and the two pitching arms (assistant). The musical effects *recast* [27, 4:358] and give words like “Taco” and “Pizza” new and funny meanings. The musical effects establish an arena [29] and a positive context,

away from training and school, where the children can explore new roles and re-define their relationship.

4.3.2 Many Possibilities

Being in a constant flow of musical sounds in both *ORFI* and *Wave* the persons interacting are offered many possibilities and structures for actions at once [6]. An experience from the user observations is that it is neither enough to offer isolated sound events in a sequence to listen to, nor to offer direct response to interactions only. It is neither enough to offer music creation only, nor to engage in social play or relaxation only. When David interacts in *ORFI* and decides for himself, he goes back and forth between listening and feeling vibrations, while making his own vocal sounds. He shifts roles from being a passive consumer to a creative person. These many possibilities take him from being on his own to be part of a group. What is most important, it takes him from being “the patient” among staff, to a person with resources. A person contributing to the group’s musicking [26] with his own voice, that he didn’t think he had at all. That experience makes him less isolated and motivates him to master *ORFI* and be more socially active.

David also experiences difficult emotional and physical boundaries as he realises that he has the possibility to record and listen to his own voice in *ORFI*. He starts to think about how to integrate vocal abilities into his everyday life. At first, though, he doesn’t manage to create sounds with his untrained voice. The difficulties don’t lower his enthusiasm, but challenge him to practice his voice. Meanwhile *ORFI* creates expectations as David listens to and plays with other people’s voices. As he explores the way *ORFI* manipulates the sound with synthesis, adding pitch, echo and harmonic effects, *ORFI* recasts the voice [27, 4:358]. It makes David view the voice in a new context, giving the voice new, funny roles. It shows David new and possible worlds, *empowering* and *strengthening* him in his efforts to make sounds and music.

Wendy’s discovery of the creature-like *Wave* with glowing microphones and cross-media vibrations makes her face up to her shyness in a safe environment. Playing and making fun of her own voice makes her identify her boundaries, release blockages and strengthen her self-expression [4:358, 27, 2].

4.3.3 Design Composite, Distribute in Space, Time

From a designer’s perspective, in order for David to be able to interact as freely in *ORFI* as he does, the design needs to offer several processes in parallel. It needs to be able to record, analyse the voice and tangible interactions, modulate the voice, loop and place the recording in one of the cushions, at once. It needs to be able to combine and playback many voices in real-time so that the result is musically satisfying rhythmically, harmonically and melodically at once, with changes over time, following users’ shifting roles and actions.

The design in *Wave* needs to record the voice, analyse the voice and place it in a list for the person using the arms with accelerometers to chose from. For the cross-media relations to work properly *Wave* needs to translate user actions into melodies, rhythms and glowing light and further in to vibrations in the smart textiles. It needs to distribute the lighting, sound and vibrations spatially to different parts of the physical form and its 7 arms.

Wave needs to be able to make composites of *synthesis*, recorded *samples* and real-time *streaming voice* in order to give sound feedback that is musically and tangible satisfying for our target group. A satisfying synthesis component that can change *dynamically*, recorded music sample-components from a *culturally well-known* music genre, and a *personal* real-time voice component.

CONCLUSIONS

Computer-based and interactive music technologies known to the *NIME* community [8, 11, 15, 18, 19, 20, 21, 31] offer unique possibilities to work with the voice for health and wellbeing in *everyday situations*. It should be seen as a complement to what is already possible within voice for non-computer-based, traditional *Music Therapy*, and *Music and Health* research for wellbeing.

Computer-based media offer, not only multimodal and direct sensory response, but also *shifts* [13, 7] between tangible and musical-vocal media qualities that change with *distribution* in *space*, over *time* and with the *roles* an interacting person can take in relation to the media. We have called this design quality *cross-media*, because users can create sounds that develop over time and because the media create *expectations* and motivate the users to interact. In this sense, vocal and tangible interaction offers *structures for actions*. These are structures offered by the cross-media vibrations, musical melody, rhythm, harmony, light and colours, for collaborative actions. For example, when one person’s singing is translated to tangible vibrations felt by another person in a different part of the room. And as the media change spatially, they also shift role. From being instruments and tools, always answering with direct response, they expand [8]. Media expand and shift from instrument into actor, co-player, inviting the users to interact and direct their attention elsewhere and towards other persons. It is not merely the music that has changed role, as is the case when harmonic chords and style are *recast* [27, 4:358]. No, it is much more powerful. As the users David and Wendy interact they also *shift roles*, from being *passive* to physically, musically and socially *active*, with focus on music creation and collaboration. As the users in this sense shift roles, the use of voice, creating melodies, rhythms and harmonizing, *empower* them to connect with their bodies through cross-media tangible, vibrations.

They use vocal techniques to ground and strengthen the self. Vocal techniques like singing, toning and making melodic and repeated sounds from within their bodies. Listening and touching materials that vibrate from speakers, seems to create a safe and positive atmosphere that empowers them. Making sounds and movements, therefore empower them to explore *positive* emotions, and also to identify difficult *boundaries* and release emotional *blockages* and tension. It therefore empowers them to integrate emotions and body.

They recognize the computer-based vocal and tangible media as *actors*, which are independent from themselves and other people they know. The computer-based actors are different from human caregivers, family and friends, as they can wait as long as it takes, without interfering or hurrying the user. The computer also remember the users’ interactions, learn, and change the sound synthesis algorithms accordingly over time, still being consistent with the actors’ musical and social characters. The media therefore motivate the users to develop independent relations to things and other people, reducing passivity and isolation and strengthening health.

5. ACKNOWLEDGEMENTS

Without Fredrik Olofsson’s unique artistic and technological competence in development of music, hardware and software, *ORFI* and *Wave* would not have been possible to create.

We thank the Research Council of Norway and the VERDIKT programme for their financial support of the RHYME project. We thank Haug School and Resource Centre in Bærum in Norway, and Korallen and Lagunen at Rosenlund Hospital in Stockholm in Sweden.

We thank members of the Nordic Research Network for Sound Studies, Norsound, writing workshop for late comments. Norsound is funded by the Nordic Research Council.

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