Facilitating the experience of agency through an intersensory interactive environment

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Abstract
The project presented provided a group of elderly participants in sheltered living conditions with an intersensory environment in which participants create expressively, by the use of their voice or movements, events which are specified auditory, visual and/or tactile. Being part of long-term research the *i*Muse project explores the effect of additional visual feedback for this specific client group. Through interviews and video-based behavioural observation an account is given of the change in experienced control during *i*Muse sessions with and without visual feedback. The effects in terms of experience and observed behaviour are evaluated in relation to specific impairments as well as individual aesthetic preferences.

Keywords: wellbeing in elderly, person-centred intervention, inter-sensory therapy, vibroacoustic sound therapy

1. Introduction

The power and effectiveness of sound and music in enabling people to come to terms with, sometimes even overcome, disabilities has been noted by many authors (Boyce-Tillman 2000, Storr 1992, Wigram, Saperston and West 1995). Aspects from all these areas provide the grounding for this intervention, which is essentially non-invasive. Emphasis is placed on providing an interactive environment in which a high level of experienced control of action can be achieved through *aesthetic* interaction with sound.

The increasing loss of autonomous agency is a deeply felt problem for elderly people. Agency is understood in the sense of Fischer (1980) as intentional action including the skill to organize and control behaviour in order to reach a certain goal in a specific domain of action (Fischer, Bullock, Rotenberg, and Raja 1993). According to this approach agency is the result of a dynamic interplay between affect, cognition and motivation (Mascolo, Fischer and Neimeyer 1999). The age-related decline of physical, cognitive or emotional functioning can have a profound effect on the experience of agency (Fung, Abeles and Carstensen 2003). The presented project provided an environment which aimed to meet all three components of agency: at cognitive and physical level a maximum of continuous and fine-tuned control of multi-sensory events was given in the hands of the participants in order to support the experience of control. In order to create an emotional/affective positive experience, aesthetic preferences were taken into account in choices of timbre of sounds, type of visual patterns of change as well as colour schemes. The feedback in all sensory domains aimed to create a relaxing and individually effective experience. Motivation was assumed to result from interactions meeting diverse individual needs such as relief of pain, anxiety or a lack of stimulation, and from the active involvement of participants in shaping the content of the sessions.

2. The *i*-Muse project

2.1. Context of development

Many approaches or therapies work from the outside – in, with a stimulus being provided by an external agency. In traditional music therapy this is provided by the therapist often playing the piano or other instrument 'at' or 'to' the client, or in time with the client's movements. Person-centred music therapy (Hatfield and McClune 2002) gives more importance to the individual, often within a group situation. In contrast, Sound Therapy, VAST and *i*MUSE are one-to-one events, underpinned by aesthetic appeal and individual control, an experience from the inside – out. In the three approaches listed above, which can hitherto be concatenated as *i*MUSE, the emphasis is on the therapist providing a live acoustic environment, which is optimised, to the individual.

Physical movements from the client can result in sounds that are both pleasing and potentially expressive, and in time the environment and the sounds can be individualised to enable maximum expression and response from the client. The approach presented here also differs from multi-sensory approaches known as Snoezelen or 'sensory' rooms where many stimuli are given in order to compensate for a lack of stimulation (for detailed information see e.g. Baillon, Diepen, and Prettyman 2002). Control of these environments by users is restricted to the use of

on/off switch triggering e.g. sounds. The different visual, auditory and tactile stimuli are not related to each other and are designed to invite mainly passive attention and relaxation through ongoing stimulation.
In contrast, in the intersensory environments presented here the participants created, by the use of their voice or movements, events which were specified auditory, visually and/or tactile. Changes of feedback were closely related to changes in several parameters of action. The approach invites active engagement and interaction through action-specific feedback as well as passive relaxation. Effects were expected to vary according to individual needs and to become apparent over middle-and long-term with weekly sessions.

In research contexts the potential of multi-media feedback in virtual environments is explored for meeting the needs of users with disabilities for active engagement and interaction. Examples are projects in special needs and rehabilitation contexts (Brooks et al. 2002) or the 'Mediate' project for children with autism spectrum disorders (http://www.port.ac.uk/research/mediate/). While the effectiveness of multimedia environments has been demonstrated, little is known about the reasons for this effectiveness.

The study presented was a first step to systematically vary the type of multimedia feedback in order to explore the effect that, in this case, visual feedback has when added to sound and tactile feedback for actions. Increasing understanding of the perceptual, cognitive and emotional processes involved in this type of interaction will allow better specifying user needs and adapting the design of multimedia environments accordingly. The present pilot study also aimed to explore several research methods in order to better describe and evaluate the effectiveness of these types of interventions.

2.2. Method
Subjects: 13 participants (3 male, 10 female; average age was 78 ranging from 67 to 92) who were from sheltered living accommodation in the Northeast of England. All were living independently but had 24 hours access to support by the agency running the communal centre. Participants were free to join sessions after a demonstration and could stop at any time.

Material and apparatus: An Alesis microverb was used for sound processing vocal activity, with reverb and delay programmes selected. Physical gesture was captured via Soundbeam. The resulting MIDI data were used to control an FM7 softsynth. The vibroacoustic facility was provided by a Soundchair which converts audio into vibration over three areas of the body – the back, the seat and legs. Output from the Microverb and the FM7 was sent to a Tascam Portastudio 4-2-4. This was used as a mixer and also to replay the vibroacoustic tape. G-Force visualisation software converted the MIDI signal into changing graphical patterns.

Sessions were video-recorded with one digital camera.

Procedure: The study was designed so that half of participants started without and half with added visual feedback. After five sessions the visual feedback was added for the first and removed for the second group for two sessions. In the remaining three sessions participants were free to choose which types of activities and feedback they wished. All sessions were video recorded. Three semi-structured interviews were held in order to monitor experienced physical and mental health problems (Health questionnaire); the effectiveness of sessions related to the experienced health problems after five sessions (interim effectiveness questionnaire), and a more detailed questionnaire (final questionnaire) after the tenth session concerning effectiveness, motivation and wishes for future developments.

A typical one-to-one *i*Muse session took about 30 minutes. Participants were seated in a vibroacoustic chair which transformed sound into vibration. In a number of sessions additionally sound was transferred into complex changing visual patterns through visualisation software (G-Force).
The session usually consisted of three parts:

- Social or solitary interaction with the microphone – the voice feedback is processed e.g. as reverb, delay or pitch transposition.

- Solitary or social interaction using Soundbeam – lateral hand- and arm movements in the beam caused sound feedback depending on the distance from the ultrasonic sensor. Synthesized sounds used varied from bells to orchestral and hybrid or 'fantasy', all containing low frequencies which can be felt most effectively through the Soundchair.

- Relaxation – calming music with added low-frequency sine tones between c. 40 -120Hz was played.

2.3. Data analysis
The project aims to combine qualitative description of case studies with quantitative modes of data analysis.

2.3.1. Interviews
Health questionnaire: Before the start of sessions semi-structured interviews using questionnaires were held with participants in order to identify experienced problems and needs at sensory, cognitive, physical and emotional levels of behaviour. Note that only areas that were related to the iMuse interactions were included.

Interim effectiveness questionnaire: Effectiveness of and preferences for the three parts of the intervention and types of feedback were monitored after the first five sessions.

Final effectiveness questionnaire: Additional to the question from the former questionnaire motivation and required changes in sessions were discussed by an independent interviewer.

2.3.2. Systematic behavioural observation
A micro-analysis of behavioural change (Lee & Karmiloff-Smith 2002) was carried out by analysing series of individual sessions with respect to physical movement and facial expression. The goal of this analysis was to move from demonstration of changes in behaviour to a structural description of individual change. In this context one example will be given for this type of analysis. An observation scheme was developed for interaction with the Soundbeam in which the size (small, medium, large, irregular), and type and duration of facial expression (neutral, positive, negative) were coded. 'Observer' software was used for coding the video sequences and descriptive analysis of the data.

2.4. Results

2.4.1. Interview results
Health questionnaire

As Figure 1 demonstrates sensory and physical impairments were diverse with a high frequency of experience of pain.

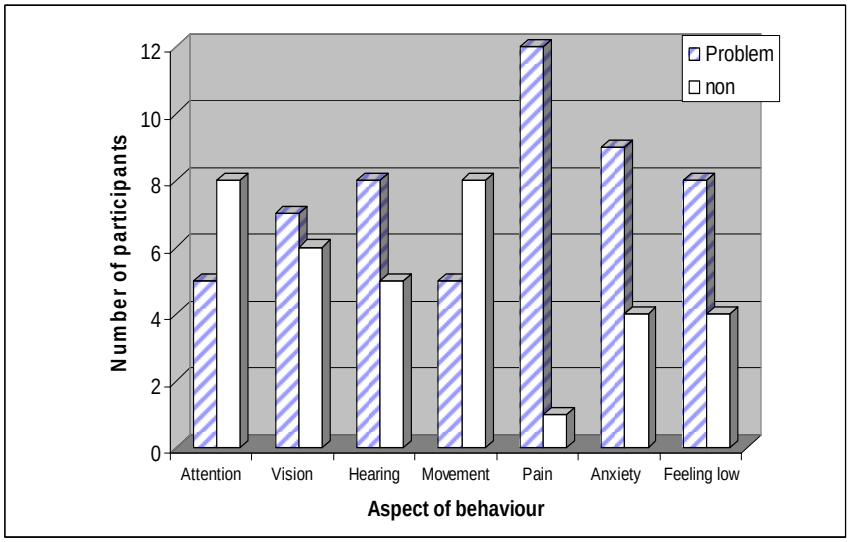

Figure 1 Experienced areas of impairment for n=13 participants of the *i*Muse study

Six original participants from one of the two sites we worked with were leaving the study due to organisational problems. Therefore the remaining data are from a reduced sample of 7 participants (1 male, 6 female).

Interim effectiveness questionnaire
After five sessions semi-structured interviews were held in order to review the sessions and assess experience of change. Figures 2 and 3 give an overview of experienced improvements in the areas of pain and stress relief (anxiety) for the group without visual feedback (Figure 2) and the group with visual feedback (Figure 3).

Experienced effects seem higher for sessions with visuals compared to sessions without. The low number of participants makes it impossible to statistically test the significance of differences in experienced effects.

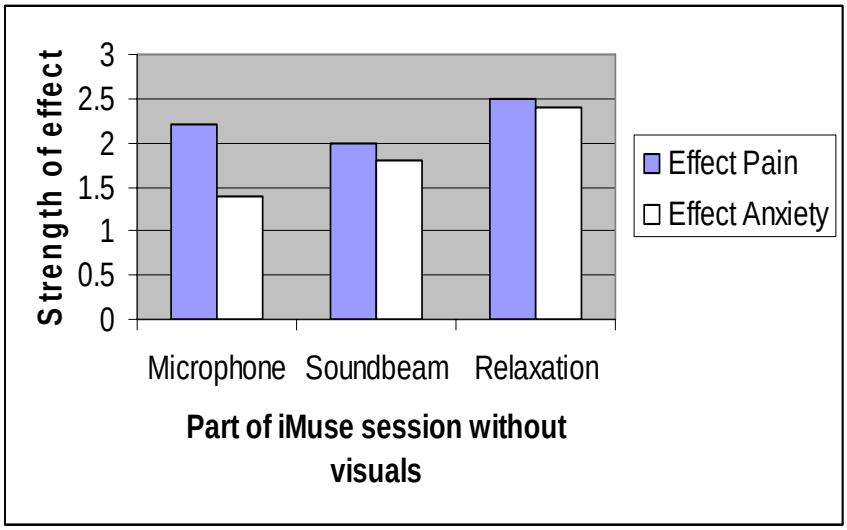

Figure 2 Experienced strength of effect of the parts of the iMuse sessions on pain and anxiety problems after five sessions **without** visuals. Experienced strength was measured on a rating scale 1= little or non effect; 2 = some effect; 3 = strong effect; N=4.

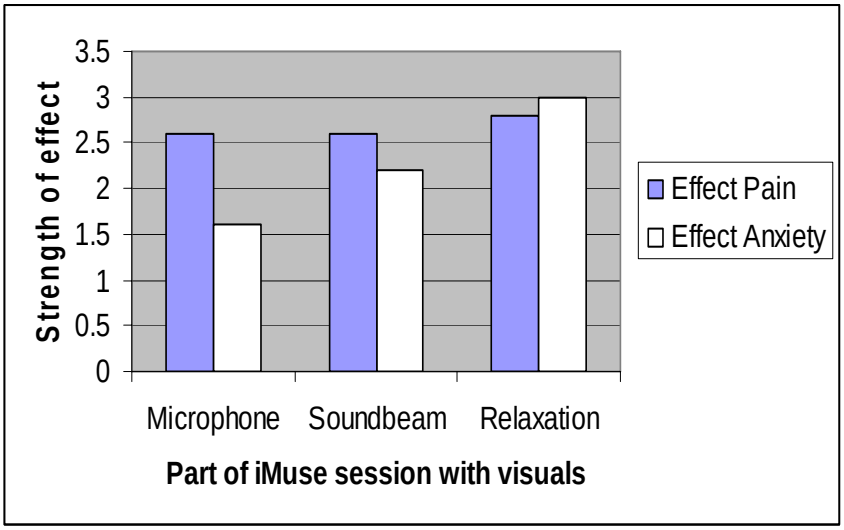

Figure 3 Experienced strength of effect of the parts of the *i*Muse sessions on pain and anxiety problems after five sessions **with** visuals. Experienced strength was measured on a rating scale 1= little or non effect; 2 = some effect; 3 = strong effect; N=3.

Final effectiveness questionnaire:

For sessions 6 and 7 the availability of visuals was reversed for the two groups. For the last three sessions participants were free to decide if they wanted visual feedback or not. Sixth of the seven opted for visuals in all parts of the session. One male participant was opting against visuals for the first two parts of a session but wanted them for the relaxation part. The experienced effectiveness after 10 sessions mirrors the results of the group with visuals after five sessions. Two participants with hearing problems reported that the presence of visuals would give them a clearer idea of the events ("It is as if I can hear better when I watch the patterns", citation Participant 4).

Figure 4 shows the effectiveness for all assessed areas of problems with the addition of 'Beauty', an assessment of the role that aesthetic appeal played for participants' experience. Of particular interest is that the role that the aesthetic appeal or experienced 'beauty' of both the visuals and the sounds play for the experienced effectiveness was rated as important or very important by all participants. Figure 4 gives an account of the role which the three different feedback modes (sound, vibration and visuals) play for the experienced effectiveness of the three parts of an *i*Muse session. Vibration was rated highest by all over all parts of the session while sound is seen

differently depending on the source of sound. Visuals are experienced as medium important for all parts of the sessions.

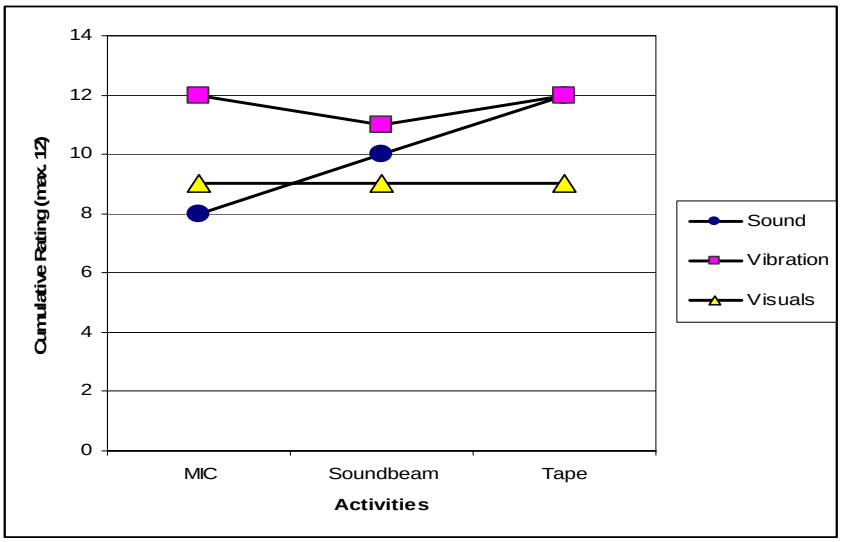

Figure 4 Cumulative rating of the role of the three feedback modes for three parts of the iMuse sessions after 10 sessions. 0 = no or negative effect; 1= little effect; 2 = medium effect; 3 = strong effect (N=4)

2.4.2. Systematic behavioural observation

Observational data give an idea of patterns of observable action during sessions. Figure 5 gives an example of changing arm/hand movements during the use of the Soundbeam depending on the presence of visual feedback for one participant. The overall time analysed is 25 minutes over five sessions without and 25 minutes for sessions with visual feedback. Small, medium and large movements describe rhythmical patterns of movements lasting minimal 5 seconds while irregular movements describe fast changes in size and timing of the movement. The frequency of movements increased overall for episodes with visual feedback. The large differences in irregular movements indicate a higher level of exploration in the presence of visual feedback. Measurements of positive facial expressions showed that the duration of positive facial expression increases with the presence of visual feedback.

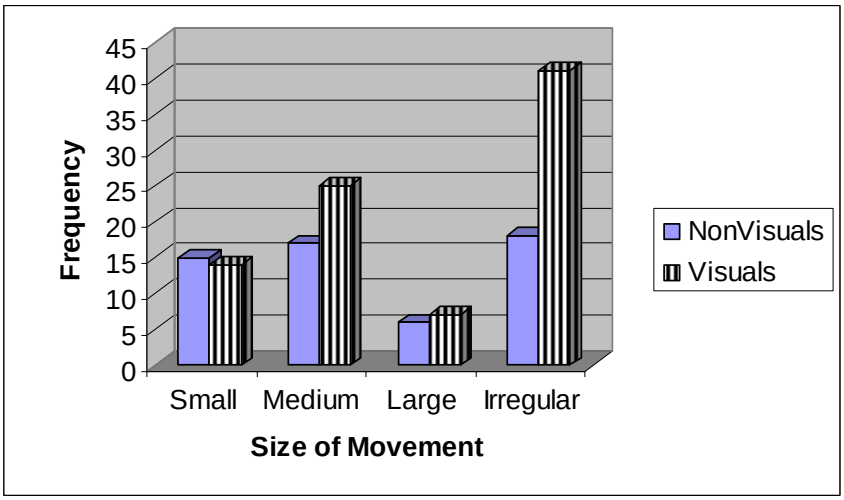

Figure 5 Comparison of the frequency of four types of arm movements during Soundbeam use with and without visuals over 10 sessions by one participant.

3. Discussion and conclusion

The pilot study intended to compare experienced effectiveness of *i*Muse sessions with and without visual feedback in order to learn about the additional role the visual domain could play in the sound and vibration based intervention method. The data from structured interviews show experienced effectiveness in all parts of the intervention and an overall preference for the presence of visual feedback. When comparing auditory, visual and

tactile feedback, the role of visualisation seems equal for the different activities of *i*Muse sessions with minimal fluctuations in opinion between participants. The role of visuals was seen by all participants in the aesthetic-affective domain while vibrations were seen as the main component for change in physical state. Sound was experienced in its aesthetic and relaxing meaning during the relaxation tapes and more functional for producing specific patterns of vibration in the other parts of a session. It is important to realise that the roles of different feedback domains could change with changing needs for control and with differing motivations.

Observational data suggest that the level of exploratory actions trying to manipulate the feedback increases sharply with the presence of visual feedback. When relating this to the interview data, the meaning of this increase in activity seems to be related to the motivation to produce beauty. Further data analysis will reveal if this is an effect which can be found in the majority of participants or is individual specific. The active exploration of feedback control reflects increasing levels of active cognitive engagement. The analysis of facial expression gave a description of a changing emotional dynamic due to the presence of visual feedback. At cognitive /physical level the awareness and realisation of control is sufficiently high when based on auditory and tactile feedback only. Therefore the added value of visuals here seems to lie in motivational and affective factors which in turn spark cognitive curiosity. This role could change depending on perceptual and motor skills of participants. However, the role of experienced beauty through visual feedback has been surprisingly stable over participants with different needs.

The small sample used can only give very preliminary insights for other multimedia environments. The concept of agency seems very fruitful in trying to capture the complexity of the interplay between cognitive/physical, affective and motivational factors in relation to different feedback modes. Further research needs to concentrate on the diverse roles feedback modalities can play in order to formulate design criteria for interactive multi-media environments. The combination of interviews and observational analysis has proven to be fruitful for the improvement of our understanding of interactivity.

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