Sensorer hjälper multihandikappade barn

I Landskrona får barn med multihandikapp hjälp att utveckla sin motorik och kroppsuppfattning med hjälp av sensorer. Det är ett treårigt projekt som finansieras av EU.

Lewis Brooks, Anthony (aka Tony)

Publication date:
2010

Document Version
Accepteret manuscript, peer-review version

Creating aesthetically resonant environments for the handicapped, elderly and rehabilitation: Sweden

A Lewis-Brooks[1] and S Hasselblad[2]

[1]Computer Science Department, Aalborg University Esbjerg,
Niels Bohrs vej 8, 6700 Esbjerg, DENMARK

[2]Special Needs Teacher, Emaljskolan,
Emaljgatan 1C, S-26143 Landskrona, SWEDEN

tonybrooks@cs.aue.auc.dk, stefan.hasselblad@mila.landskrona.se

[1]*www.aue.auc.dk,* [2]*www.emaljskolan.se, www.bris.ac.uk/carehere.htm*

ABSTRACT

This contribution expounds on our prior research, where interactive audiovisual content was shown to support Aesthetic Resonant Environments with (1) brain damaged children -extended here with the addition of (2) learning disabled, Parkinson's disease, and the aged. This paper appraises the experiments involved in preparing, developing and authenticating 'aesthetic resonance' within the Swedish partners' research (1 & 2). It reports on the inductive strategies leading to the development of the open architectural algorithms for motion detection, creative interaction and analysis, including the proactive libraries of interactive therapeutic exercise batteries based on multimedia manipulation in real-time.

1. INTRODUCTION

European Project IST-20001-32729, CAREHERE; *Creating Aesthetically Resonant Environments for the Handicapped, Elderly and Rehabilitation* was funded under Framework V IST Key Action 1 supporting the programme for 'Applications Relating to Persons with Special Needs Including the Disabled and Elderly.' It implicated a consortium of seven members from four countries. Following the project overview, this paper informs specifically on the investigation of the partners from Sweden who had responsibility for the 'user group programmes research' and the 'user forum network,' P3 and P7 respectively.

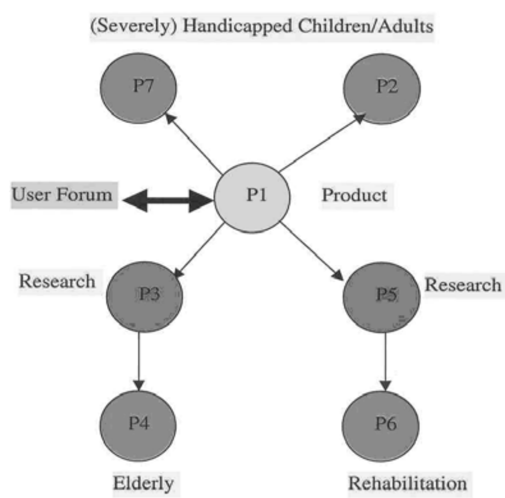

Figure 1. *The CAREHERE consortium with Swedish members P3 Lund & P7 Landskrona.*

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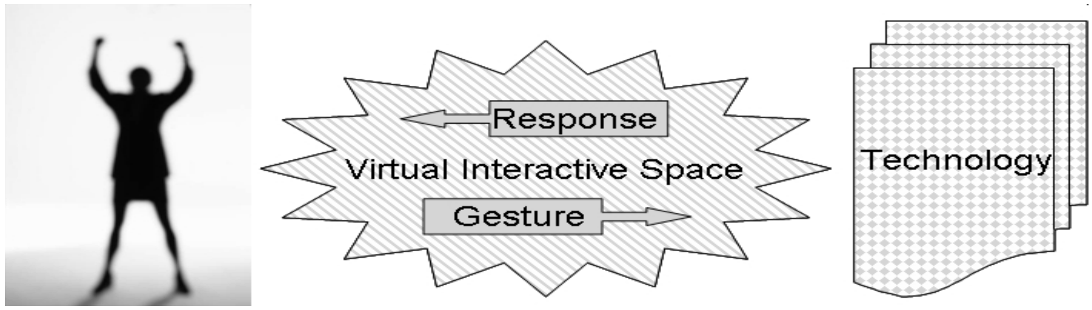

Figure 2. *Aesthetic Resonance refers to a situation when the response to intent is so immediate and aesthetically pleasing as to make one forget the physical movement (and often effort) involved in the conveying of the intention. See also – VIS* (Brooks 1999).

2. AESTHETIC RESONANCE, THE CONCEPT & THE COMMUNITY

Augmented real-world environments with inherent responsive technology are created so as to explore 'Aesthetic Resonance.' These are explored proactively where a sensory stimulating *feedback* (e.g. sound or visual), responding to an initial physiological gesticulation, instigates suggested potential closure of the afferent-efferent neural loop through subsequent *feed-forward* (also known as homeostatic control system) iteration which is anticipating the result of the associated motor action on the *feedback*. This stimulating *feedback* is selectable depending on user preferences, desires, and abilities; and similarly any *feed-forward* limitations – physiological or psychological - of the user need to be accountably optimised through the adaptability of the system so as to motivate the iterative causal interaction. This evokes a clear (at suggested various levels of consciousness) understanding of the causality involved and is analogous to the *flow state* involved in play & game psychology - exhibited when a child is engrossed in a computer game. However in our research, whilst using a computer workstation for signal processing, there is no joystick, mouse or tablets involved, nor are there attachments worn by the user such as in motion analysis laboratories that cater for rehabilitation therapy. A strategy of no invasive techniques or strict homogeny such as in most motion tracking techniques is maintained, the user is free to move in 3D Virtual Interactive Space (VIS), unencumbered by wires or attachments (Brooks 1999). This freedom is a catalyst of the concept - especially in respect of when the effort in the achieving of a goal means the overcoming of a pain.

2.1 The lineage to the scientific community's current growing interest.

The concept of using interactive feedback with movement has been around for some time. In 1990 a Danish national newspaper reported on the pioneering work of a Canadian (Rokeby 1990) where a camera was used to capture movement to play music on a computer. Later he worked within the disabled community with his system. Two years later Jaron Lanier, in his keynote address for the 'Virtual Reality and Persons with Disabilities' conference in California State University emphasized the importance for the VR industry focus to be on the *human-centred* and *empowering of the human* attributes of the technology and further informed of the incredible overlap between the communities stating, "In the history of Virtual Reality development, the community of researchers building the Virtual Reality machines and Virtual Reality software has been, in many cases, almost the same community as the people working on tools for disabilities" (Lanier 1992). In that same year Dr. Jeffery Pressing, who was a musician and an academic psychologist, published on real-time musical synthesizer techniques, improvisation composition and also numerous papers in human science. His writings [1] are a good example of the continued nascent overlap between the arts (esp. music) and technology into the human sciences. This is further exemplified in Pacchetti (*et al*. 1998, 2000) where *active* music therapy was used in rehabilitation of Parkinson's disease patients. Subsequently, publicly accessible Human Computer Interaction demonstrations and workshops (e.g. Brooks & Hasselblad 2001) presented technologies that enabled such a cross over between the communities and took advantage of the increased power and usability of computers and the inter-disciplinary research potential. All point to the fact that the lineage had come of age with the inferred growing interest from the scientific community in exploring therapeutic exercises based on interactive multimedia techniques. Further reinforcement of the interest is exemplified by the cross-disciplinary work of:- Bianchi & Saba (1998) in the autonomy of the disabled and elderly; (McComas et al. 1998) with children with disabilities; Wong & Tam (2001) in therapist-instructed training with autistic children; Brown (*et al.* 2002) in respect of social inclusion guideline for interactive multimedia; (Rutten *et al*. 2003) in supporting learning and enhancing social skills in people with autism;

(Yano *et al*. 2003, Kizony *et al.* 2003, Brooks 2004a) in respect of stroke. Continuous support of such collaborative actions [2] is essential.

3. PROJECT OVERVIEW AND BACKGROUND

This project structure was influenced by previous experiences in the ESE Caress project [2]; the FET Twi-aysi probe (Brooks *et al.* 2002) and the SoundScapes body of research (Brooks 2004b). The key areas defined for concentration in CAREHERE being (1) iterative development, (2) sonic and visual content, (3) wider user base, (4) hands off sensors, (5) quantitative evaluation, (6) user forum networking, (7) a concentration upon software not hardware, and (8) commercial exploitation. These key areas being reflected in the makeup of the consortium – with four user partners, two technical R & D partners, and one commercial partner, supported by an evolving 'User Forum' network of interested parties outside of the consortium. The earlier research investigated the use of responsive sound and visual environments as a potential supplement to therapy for the development of physical and cognitive skills through direct and immediate feedback through the aural and visual senses. The next step was to:

- Create Aesthetic Resonant Environment and Support Programme for Special Needs: supporting the development of physical and cognitive skills by interaction with a responsive audio-visual environment.
- Audio-Visual Interactive Content: Sonic Navigation, Visual Empathy, Sonic Tactility, Capture of Expressivity.
- Individual Adaptability: A unique system able to adapt to individual needs and wishes.
- Modelling and Capture of Expressivity: production of the above audio and visual content will entail innovation in both (physical) modelling and the capture of expressivity.
- Immediate Commercialisation: technical innovations being integrated into the product development of our commercial partner.

4. TECHNOLOGIES, TEETHING TROUBLES, AND METHODOLOGY

Eventual delayed testing with the infrared sensor based system developed by our coordinating & commercial partner *Personics* from Denmark gave immediate value to the iterative development process strategy as the user groups, especially our elderly users, expressed a strong preference for real/natural sounds and pictures and videos (rather than the limited synthetic sounds and abstract pictures only available with *Personics*.) There were also problems with positioning of the sensors for optimal capture and the information to feedback was not intuitive as often a movement would generate opposed and false data often crashing the system (which can be expected for a prototype system; however this was not rectified within a promised liberal timeframe) and disrupted the research. All consortium partners' realizing the failure in time ceased use of the *Personics* system in favour of *Eyesweb*, which is based on camera acquisition, and was capable of accommodating user preferences and was stable in use. As a result, *Personics* were offered the opportunity to program their sensor as an input device to *Eyesweb* so as to be usable alongside the cameras as an input sensor in our research. This they declined - a decision which was mutually acceptable as certain other features of the unstable *Personics* system were inappropriate for our work. The project thereafter was camera based, which became optimal as the cameras were used both as 'sensor' cameras for interactivity through movement with the audio-visual content and as 'observation' cameras for evaluation.

An algorithm was created by the Eyesweb software partner representatives in collaboration with the authors when they came to Lund, Sweden to see the work. This was the success story of the project as the algorithm enabled movement by a user to paint relative to a programmable (and easily changeable) velocity threshold which could adapt for user function. It used a technique called Silhouette Motion Images (SMI) which provided values that were proportional to the absolute velocity of the body part being moved. Automatic segmenting of the movement in order to distinguish between motion and pause phases was achievable with the movement cues able to be measured in real-time and associated to each motion and pause. Such data was useable to produce a symbolical description of the movements being performed. Example cues were:

- Contraction index (openness of body posture with respect to centre of gravity).
- Directness index (direct or flexible nature of a body limb trajectory).
- Durations of pause and motion phases (inspired by psychological studies).

Layered Analysis [LA] (Ellis 1996) from the earlier Caress project [2] was used adjacent to Multiple Camera Analysis [MCA] (Brooks 2002) to archive and analyze all video footage from the sessions.

5. USER GROUPS

'Kulturcentrum' Lund group (research P3) consisted of 15 cognitive impaired – learning disabled, well functioning adults with ages ranging from 20 – 42 years, able to communicate and mobile. Experimental exercises were set up where a database of abilities was archived. This ranged from working with gesticulated painting and music making (figs. 3 & 4), *Shadow-ation* (my word inc. shadows, imagination and motivation), analogue camera/monitor feedback loops (fig. 5), and dimensional environment exercises. The *Cross Modal Painting* was a follow on from earlier adjacent experiments with movement triggering image and sound; [fig. 5 in Brooks 2004d] and was positively responded to. The *Shadow-ation* was where we had the users come into the room one at a time and stand approximately 1 meter facing a white wall within a strong 2000 lumen LCD projector beam so that their shadow was strong and clear in front of them. They were instructed to create with their shadow three living items and interpret with their shadow. Over the weeks the items changed but to give an indication they would be asked for a bird, a fish and a tree. Then they were timed and videoed in response. The analogue feedback loops were only tested with the single case study below. The environment exercises were particularly fruitful as in the Centre there was an open top elevator (approx. 1.7m x 2m) between the ground floor and upper floor. The LCD projector was fixed so as to beam images down the escalator shaft and the system set up to track movement in the space. Many stated that it was like having their own disco that they could control with result of a very definite aesthetic resonance being achieved in the environment. Subsequent tests were in a large room and an auditorium with positive results.

5.1 Single case study

The single case study was set at 30 sessions each approximately 45 minutes long with a woman of 34 years. Various feedbacks were experimented in these sessions so as to ascertain what would be achievable through the system and to give subsequent feedback to the development teams. The education leader worked close with the author in this study as she had known the woman for 10 years. The woman was profiled as complex in personality and living at a collective (group). Brought up in a foster family who she did not get along with and she had changed work place many times as she finds problem to fit in and takes up a 'huge space.' She was disruptive, bossy and dominant in the school and talked a lot with many words that she did not understand often trying to involve herself in teacher issues. She had a need to be good (best) and not disabled. The leader felt that the woman had no contact with her own feelings as when others would laugh or cry she would force an enacting of the same. When she cried there was no substance but when she gets angry and screams she has a contact. She has much aggression in her body, always large movements without any nuances. In music she had to be loudest on the drum or similar in other class and has problems within teams. The centre was considering expelling her. I worked on developing exercises associated to awareness of her 'self', her social skills and self-esteem alongside confidence and dynamics.

During the 2 weeks where 3 sessions a day took place she was not allowed in class. We began with a questionnaire (compiled through online research and teacher input, supplemented by input from Centre for Rehabilitation of Brain Injury, Copenhagen) which she completed while being videoed attached to a biofeedback stress indicator (GSR[i] attachment). Each day had variety in which exercises were undertaken but never two the same in one day. The videoed sessions resulted with commented marked progress by staff and other users to her change in behaviour. At the end of the two weeks I took her out in the Centre's van to the city blindfolded and with headset and microphone into which she was to speak of what she perceived as the outside sound being, for example a pedestrian crossing alarm, a person with a shopping trolley, a dog, etc. This was recorded by an authorized concealed video camera in the van. The resulting 30 minute commentary and others from the sessions was played back to her in the company of the leaders and author on the last day. She was asked to comment on the sessions and especially on how she felt about what she saw and how she remembered the sessions. This was a key aspect of the work as she made comments that the leader was in awe about. Her sense of achievement from being able to create with the given audiovisual feedbacks was readily apparent. This seeing and hearing of herself was a powerful tool combined with the sessions. Her 'outside in' reflection from what she saw on the videos seemed to have a positive effect on her in the immediate period at the education when she went back to the classes exhibited by a diminishing of her disruptive effect on fellow users and a quieter disposition. At the start of the two weeks an e-mail account to researcher two was set up and she was shown how to use it as although limited she had verbal and writing skill. She knew him from earlier and she was positive about the idea. This was so as to allow me to have time to prepare the next session, to write up the results and to review and archive via layer analysis the session videos. Response was daily and her diary of events in the sessions told how she felt about it all. The leaders were amazed at some of her writing and even after the sessions had finished and she returned to class she continued writing mails to colleagues and this was a new expressive outlet for her.

5.2 Lund results

Apart from some problems with certain aspects of the questionnaire (translation from English to Swedish and some of the personal questions asked) but following an interview with the user, the leader cleared up the misunderstandings and explained to me the problems. The leader was extremely pleased with the study.

Figure 3. *Movement data captured from the user's brush strokes when she was painting triggers synchronized images and sounds that was relative to the movement. A smooth sound inspired painting with care and smooth strokes - this in turn made the music smoother. Correspondingly, aggressive sound resulted in a disjointed and violent painting action. Both quad images show through facial features and posture an immersive aesthetic resonant experience which at one point resulted in her initiative to paint with two brushes.*

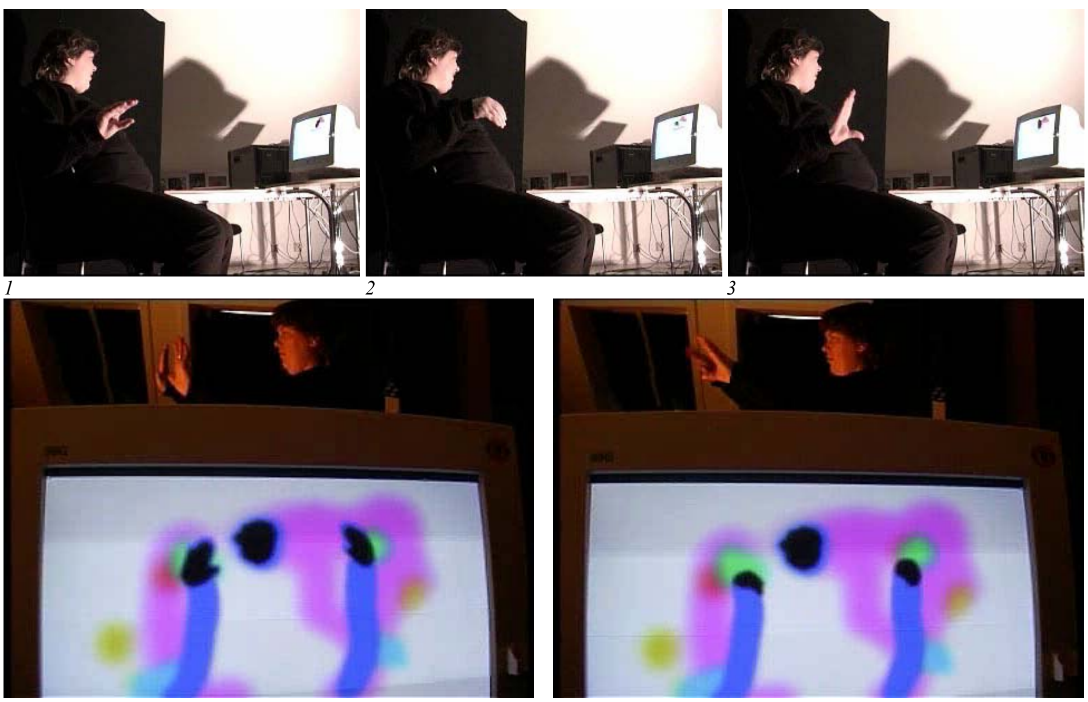

Figure 4. *Hand movement painting being followed on monitor (1, 2, & 3): Lower - similar but she faces the large screen, we see monitor results where the velocity acts as nuance training. Her task was to paint a shape keeping the same velocity which results in the same colour. A deviation in velocity resulted in a change of colour which meant a restart.*

An experiment in the use of the feedback as primary instruction rather than the body part as primary was in two forms of instruction (1) *"When you move your hand in this way the colour will go from dark to light green.,"* = body part as primary (2) "*To make the colour go from dark to light green you will have to move your hand in this way.,*" = feedback as primary. This was to influence the user to think out of the body and in so doing approach the Virtual Interactive Space (VIS) that is inherent between the technology and the user in Aesthetic Resonant Environments, (2) proving more effective with the user mind-set.

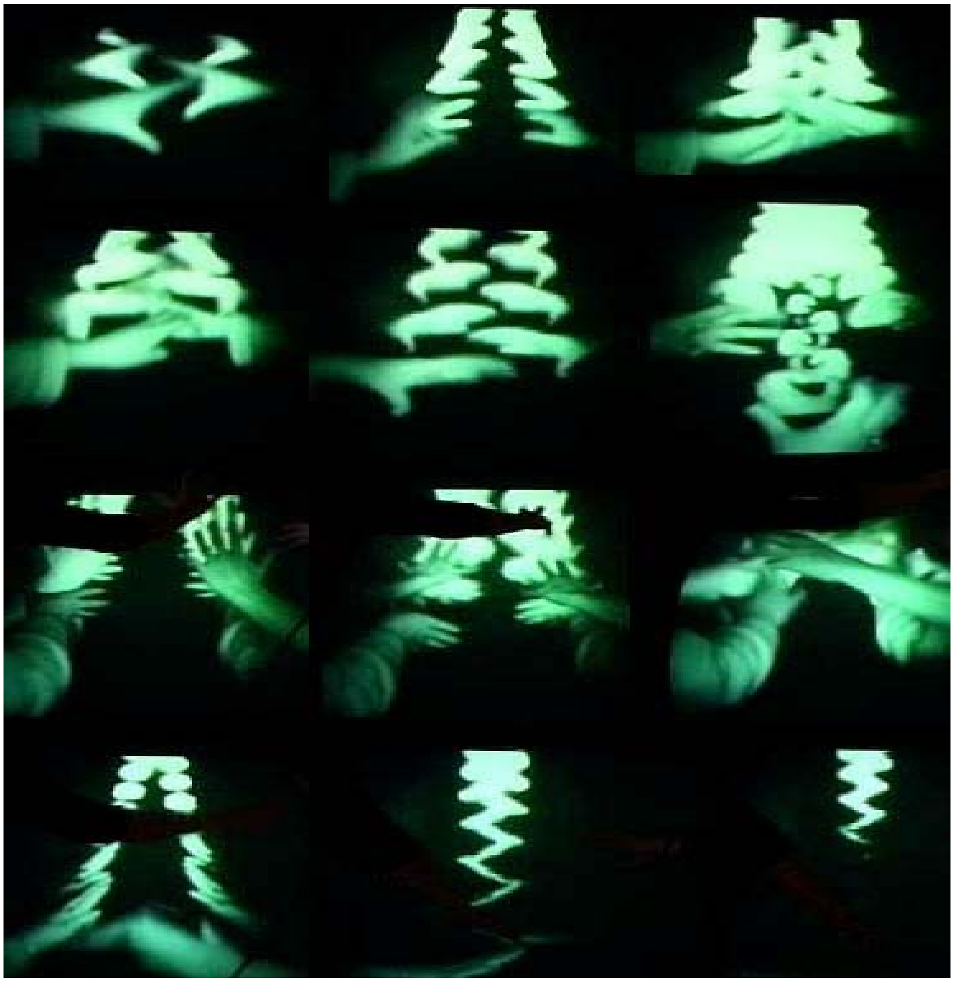

Figure 5. *Video feedback to research potential use as an Eyesweb new algorithm; the upper six images are of our single study alone and the lower six screen shots are from an interaction with a member of the staff. It was wonderful to observe our single case study laughing out very loud as she explored, created and experimented. Her awareness to her hands was total. Interaction with another person was also encouraging.*

5.3 Landskrona

Landskrona (P7) users were six children between 10 – 19 years of age with severe brain damage and additional disabilities. The children are all restricted to use a wheelchair and they have no speech communication. They additionally have mobility and attention problems. Every session was video filmed with MCA to catch the visuals and sounds as well as the facial and the bodily expression of the children. These were then edited and analyzed according to the project goals (inc. LA) and then burned on CD-Rom. After the Personics problems all sessions used the Lund Eyesweb algorithm (as fig. 4) and all users reacted in a positive but different way. This could depend on them having different preferences regarding visual or sound stimuli or both in combination. The few times they have not responded in a positive way could be explained by physical reasons like bad colds, lack of sleeping during the previous night, having had severe or multiple epileptic seizures during the night or day. The epilepsy has never occurred during the sessions.

The sessions resulted in cases with positive reactions of higher motivation in schoolwork, and an increased feeling of well being and pleasure after the sessions. Also it seemed the pupils are further stimulated to see their own real image as a little part of the large visual on the screen which also makes it easier to video both what happens on the screen and catching their facial and body expressions.

Table 1. *An overview of the Landskrona user group of children.*

Ref	Child info.	Focused project work to empower:
A1	Male 19, severe mental retardation + cerebral pares with severe disability + cerebral atrophy + epilepsy. Low awakening grade sometimes makes him sleep for days.	• Awakening grade • Mobility • Expression
A2	Female 10, significant microcephal mental disability + slight deviation in her contact behaviour + walks without support though very spread legged + very hard to motivate regarding exercises of a cognitive nature. A lot of sounds.	• Body awareness • Focusing • Cause +effect • Expression and communication
F1	Female 9, brain damage which severely affects her speech + motor skills + very spastic + cramps. Can take instructions + trains on BLISS method.	• Verbal activity • Coordination/Body awareness • Expressivity
M1	Male 14, brain damage + cerebral pares type spastic tetraplegia + sight impairment + epilepsy + severely disabled + severe mental retardation. Emotionally reacts.	• Motivational aspect • Movement • Communication aspect
M2	Female 18, microcephal + severe brain damage + cerebral pares. No mobility or meaningful motor skill. Severe curvature of the spine + spastic tetraplegia + severe mental retardation + limited contact ability + strong tendency to constipation which makes it important to stimulate her own movements.	• Motor skill • Body awareness • Understanding of cause and effect • Expressivity
P1	Male 6, microcephal mental disability + cerebral pares + explicit spasticity + epilepsy. Alert + contact skill + no language + no mobility.	• Motor skills • Body awareness • Focusing

6. CONCLUSIONS

The biggest success from the project was the creation in Sweden of the Eyesweb painting algorithm reported in Camurri (*et al.* 2003). In both Swedish locations a large 2.5 (w) x 2 (h) meter projection screen was used and this is optimal for one-to-one relationship and sense of presence. A screen-mounted sound system is also used. We observed how free movement that resulted in causal manipulation of interactive responsive sound and visual feedback was able to achieve a state of aesthetic resonance. The creative content was observed as being a motivational tool for the therapy. The data parameter information that enabled this creativity can be a quantifiable entity so as to support and verify results. However the planned data bases of libraries and archive means was not accomplished because of timeframe. The audiovisual interactive content: sonic navigation, visual empathy, sonic tactility, and capture of expressivity was achieved (to a point) through the relational sounds and shapes from our UK partner and the software algorithms. Adaptability of the system was through the graphical user interface sliders but more time was required to build libraries to complement the Eyesweb libraries. The modelling and capture of expressivity however was limited by the timeframe and we did not work with physical models which would have been optimal. The commercialisation of the technical innovations integration into the Personics product was curtailed by the consortium. Personics have since commercialised their own independent product.

As a result of the project we have established new qualitative and quantitative user evaluation methodologies most appropriate to our wide user base. This will be exploited more fully in the next project with the creation of much needed new testing methods for process analysis and user categorization. The research which the Swedish partners conducted is ongoing by the co-authors where we are using the Soundbeam ultrasound sensor in conjunction with the Eyesweb camera system. The Soundbeam is a mature technology that was used in the prior research and is acknowledged as an industry leader. It is more stable than the Personics infrared sensor and unlike the Personics sensor it gives a predictable intuitive response to the user. Our Italian software partners continue to develop Eyesweb. The project proposal identified the Minimum Data Set / Resident Assessment Instrument (MDS/RAI) as a proven assessment tool for measuring the impact of CARE HERE interventions with older people and with Parkinson's patients and to explore its possible applicability to the other client groups in the study, notably younger people with severe physical and learning disabilities. The tool was shared with the partners and tested for suitability. This was rejected by the Swedish researchers as unsuitable for their user groups.

Acknowledgements: The authors would like to thank all the *non-Personics* consortium personnel who worked so hard to realise the project and especially those involved in the Swedish research and the developed network that assisted us in our endeavours in the South West corner of Sweden.

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[i] Galvanic Skin Response – a biofeedback technique used in lie detection.