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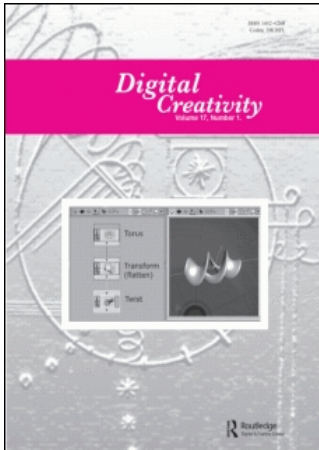
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Empowered interaction through creativity

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Abstract

This paper reflects upon a case study where exploration, play and empowerment in interactive therapy sessions with audio and visual stimuli resulted in achievement, self-esteem and a shared pride between a young adult with profound and multiple learning disabilities (PMLD), his mother and the special teacher that conducted the sessions. Following the gift to the mother of a video recording that depicted the young adult's progress as a result of the sessions it was found that upon viewing he was able to recognize himself and associate with his activities. Further, when watching alongside his mother, the recorded material became as a mediating reference for his communication. Conclusions consider contextual parallel activities from earlier research where digital paintings that were printed from screen shots of interactive sessions and recorded auditory achievements were presented to helpers and family of similarly severe disabled users.

Keywords: concentration, curiosity, novelty, self-expression, therapy

1 Introduction

The study included in this paper is based at a special school in Landskrona, Sweden, where eighteen students between the ages of 8–55 years attend a single session of interactive audiovisual stimulus therapy every week. The duration of a session is mostly between 1–45 minutes in length depending of the individual. The students have a variety of diagnoses and all are severely disabled with mental retardation. All sessions are filmed on video and edited for the purpose of monitoring progress. All students are given a copy of edited sessions from the year to reinforce the experience and to show to their families and other people figuring in their lives. The work has evolved from that reported earlier as a result of three European research projects. In the first, titled *CARESS* (Ellis 2004) solely sonic elements (music scale tones) were used as the feedback stimulus in response to

- 1 sensors that were attached to the body and/or
- 2 movement within a linear ultrasound sensor that is commonly used in the field of disability called *Soundbeam*.

The second research project was a feasibility study funded as a future probe by the European Network for Intelligent Information Interfaces titled *Twi-aysi* (Brooks et al. 2002), acronym for *The world is as you see it*. This feasibility study was an extrapolation from the ongoing evolving body of research titled *SoundScapes* (Brooks 1999; 2002; 2004; 2006) where 3D non-invasive sensor technologies were developed to empowered adults and children with severe disabilities to

control audiovisual feedback from intuitive and natural gesture as a means for treatment and analysis. The third research project segued directly to the feasibility study and was called *CAREHERE* (Creating Aesthetically Resonant Environments for the Handicapped, Elderly and REhabilitation) and reported in Brooks & Hasselblad (2004). *CAREHERE* was funded as a European Project under Framework V IST (Information Society Technologies) Key Action 1, supporting the programme for ‘Applications relating to persons with special needs including the disabled and elderly’. Multimodal stimuli feedback including the forms reported in this paper were used in *CAREHERE*.

Multimodal stimuli interaction involves a (student input) feed-forward action to system multimedia feedback response (student stimulus), which evolves as an iterative loop that empowers an intuitive engagement with the interactive environment that is confronted by the student. The selected feedback is idiosyncratic and reflects knowledge gained from participatory input from those closest to the students, e.g. family, helpers or therapists. Mostly the tailored content is targeted as giving fun, playful and/or creative experiences to the student. This can be in the form of concrete feedback such as specific interactive digital games that address the competence level of the student and where the student views his or her input results on a large screen that is positioned directly in front for targeting immediate associations—or it can also be abstract composing with sounds or visual feedback such as painting, colouring or a combination of the choices available. The main thing being that the personal profile that is initially created is evolving according to input device and output content feedback selection so as to optimise the student engagement in a fun and joyful manner.

This is referred to as ‘ludic engagement’ (Brooks 2006; Petersson 2006) and is optimally created through non-invasive interface

technology, i.e. non-worn sensors that are capable of sourcing bio-signals; which in this particular case study focuses upon movements and utterances. Such a loop enables the student opportunities in which he can play and express himself through a safe and challenging environment. In the environment there are no inherent expectations of the student and no rules to obey in how to act—besides the damaging of microphones through overly zealous engagement as in the case study herein reported!

The created interactive environments and the experiences generated for the student offer an ideal situation from where to collect data of the effect on the user (input/output) with minimal corruption through his or her research bias. Video recordings enable post-session analysis and inter-coder annotations to be made so as to further refine the system and inherent selections in an iterative manner. The resulting activities of the student when confronted by the interactive environment have led to the hypotheses that are the foundation of the ‘SoundScapes’ body of work. In this article specific game content is not involved.

Since most of the students do not have the physiological means to express their wishes, preferences and desires, the interactive environment becomes a tool for communication, wherefrom the therapist or facilitator is engaged to interpret what he or she understands as potentially being the student’s current thoughts, concerns and desires. This defining of the meaningful communication is sourced from the student’s non-verbal body language, nuances of gesture and the ability of the therapist or facilitator to ‘feel’ through the tacit knowledge that is gained from experiencing and sharing the interactions with the student. As the system is affective to the student’s expressions, the designation of the specific “moments of communication” by the therapist or facilitator is imperative to the student gaining optimal experience, and hence training potential benefit from the concept.

This optimal scenario is encountered when the challenges that are embodied in the interaction with the environment confronted by the student matches a competence that is garnered from the created and evolving personal profile.

In other words, the play aspect within the interactive environment offers opportunities for the student to communicate through self-expression and to approach a state of flow (Csikszentmihalyi 1991; 1996). Additionally, the adaptive features of the environment provide appropriate opportunities for the student to achieve mastery and enhance communication.

In this paper, the play is considered as social, where the adult (therapist/facilitator) is of decisive importance for the development of the play (Bateson 1976; Vygotsky 1978; Olofsson 1987). In line with the activity theory (e.g. Vygotsky 1978; Leontjev 1982) we consider communication as a part of the play. This is in contrast with the communication theorists (e.g. Bateson 1976; Olofsson 1987), who primarily look at the play as communication. In line with Lisina (1989) we consider this view as limited as the play also, beside the communication, contains a content, human and social functions, which are communicated through the play and, accordingly, have to be considered. Thus the overall aim of this paper is to illustrate how adaptive interactive environments, which can be tailored to match a user, can stimulate and empower play and communication through self-expression. More precisely, the aim is to take the student's experiences within the interactive environment and the parent's descriptions of the student's progress as starting points to interpret how the student understood the content of the play and the communication and the interaction embodied within the play.

In line with Petersson and Bengtsson (2004) we regard empowerment as a dynamic concept that concerns individuals' possibilities and resources associated with growth and development in everyday interactions. By this,

we take on a holistic and process-directed view on empowerment (in contrast to considering empowerment as a mental state), where the play in the interactive environment serves as a means to enhance the individual's communication through the feed-forward, feed-back loop (self-expression). At a philosophical level, this view enables experiences with an outcome of a more positive self-perception and belief in one's own ability and capacity (Petersson and Bengtsson 2004).

2 Method

The aim of this research is descriptive and centered on achieving an understanding of how interactive environments can stimulate and empower play and communication through self-expression. The decision was taken that this aim was best achieved by qualitative research methods. A case study using observation was conducted with one child with multiple disabilities who was interacting with digital technology as an assistive means to empower his interaction in a responsive environment. Additionally, documentation in the form of an unsolicited letter from the mother of the student and open-structured interviews are referenced in the case study. In this way it was hypothesized to be able to define characteristics of play and communication in interactive environment for use in therapy.

2.1 Description of Rasmus

Rasmus is 16 years-of-age and has an estimated intellectual age of 2½ years. According to the neuropsychiatric judgement, Rasmus has an extreme motorical impulse driven over activity, profound mental retardation, Angelman's and Pader Willy's syndrome and epilepsy. He needs constant supervision both in the outside and inside environment. He has severe concentration problems and is very difficult to handle in conflict situations because of his strength and size. He pinches, spits, kicks and bites both himself and others

and is very demanding to work with. Waiting, social interaction, obstinacy and sticking to rules are other areas where Rasmus could have problems. Most of the time he is in good spirits but he is very difficult to motivate and engage in any activities.

2.2 Material

Digital technological assistive means, as described above, are used to empower Rasmus to extend his own limits through interacting with multimedia. The multimedia is real-time corresponding auditory, visual and vibratory feedback that is manipulated as a direct result of feed-forward movement. To achieve the auditory feedback a number of devices were used. The main device used was the *Soundbeam*. This consists of a sensor head (Figure 1 shows two) and a control unit (Figure 2) that together empower the playing of music without any need for dexterity or strength. The sensor head emits an invisible linear ultrasonic signal to detect movement within a defined range. Detected movement results in a corresponding signal generation from the sensor's controller unit as *MIDI (Musical Instrument Digital Interface)* information, which in turn is routed to a sound module. The sound module contains synthesised digital algorithms that closely replicate known musical instruments. The sounds can be determined by a user profile that saves favourite selections and combinations. Presets in the *Soundbeam* controller enable blues or other scalar improvisations. Thus the ultrasonic beam acts as a non-intrusive interface within which interference and subsequent movement change activates a signal transform that subsequently results in an auditory representation of the movement that is direct and immediately available for associated correspondence by the student initiating the action. In the sessions with Rasmus a number of touch-sensitive switch controllers were also used as tactile stimuli and these were also routed to the *Soundbeam* controller to empower him to create further favourite sounds.



Figure 1. Two *Soundbeam* sensors on stands plus camera on tripod in front of the back projected Perspex screen. The table with tactile switches rests upon the vibroacoustic soundbox platform.



Figure 2. (left) *Soundbeam* control unit; (upper left) stereo sound module and stereo effect processing unit; (left middle) speaker protection unit for vibroacoustic soundbox (white) with wireless microphone upon it. All rest upon the main system stereo amplifier.

A microphone and a sound processor (Figure 2) were additionally used for collecting Rasmus' utterances and that empowered him to make fun noise effects from his own personal sounds.

The sounds that result from Rasmus' movement were routed to a vibration soundbox that contains an amplifier feeding a low frequency speaker array. The wooden box resonates to the sound and enabled Rasmus to 'feel' variations in pitch frequency that changed as a direct result to his movements.

The visual feedback attributes of the system were through a video camera sourcing movement data which was routed to a computer running a commonly used graphical programming software called *Eyesweb*. Specific algorithm patches that were developed as a result of a parallel research study were used (Brooks et al. 2002; Camurri et al. 2003; Brooks & Hasselblad 2004). The patches were called 'body paint' as they enable the user to be able to digitally paint from body and limb gesticulations where dynamic and range of movement directly correspond to colour change and saturation.

The body paint visual signal is generated from the computer and routed to a LCD projector that back-projects the image onto the rear of a large screen. This screen is constructed of the material *Altuglas Black 'n' White* (a form of *Perspex*) within a box frame profile made from aluminium. The frame is mounted onto supporting wheels for ease of mobility. The screen is positioned directly in front of the user so that the (approximate) one-to-one representation of the user can be directly associated (Figures 3–5). This concept relates to the use in institutes for people with physical disabilities of a traditional silver mirror in body proprioception (awareness) associative training by physiotherapists (Brooks 1999; 2002; 2006).



Figure 3. Rasmus sitting upon a chair on the vibroacoustic soundbox which enables him to feel the sounds he generates from his movement in the *Soundbeam* sensor whilst creating video and sound effects with head, hands and utterances.



Figure 4. Rasmus plays with video special effects which distort his face—his response is immediate joy.



Figure 5. Rasmus in serious concentration as he multi-tasks in playing upon the tactile trigger switches which creates sounds he can feel from the soundbox whilst painting through gesture dynamics.

2.3 Session procedure

Rasmus' first session was in September 2005 and lasted about 7 minutes. At first it was thought that Rasmus was a little afraid of the massive sounds and the vibrations. He also seemed afraid of seeing himself and the visual projections. It was considered that possibly he was not interested and could not concentrate on the activity. So for the next session the vibration box was taken away. However, Rasmus made it very clear that he wanted it back. He then exhibited much more interest and the session lasted for 15 minutes.

In three weeks the sessions progressed so that due to his elongated engagement a time limitation had to be set at 35 minutes as other students needed to have their session.

2.4 Data collection and analysis

Total observation timeline for the case study ranged circa 28 sessions over a period of one year, with a mean duration of 30 minutes per session.

In this study, a qualitative observation guide based on the exploratory aim of the study and a review of literature was used. Three topics guided the observation process:

- 1 the child's perception of the interactive environment;
- 2 specific interests; and
- 3 achievements.

All sessions were video taped. On a regularly basis the parent of the student was involved in the reviewing of the collected and edited video tape data. This approach is in line with related research where we have developed a methodology named 'participative involvement through recursive reflections' (Brooks and Petersson 2005b).

Video and observation annotation were central to the analysis. The transcribed observations were coded separately by one of the three authors and then checked for validity by the parent and the helper. The

data were analysed using an explorative, inductive method (Atkinson and Delamont, 2005).

Ethical considerations were made and the parent was approached about the study, informed of the goals, and was asked to give permission on behalf of the student beforehand.

3 Results

The results are based on the analysis of a case study including weekly therapy sessions using digital technology and the analysis of open-structured interviews with the parent of the student involved in the case study. The student's actions within the interactive environment were the basic unit of analysis. Our findings presented the fact that it was useful to apply an inclusive participative analysis (Brooks and Petersson 2005a) of the video material to understand critical emerging elements in the progress of the student's communication.

Two main themes emerged from the data that were related to the child's interaction with the digital technology. These themes were:

- 1 "My expressions cause funny effects" [section 3.1], and
- 2 "I need guidance—at least for a short while" [section 3.2].

The results pointed to motivational potentials in the form of novelty and curiosity from self-expression within an interactive environment. The choice of the digital devices was astute through their ability to generate variance of multimedia feedback that could be adaptively tailored to the individual over time.

The 'physicalness' of the units also seemed to offer a conduit that the student liked and which facilitated progress in his play and communication according to the therapist and to the parent.

3.1 My expressions cause funny effects

Through exploration Rasmus quickly exhibited a clear understanding of how all devices were to be operated. Often he discovered a special effect, e.g. a sound, and remained with that for a session. These findings led to Rasmus' subsequent experimentation with the multimedia feedback. We categorize this exploration and subsequent experimentation as evolving to a play experience.

Concentration, happiness and surprise were evident as he experimented with his movements, facial expressions, voice, rhythms and sign communication. On occasions he got up from his chair and started dancing. In other words, this exploration and experimentation took the form of a variation of responses from Rasmus. The feedback stimulated his curiosity, which reinforced his own input (feed-forward) and his curiosity.

Rasmus enjoyed experimenting with his voice in the microphone. He destroyed two microphones by putting them in his mouth so the activity was curtailed. Initially he showed surprise when experimenting with his expressions, but after a while he developed self-awareness and speech-ability skills based on the understanding of the cause and effect attributes of the interaction.

3.2 I need guidance—at least for a short while

During the year that Rasmus was attending the sessions there were only two occasions where he refused to participate. On these occasions he showed quite clearly that he was going to sit on the chair at the back of the session room where his helper would normally sit and that he would observe the teacher and the helper performing interactively with the system.

When he himself engaged in interaction with the system it was observed that regularly he would turn away from the screen in front of him so as to look back to his helper or the teacher for confirmation.

It was important for Rasmus to experience not only surprise, but also familiarity in the features of the environment. Here, the adult (teacher or helper) was bridging Rasmus' 'old' knowledge to the 'new', by confirming and challenging him—the means of bridging being dependent on each particular situation and often improvised through experience. Both the surprise and the familiarity awakened the curiosity to explore and to experiment. However, the surprise, more than the familiarity, had the power to attract Rasmus' attention. This showed that his exploration of the interactive environment was activated by the surprise, and initially dependent on the familiar aspects of the situation. Shortly after the surprise Rasmus was absorbed by the exploration and play, and the teacher could take a step back in the guidance of Rasmus.

4 Discussion

Key components that are required for play and communication became evident in his case study. Through cause and effect and the surprise feature of the interaction (based on Rasmus' input or feed-forward action) he could acquire new abilities, interactions, expressions and emotions, enabling a mastering of the exploration and practicing of skills. An observation of progression from unintentional to intentional was evident through the sessions especially where surprise from explorative actions resulted in playful intentional activity that resulted in achievement from doing.

4.1 Exploration—a form of motivation

The interactive therapy sessions indicated an enhancement of the quality of play and communication, which, in turn, facilitated explorations and experimentations that were utilized in the therapy. Berlyne (1950) refers to interactions such as reported in this case study as instrumental exploration, motivated and learned by the cause and effect, and surprise exploration awakened by pure and simple novelty. This is

to say that the instrumental and the surprise exploration achieved from the interactive environment have relations as forms of motivation due to the novelty (see also Berlyne 1950). However, these statements relate to problems that demand further investigation. What was shown though, was that the interactive environment had the potential to evoke the student's interest in expressing and practising otherwise limited skills. This interest was not just in the session but also on the session as reported by the mother's letter to the teacher. This in-action and on-action reflection relates to the design and educational theories of Donald Schön (e.g. 1983; 1991) and relates to the 'SoundScapes' concept as reported in Brooks (2006).

Vygotsky (1981) states that the play is the source to the child's development. When the child is playing, a potential development zone is created—the zone of proximal development (ZPD). The ZPD is defined as the distance between the actual level of development—which is determined through the child's own way of solving problems—and the potential level of development—which is defined through guidance of the adult (Vygotsky 1978). By facilitating Rasmus' optimal experience of the interactive play through the bridging of his old knowledge to the new, the teacher created a fit between the skill level of Rasmus and the challenge offered by the digital device/system. However, and as stated above, the guidance from the teacher was crucial in relation to the awakening of Rasmus' curiosity, which in turn was initially important in order to create familiarity. When the initial familiarity was established the surprise by novelty was the driving force for the exploration. In that way, the interactive play offered an experience where Rasmus was able to experience surprise, awareness, and growth.

5. Conclusions

In this case study the goal was to illustrate how interactive environments stimulate and empower play and communication through

self-expression. According to Rasmus' teacher, helper and mother he has gained better concentration, is more harmonious and exhibits an increased sense of happiness with an improvement in his well-being. Also his understanding of cause and effect has improved relative to the consequences of his actions. Rasmus is aware and happy when it is time for the session and is always eager to go to them. He also more readily accepts when his time is up for the session.

At a more general level, therapists and teachers working with such case studies as Rasmus have stated realisation at the potentials of empowering interaction through creativity. Through giving a success to children and adults with functional impairment an important self-worth is evident as they get an opportunity to show the achievements from their activities to those around them in their daily lives away from sessions. As a life quality this is important.

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Stefan Hasselblad has considerable experience working with children with special needs, especially in the use of *Soundbeam* technology for controlling the sound environment. His approach has always placed the child in a responsive environment that encourages active learning through self-motivated and creative exploration in a playful scenario. He teaches at the Special Needs School in Landskrona and has worked with the mentally and physically disabled for 34 years and as a special teacher for 30. He graduated as a special teacher to work with children with special needs after studying psychology and sociology at Lund University.

Eva Petersson, Aalborg University Esbjerg in Denmark, has developed theories on non-formal learning in relation to how toys and technologies can support playful activities motivated by curiosity and exploration rather than externally defined tasks. She considers systems designed to support playful values as open-ended and offering situations for people to appropriate, explore and interpret. Petersson's work includes methodological approaches which consider idiosyncratic appropriation, participatory involvement and action driven use. She has realised a number of interdisciplinary and international projects applied in play, learning and rehabilitation contexts, involving flexible methods of delivery for local, national and international users.

Tony Brooks is from Wales in Great Britain and attained his PhD at the University of Sunderland in England. He is known as a visionary contemporary artist that utilises digital technologies in human-centred interactive installations and performances. His work has been presented globally including the Olympic/Paralympics in Atlanta, USA 1996 and for the Millennium event of the Olympic/Paralympics in Sydney, Australia

in 2000. In Europe his art has toured leading Museums for Modern Art and he has been featured as director and performer in a number of European City of Culture celebrations. He has been awarded the European 'Eureka BAM' prize for applied multimedia design and application (1999) and the Danish 'Vanfonden Forskerprisen 2006'—both in respect of his 'SoundScapes' concept. He has over 40 peer-reviewed international publications and is on the editing board of a number of international journals. Brooks is the founder of the *ArtAbilitation* international conference.