Mobile Probes for Special Needs

Cumhur Erkut
Institute of Inclusive Science and Solutions
University of Eastern Finland
Cumhur.Erkut@uef.fi
(July'13 onwards: Medialogy, Aalborg University Copenhagen, Denmark, cer@create.aau.dk)

ABSTRACT
At our institute we currently run several projects in a Technology-enhanced Learning Environment (TEL) with and for the children with special needs. Families participate as experts in the development and evaluation process by sharing feedback and user experiences with the design team. Also children give constant feedback on the technologies and the working model. The full description, activities, and outcomes of this process are reported elsewhere. Recurring themes in this process are the need for sound and music applications, and that some children refuse to use the technologies under development altogether. To investigate the issues further, we propose simple interactive applications that run on smartphones and tablets as technological mobile probes. Our probes are collections of mini-applications to inform our subsequent design and evaluation, and facilitate a dialog on sensory and motor issues otherwise hard to pronounce. Through them, we seek for individual strengths of children in game and play settings. We outline the process and outcomes of several sessions we have conducted. In the future, we are planning to place them into the homes and schools of our participants, by taking advantage of their mobility.

Author Keywords
Mobile Computing, Technology and mobile probes, Sonic Interaction Design, Sound and Music Computing, Designing for Special Needs.

ACM Classification Keywords
H.5.2. [Information interfaces and presentation]: Auditory (non-speech) feedback

INTRODUCTION

At our Institute of Inclusive Science and Solution (IISS, http://uef.fi/fi/iss), we currently run several projects in an Technology-enhanced Learning Environment (TEL), with and for the children with special needs. Our mission in one of the projects (ATE, http://honkalampisaatio.luovanet.fi/evtech_in_english) is to design, develop, and research technologies for everyday use with the participating children and their families. The project runs technology clubs for 4-13 year old children diagnosed, e.g., with the autism spectrum disorder (ASD), or attention-deficit/hyperactivity disorder (ADHD). The families attend to the club meetings weekly (1 hour 15 minutes/club). In the meetings children and their families work jointly with researchers in several technology settings according to child's choice.

At our clubs, children use interactive technologies, such as touchscreen-based story-telling or drawing/painting applications, robot-building and steering, and simplified console games with novel interfaces such as Microsoft Kinect. Families participate as experts in the development and evaluation process, by sharing feedback and user experiences with group leaders. Also children give constant feedback on the technologies and the working model. The full description, activities, and outcomes of our project are reported elsewhere; [1] provides a short description of a related activity.

One recurring theme in the evaluation is the desire for encouraging creative expressivity, by means of multimodal interactive technology. Especially, parents ask us to develop sound and music applications, or extend the existing applications with sonic interactions [2]. This wish is based on the affinity of the children with music, their creative musical potential, the structure and guidance provided by the music with patterning, repetition, and anticipation [3], or in general, due to the calming effect of music. There are other projects aiming at musical participation and creativity, see for example http://www.museproject.co.uk or http://resonaari.fi/?sid=156.

This paper describes our starting points towards extending interactive applications with non-speech sound, and deploying them on mobile platforms for special needs. In this ongoing work, when we took the first steps to understand and explore our design space, we have faced theoretical, methodological, practical, and participatory challenges. We argue that (mobile) probes can be a good method for a deeper understanding of challenges in designing for special needs. In addition, they facilitate communication between all stakeholders involved in the process, and construct a shared, situated understanding of mobile technologies in use. This is especially important for sensory-motor issues, which are taken for granted in mainstream interaction design. Our mobile probes for special needs are based on fully-functional interactive applications developed by an expert team from UK, and released as open-source code under a simplified BSD-license (https://github.com/HellicarAndLewis/MulticolouredMagic). They readily provide useful, inspiring observations and data, but we aim for larger coverage from homes and schools.

The structure of this contribution is as follows. We first provide a background on mainstream sensorimotor interaction, together with the assertions it imposes. We explain how these assertions provide challenges for us, and indicate our starting points in tackling them. We then revisit

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sensorimotor interaction, by considering the motor abilities of ASD children. Next, we explain how we use probes to explore theses abilities, with a longer term goal of obtaining the sensory and motor profiles of our participants. Our discussion includes the procedure that presents our observations and probing examples. We conclude by highlighting the potential of the probes to supply important information for design choices, and indicate our future work in video analysis and integrating the probes further to participants' lives.

BACKGROUND

Sensorimotor Interaction

Starting with the observation that only a small fraction of the HCI research survives up to deployment, the need of models, methods, and tools that go beyond "point designs" is identified early in [4]. In the pursuit of designing the interaction rather than interfaces, two levels of analyzing and designing interaction are proposed: *interaction paradigms* that offer a high-level description of the interaction, and *interaction models* that are more specific, operational guidelines how interaction unfolds in time and space. An interaction model in [4] considers *sensorimotor phenomenon*: the user acts on the system, which generates output perceived by the user, and in our understanding, further guides to user towards the desired state of the world. The human sensory-motor capabilities are considered constant *across users* and *over time*, justified by empirical laws such as Fitt's or Hick's law [4].

These assertions are very strong, and if we consider children, especially those with special needs due to autism spectrum disorder (ASD), attention-deficit/hyperactivity disorder (ADHD), developmental coordination disorder (DCD), or childhood anxiety disorder, they are ungrounded. A recurring characteristic in these disorders is the difficulty in processing individual sensory modalities, or their integration into higher level capabilities, such as sensory-motor skills.

There is a tremendous variation of abilities *across* these children, in comparison to typically-developing children, within development disorders (e.g., ASD vs ADHD), or even within a same group (Asperger's vs. low-functioning autism). Moreover, motor learning can improve the sensory-motor skills [5], while aging-related diseases, such as Parkinson's may impair them, *over time*. Finally, sensory-motor capabilities require correct interpretation and integration of sensory signals. While the visual, auditory, tactile and proprioceptive processing are intact or even enhanced in ASD, evidence suggests that impairments arise at the level of interpretation and integration of these signals, effecting efficient motor planning [5]. In particular, the *hypersensitivity* and an *enhanced ability to detect detail in a stimulus* are combined with difficulties in *integrating sensory information* into a coherent whole in ASD individuals.

If the fundamental models of interaction does not hold for a target group, where do we start with sonic interaction design (SID)? The main rationale of SID is formulated in [6] as "to create a *multimodal* interface that engages users in active manipulation". The design provides users with auditory feedback that is *complex enough* to *discover new patterns*, and *intuitive enough* to successfully modulate their actions and gestures. While the importance of the sonic interactions to affect the user's emotions is acknowledged [6], relations between sound and action are very complicated in children with special needs.

Real-world Challenges

When we took the first steps to understand and explore our design space, we observed that some children reject interactive artifacts altogether, especially (but not exclusively) when sound is involved. They exhibit strong psycho-emotional responses, such as closing their ears with their hands, repetitive vocalizations and gestures, and other observable signs of stress, sometimes at the edge of an sensory/emotional meltdown. Such *sensory issues* have been also reported in other studies. For instance, in [1] two children express dislike and negative feelings towards kinetic interaction (probably because of the lack of tactile feedback), in [7] a child touches the tablets only after a long period of time, and several children in [8] avoid using the developed mobile application altogether because of the audio-tactile feedback provided.

A closer look into interaction design while being mindful about sensory issues brought about other challenges:

1. the sensory-motor sensitivities and strengths of the children in our club were not assessed. We have learned that they are not a part of diagnosis, nor subsequent procedure in Finland, despite a large battery of standardized and non-standardized methods for assessment (see e.g., [5] [9], and also [10]).
2. the collected accounts and reported experience of use, both in the literature and in our own studies, (e.g., [1]) were not straightforward to translate to design inquiries especially for non-visual modalities,
3. as stated above, there was a need in our club to implement multimodal interactions on different platforms (touch-screens, near-field proximal interactions with sensors such as Leap Motion, and far-field proximal interactions with Kinect, in addition to smart phones and tablets), requiring a large developer team with varying familiarity to multimodal interaction,
4. other stakeholders (i.e., children, families, teachers, experts in special education or human-computer interaction (HCI)) needed to be informed about the design and development effort, notwithstanding the interdisciplinary challenges of developing interactive technologies for special-need children [11].

Starting Points

We have initially adapted a structured design and evaluation model, reported in [12] to the special needs and strengths of the children in our club. Our approach is based on an accessibility model [13], which recently has been introduced as a reflection tool in design education [14].

We have chosen a model-based design and evaluation procedure for clear communication with the rest of the action research team and other stakeholders. With our adaptation, the model, like the pyramid of learning used by occupational therapists, assumes that highest level goals of learning and creativity can only be attained constructively when all the layers leading towards them (i.e., sensory, sensorimotor, perceptual motor, and cognitive development) are individually supported by proper interactive technologies.

We have aimed at several deployment platforms, by facilitating available sensors and displays (visual and auditory) in each platform. The platforms and associated input devices (sensors), in order of the proximity of the interaction are: 1) smartphones and tablets (microphone, accelerometer, camera, multitouch), 2) touchscreen desktop computers (microphone, camera, multitouch), 3) close-proximity accurate 10-finger hand-tracking (by means of LeapMotion sensor) and 4) full-body natural interaction (by means of Microsoft Kinect Sensor). Here, we concentrate on mobile devices, i.e., smartphones and tablets.

Our process started with reflection on interaction constraints due to possible misalignment of human sensory modalities and computational modalities, as in the original model, however by taking the sensory issues into account. We have first considered the inquiry of the Kinect-based game reported in [1] for the next design iteration. Soon it became clear that reflecting upon each sensory mode individually left some observations unaccounted for. Therefore we have focused on the next level of interaction constraints based on the computationally-inspired sensorimotor model reported in [5]. This model is depicted on Fig. 1, and has been the primary inspiration in our probes in sketching sonic interactions with *action-sound relationships* [15],[16].

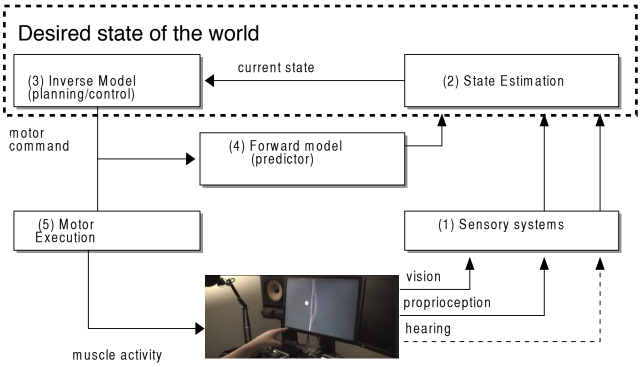

Figure 1. Stages of sensorimotor interaction, after [5]**.**

Motor Abilities in Autism

Gowen and colleagues [5], after reviewing the literature on each part of the model in Figure 1 conclude that altered sensory input and variability in motor execution, together with deficits in organizing motor knowledge may play an important role in the motor abilities of autistic people. They warn us that this model does not include the process of motor learning, hierarchical organization of complex movements, and dedicated motor processing in the brain involving e.g., mirror neurons [5]. Nor they provide an account how the sensory input is tied to strong emotional responses or meltdowns.

On a more elementary level, however, they present profound evidence on the functioning of model components, indicating (with reference to the numbers in Fig. 1):

1. Low-level sensory processing of input (visual, tactile, and proprioceptive) seems to be (at least) the same with neurotypicals, while higher order visual processing (e.g., motion detection) that requires interpretation or integration, is different. Additional studies are required to test whether this suggestion holds for the other senses.
2. Integration of different senses is abnormal, which could lead to inaccuracies in state estimation.
3. Motor planning appears more challenging for ASD individuals, with difficulties in organizing motor knowledge and longer reaction times when planning movements. Thus, movement kinematics could be planned appropriately but more slowly and actions may not be chained together.
4. predictive ability is perhaps not a key element of impaired autistic motor control, although evidence for the integrity of feed-forward control is mixed,
5. Consistent findings of dysmetric and more variable movements suggest that increased noise and/or mistimed muscular forces may hamper movement execution.

A key observation in the review is that autistic participants are able to adapt their motor system and benefit from repeated practice of movement sequences. Perhaps with more experience and practice, ASD individuals could overcome some of the detrimental effects of the model components.

In search of the best way of facilitating this experience and motivating the practice, we have came across the design thinking of Dr. Wendy Keay-Bright [17], [18], and related applications and the code-base developed by her in collaboration with the creative coding community, in particular with the creative duo Hellicar & Lewis. Next, we introduce these series of interactive applications for ASD children, released as open-source code under a simplified BSD-license[1], and the rationale behind using them as probes.

MOBILE SENSORIMOTOR PROBES

Rationale: Research Through Design (RTD)

RTD starts with research questions and aims to results on communicable knowledge. We have already stated our research questions in the previous section, the knowledge we are after is multiple-fold: understanding the sensorimotor abilities of our participants with contextual checklists, communicating their profiles with all stakeholders both structurally and as lived experience, and extend the probes with action-sound relationships [15],[16] considering the abilities, strengths, and preferences of our participants. The probes therefore add to the design knowledge on developing interactive applications for special-needs, through a process where both the design and evaluation are important. Mobile applications readily afford similar design inquiries, for instance as reported with *mobile probes* [19][20].

Probes in HCI and Interaction Design

Starting with the cultural probes [21], probing became an important design tool for co-creation in HCI [22], especially when the designers are culturally or geographically distant to the target populations, and cannot understand their world clearly.

A recent review [23] shows how the use of probes has evolved in time, and captures the most important properties of probing as 1) keeping the design at the heart of probes, 2) thematic openness and boundedness, to provide space for reflection, and 3) completability

Mobile probes especially aim for contextual data of use in the wild, [19], and have also been used in sonic interaction design [20]. More recently, the current foci in mobile user

1 https://github.com/HellicarAndLewis/MulticolouredMagic

experience on the portable device and moments of experience has been criticized, and the scope of the field has been extended by a fabric-based probe [24].

As far as special needs of the ASD population have been concerned, Larsen and Hedvall [25] found that fully-functional, simple interactive artifacts are probably the only way to explore co-creation with all stakeholders. Especially when combined with the video clips of children interacting with exploratory probes, they have offered non-speaking children a possibility to affect design ideas through their actions. Similarly, minimal interactive code that was developed in previous creative coding projects have been refined in Reactickles projects [17], [18].

ReacTickles Magic

ReacTickles Magic is a suite of applications that use touch, gesture and audio input to encourage interactive communication (http://reactickles.org). They motivate users to playfully explore the magical possibilities of the system without prior knowledge or skill with technology. The variety of input modes reward any action with a dynamic array of animated shapes and patterns, and provide benefits of relaxation and learning about cause and effect. The suite has been adopted by healthcare professionals, teachers, and parents worldwide, and it runs on almost every platform we are interested in (c.f., Challenge 3).

The individual applications are mostly named after action-verbs (Expand, Flip, Find, etc) and are therefore suitable for sound design via action-sound relationships [15],[16]. They are accessible from a main menu that contains minimal abstract icons. Each application provides an excellent visual figure-ground separation, and several modes that can be selected by holding a touch-button for three seconds. The minimal and abstract design language is consistent across the applications. The colors of the Reactickles and the brightness of the suite are fully customizable.

Somantics

Somantics is another suite of applications that use touch, gesture and camera input to encourage self-expression and communication (http://somantics.org). They promote users to playfully explore the magical possibilities of the system without prior knowledge or skill with technology.

Interaction with Somantics is repetitious, flowing and highly expressive. The applications are non-competitive; users discover their own purpose. The Somantics interface enables users choose an application and to explore with little, if any, assistance from others. Independence will increase through further exploration of the system.

The individual applications hint mostly what can be constructed/acted with them (Tunnel, Corridors, Painter, etc). Like Reactickles, the applications are accessible from a main menu that contains minimal abstract icons. In most of the icons, the hands are clearly visible, except two which abstract, colorful polygons with dots at the edges. Therefore all icons hint multi-touch or dedicated hand movements. In sonic interaction design, besides action-sound, they applications afford also audio post-processing (reverberation in the tunnel or corridor, etc).

Some applications present the clear visual figure-ground separation as in Reactickles (Paths, Corridors, etc), while some display camera output as interactive canvas. The minimal and abstract design language is consistent across the applications, and mostly also with Reacktickles. The modes of Reactickles are taken away from Somantics, but navigation holding a touch-button for three seconds is kept.

Other Potential Probes

Multicoloured Magic hub has recently initiated several projects. Some of them aim at musical expression, facilitate advanced features of Kinect APIs such as skeleton tracking, and are deployable to mobile platforms. These projects could also be used as probes, however they are not reported here, since they are work-in-progress and not yet widely disseminated. Interested readers are encouraged to visit the source-code hub[1], try them out, and contribute to their development.

PROCEDURE

Preliminary Tests with Typically-developing Children

Reackticles Magic and Somantics were downloaded as tablet and desktop applications in March 2013. First, the tablet applications were tested by the author, and two typically developing children (ages 4 and 8) in informal household settings. Children were familiar with multi-touch through other interactive applications and simple games on the tablet. They were introduced to the navigation and selection of applications, and encouraged to explore the individual applications by themselves under the observation of the author, and share their experiences both verbally (as a measure of joint attention and communication), and non-verbally (SID inspiration in vocal sketching [26]).

No other information was provided about what the applications do or how to use them. However, when they asked the names of the applications, Finnish translations (the native language of the children) were provided. They referred to some applications with own interpretations (*Fairies* instead of *Sparkles*, for instance). The audio input of Reactickles and multi-user scenarios of both applications were demonstrated to the children when they were using the applications, since they could not discover the sonic and multi-user interaction by themselves.

The children exhibited great enthusiasm, fun and joint-attention during (and after) the use. When they discovered a novel way of manipulating content, or thought they have created something interesting, they have shared it immediately with each other, and with the adults around, including the author. The sessions were time-restricted (30 mins); both children continuously asked more. They have spent most of their time with camera-based applications of Somantics, but explored all applications in several sessions. The desktop and Kinect versions of the applications were also explored with them, but they will be not reported here.

Somantics Sessions with ADHD Children

Encouraged by the observations in the preliminary sessions, the Somantics suite was included in a regular club session in late March. Like all the other activities in the club, the Somantics suite was presented with a card, containing the screenshot of the welcome screen and the name of the application. Three children, all male, diagnosed with varying degrees of ADHD, participated to the club session. Two of them were accompanied by their mothers, and the third by his father. All children have chosen Somantics as one of the three activities to explore in the session. They have justified their choice by saying that it was new. Two children wanted to try out Somantics as the first activity in the club; they have negotiated the order and settled in an agreement.

The child-parent groups were guided to the activity corner (a small table with two chairs around and the tablet supported by its smart cover in the landscape orientation on top of the table). As in the preliminary trials, the groups were instructed on the basics of the navigation, and the parents took over the translation of the application names to Finnish. The author was observing the group while being attentive to possible vocalizations [26], taking notes, and comparing his observations with the sensory profile checklist [10] at hand. All sessions were videotaped.

Observations during the first session

All children preferred the camera-based applications over more abstract presentations. The *Kaleidoscope* application, which parcels the display to two or more identical versions of the camera output, was their favorite. They have discovered how to change the number of the parcels by touch control, and experimented with different tessellations. Pushed their chairs aside, the children moved back and forth in the vicinity of the tablet, coordinating their body position according the visual feedback on the display. All of them explored the disappearance, symmetry, deformations with planned action by using either the whole body at the distance, or by their face and hands around the tablet. Making funny faces was a favorite activity, and so was inviting the parents into the field of vision. Sometimes, they left the field to their parents, and observed their action. Other camera-based applications facilitated whole-body interactions with planned coordination similarly.

The multi-touch interaction was not immediately discovered: the children have started with one finger, which did not result on any observable effect in some multitouch applications (e.g., *Tunnel*). After several trials, they gave up and have chosen a camera-based application. When they have selected another multi-touch application later on, the author promoted multi-touch, and invited the parents to play along. Then the interaction became meaningful for the participants, and they have explored multi-touch in playful manner. This was somewhat surprising, since they were familiar with the touch-screen displays within the club. However, it was their first use of a tablet (in the club), and maybe they did not think that multi-touch interaction would transfer between the platforms.

All the colors were initially enabled in the platform. When brown objects appeared, one of the children constantly pronounced a WC-word. After observing the discomfort of his parent, the author suggested to child that he can pick up his favorite color from the settings and showed how to do that. While brown was among the choices, the boy choose a different color, and when all the objects appeared consistently and predictably in the color of his choice, he did not mention the WC-word anymore.

Overall, the sessions took about twice as long as the planned duration of ten minutes. Besides this prolonged attention, the signs of positive experience in use [1], including coordinated, skillful, and creative sensorimotor interaction, communication with parents, challenge taking, and performance orientation were all observed, both by the author and the parents. In addition, laughters and fun have accompanied the session. Finally, the children did not need physical, verbal or motivational support for the activities [1]. All the children evaluated the activity in positive terms in video recordings right after the session.

Observations after the first session

The parents enjoyed the fun and communication with their children while using Somantics. A father felt that Somantics have facilitated these positive behaviors, as well as focus and attention much better than the console games they play at home. All of the parents have asked how to try the Somantics suite at home; pointers (also for Reactickles) were provided. This was timely, because the families received the tablets provided by the club for home use after the same session. Unfortunately Somantics and Reacktickles are not compatible with the Windows 8 OS of the tablets distributed by the club, and we could not solve the problems until now. Therefore the home use of the suits will be only on desktop platforms.

Returning to the session, the only problem that the parents pointed out was related to our setup: the tablet supported only by the smart cover was not stable enough, falling often and causing a loud noise on the table. This was considered to have negative impact on the interaction and use experience. The second session, two weeks after the first session, was already planned on a large desktop touch screen to experiment with proximity and interaction zones, which solved this problem, too.

Despite being desktop-oriented, we briefly report shortly on the second session here, because it has important implications on the information acquired by our probes, as well on the interaction styles and attributes across platforms.

The second session

Two of the children from the first session preferred the Somantics suite also in the second session. They were somewhat surprised that the tablet was replaced with a touch screen initially, but quickly have adapted to the new situation. However, both children and parents found the touch-based interaction less smooth compared to the tablet. In addition, the children exhibited frustration when problems appeared during navigation and multi-touch interaction.

At that moments, the author intervened, and instructed the children about two aspects of this new platform: 1) moving their fingers slightly back-and-forth during the contact with the touch screen would improve the interaction experience, and 2) most of the multi-touch applications would also work with camera (since the desktop versions use OpenCV[2] and blob tracking).

The camera-based applications required more distance from the table, and also more space. It also prohibited the children from quickly changing the applications or reaching the setup screen. They have negotiated these operations with their parents.

In general, both camera-based hand tracking and the touch-screen input were less accurate compared to multi-touch tablet experience of the previous session. Children complained when exploring the touch-based applications on this new platform, and have spent most of their time with the camera-based applications. The pronounced emphasis of the movement has excited them, and they have developed quickly strategies for interesting outcomes, which has involved planning and coordination of movements. In this activity, the team noticed a difference in the strategies of one child, compared to the rest. In general,

[2] http://opencv.org/

finding the right spot, timing, balance, and coordination seemed of different quality for that participant.

The parental evaluation session has revealed that this child was diagnosed with dyspraxia, which is a lifelong neurological condition beginning in childhood that can affect planning of movement and coordination. It is more common in boys compared to girls, and about half of dyspraxics have ADHD. Our participant has had speech, language, fine and gross motor impairments earlier, gained these abilities with the help of long-term occupational therapy. In his everyday activities, the marks of dyspraxia are invisible. Moreover, to the author's knowledge, our team was not aware of this condition, and there were no discussions about his development history, probably because the lack of the context.

Towards Reactickles Sessions with ASD Children

Somantics suite is now a part of the regular club activities, and every session is recorded on video. The verbal feedback we have received from typically-developing children and our high-functioning ADHD participants has encouraged us to offer the suite also to ASD participants, who are not verbal. In this activity, we expect similar probing results from the Reactickles, since they are better suited for mobile multi-touch or sonic interaction. Their action-verb names afford sonic interaction design by action-sound relationships [15][16], but only when their sensory and motor sensitivities of the ASD children are determined and accounted for accordingly. Moreover, non-speech vocalizations are an important part of their everyday behavior [10] and will be the basis of our sound design, in a similar way we use vocal sketching in SID [26].

Our procedure will be similar in essence to probing with Somantics, but there will slight differences: we will encourage longer exploratory club sessions with the ASD children, and go trough the sensory profile checklist with the parents while the children explore the applications. When we understand the sensory profile of each participant better, we will customize and extend the suit accordingly towards multimodal interaction.

We are currently considering both the home and school deployment, but our biggest expectation is from mobile use. Mobile applications may include analytics, however we need to determine this ethically-sensitive issue together with parents, teachers, and other stakeholders.

CONCLUSION AND FUTURE WORK

In this contribution, we have documented our ongoing work and desire of extending the mobile applications developed for special needs with sonic interaction, especially for and with the children diagnosed with ADHD and ASD. Because of their strong emotional response to sounds, the design issue is rather sensitive and not straightforward. For a long time, we have tried to address the design issues at the sensory level, but recently realized that sensorimotor level could be the right one to tackle the challenge. We have indicated how sensorimotor interaction models in their original formulation impose strong, and sometimes ungrounded assertions, when the abilities of our target group is considered.

At the moment, however, there are knowledge gaps in sensorimotor abilities of special-need children, and on how to design and evaluate interactive multimodal applications, given their abilities. These gaps are important for the theory and practice of sonic interaction design in providing children with special needs with auditory feedback that is complex enough to discover new patterns, and intuitive enough to successfully modulate their actions and gestures. By using open-source applications that were developed for and with a similar target group as ours, albeit by different developers, we probe both domains with the aim of bridging these gaps. The probes already supply useful information in this respect.

Our immediate future task is to prepare Reactickles as probes, and gather information of their use at homes or the schools of our participants. In the longer run, recruiting more researchers for probe development and evaluation by video analysis [1] is an important direction. During these activities, we believe that *reflection trough interaction constraints* [14] will be a fruitful method, but only if the sensory and motor abilities of our participants are incorporated in the constraint model. We also hope to appropriate and transfer vocal sketching [26] and co-design of action-sound relations [15] from product sound design [16] to SID for special needs. Finally, contribution to upstream development of Reactickles, Somantics, and other applications, especially in designing mobile and desktop sonic interactions by a designerly exchange and basic exploration [27] remains as an important research direction.

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