Real-time composition of image and sound in the (re)habilitation of children with special needs: a case study of a child with cerebral palsy

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Abstract

This paper presents a single case-study of a child with cerebral palsy conducted within the framework of a research project examining the potential benefits of real time interactive image and music composition on the (re)habilitation of children with special needs. An interface was designed to simultaneously present audio and visual feedback stimuli. The child had low mobility of upper limbs, was in a wheelchair and had a short attention span. Sessions took place over a six month period. The first thirteen sessions were analysed. Quality of movement control improved across sessions as well as the quality of the sound produced, revealing growing intentionality on music production. Independent assessments made by the multidisciplinary team of therapists who were delivering rehabilitation services to the child revealed gains in most behavioural skills.

Keywords: aesthetic resonance, cerebral palsy, music therapy, multi-sensory environments, movement rehabilitation

1. Introduction

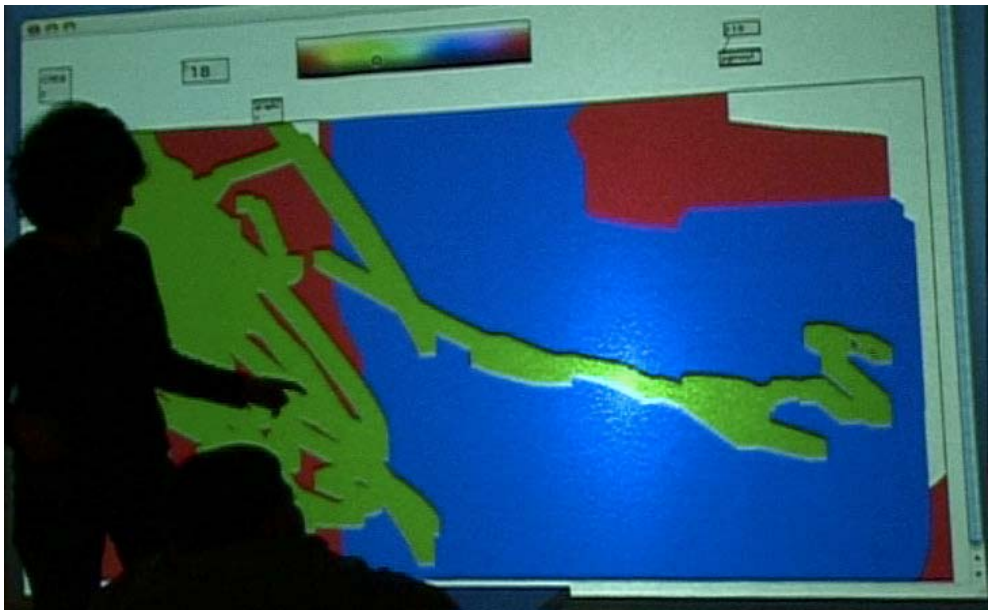

Figure 1 Illustration of a frame of a session

Interfaces that offer multi-sensory feedback in the field of rehabilitation and special needs can provide a means to promote artistic activity in which the feedback is so attractive that the child is motivated to reach new dimensions of expression. This principle draws from the Aesthetic Resonance theory that refers "(...) to a situation where the response to an 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" (Brooks, Camurri, Canagarajah & Hasselblad 2002, p. 205). The interface used in this study functions as a hyperinstrument where the visual feedback provides a kind of musical score as a visualization of the music produced. Hyperinstruments were primarily invented for people who are not musically educated but who nevertheless wish to express themselves through music (Machover 1992). The image can help to develop a better musical skill and vice-versa. The drawing feedback patterns can give clues for building musical patterns. Also the music heard can inspire the paintings and graphical patterns.

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The aim of this study is to determine whether an interactive multi-sensory interface promotes intentional music and graphics making, increase of movement control and enhancement of the quality of life of a child with motor-cognitive disabilities. The products of intentionality are the structured musical or visual units obtained. When control is observed, intentionality is also present even if the product is not an organised musical/graphical pattern. Additionally, the investigation sought to explore whether enjoyment and motivation were promoted mainly through intentional activity and to what extent musical production depended on simultaneous graphical feedback.

Artistic expression involves intentionality. The products are the structured materials observed. As Herbert Reads (1949) writes "Art, we must admit, is not the expression in plastic form of any one particular ideal. It is the expression of any ideal that the artist can realize in plastic form". (p. 19)

This interface provides a free improvisational environment where this process could be observed.

Developmental studies on musical improvisation show that there are different stages within learning processes along time. Kratus (1996) establishes several levels: (1) *exploration* (random sounds), (2) *process-oriented* improvisation with presence of "some micro-structures but no macro-structure" (p.32), (3) *product-orientated* with four more levels of relationship between micro and macro-structures. Other authors like Prével (1979) state "children's very first improvisations reflect their motor energy" (p.14). According to Prével when children start to control their movements "they begin to alternate different colours of sound, vary the intensity of volume, and make accents, conclusions, and even introductions" (p.15).

At the musical (melodic) level, the concept of structure is based upon the motif that can be defined as an organised sequence that is repeated or varied in a musical context (Cambouroupoulos 2001). The visual units can be also classified as organized or random. In this study the child had low vision and, although he could focus on the visual feedback, revealed a predominant focus of attention on the sound and music production.

2. Method

2.1. Participant

The child (J.) is a 13 years old boy that has low mobility of upper limbs, doesn't speak and moves with the aid of a wheelchair, has a short span of attention, low vision and cognitive difficulties. A grid based on the ICF (International Classification of Functioning, Disability and Health) was created at the centre of rehabilitation to represent the functionality of this participant through use of a detailed questionnaire.

2.2. Set up and procedures

The equipment used to implement the sessions consisted of a video projector directed to a white wall or onto a screen, two pre-amplified monitors, two video cameras, tripods and a laptop. The computer was connected to the video projector and to the sound amplifiers in order to produce auditory and visual feedback. The cameras were used to collect data from the sessions in two different ways; recording both the facial expressions and the projection on the screen. In some sessions a mirror was positioned behind the child and with only one video camera it was possible to capture both simultaneously.

This interface was designed by a computer programmer in Max/MSP – a graphical programming environment - according to the goals of this study. It produces sound and graphics that should remain registered on the screen. The programmer explained how the patch works and can be edited. The pitch range was a chromatic scale that can be modified in range and direction. It was used mainly in the left to right direction (lower to higher pitch) because this is a gesture that is easier for this participant to achieve.

Several kinds of feedback (graphics with sound, just graphics or just sound) were manipulated to assess how the child was interacting with the system. This was first done by editing the visual area for giving sound feedback on just one side of the screen. This didn't produce the expected response, because the child would 'wonder why it isn't working' and would stop interacting. It was decided to keep both feedbacks active when screen was being projected. The 'just sound', or 'just graphics', feedback was achieved by simply turning off either the screen or the sound.

The instrument (timbre) could be changed, as well as the thickness of trace and the colour. Interaction was achieved through a one button wireless mouse. A two-button computer mouse was used initially, but this did not work because the level of dexterity of the participant did not allow him to be able to manage the two buttons.

Other parameters like e.g. duration of notes could also be changed, significantly altering the sound effect of each timbre. The timbres used were selected among the ones that have a short reverberation period, so that the participant has a learning environment where he is able to compose motifs with materials he has become acquainted with.

Some parallel activities took place during the sessions to motivate the user and to assess how musicality might improve if the adult for example, dances to the music created by the child.

3. Results

Data was obtained from analysis of the first thirteen sessions. This analysis was done using detailed observations of behaviour for each ten seconds of interaction.

The level of activity was compared within and across sessions (Figure 2), the number of musical motifs and time spent on intentional production (Figure 3), the effect of "on-line" graphic feedback in musical intentionality, and enjoyment and motivation in the act of creation assessed by facial and vocal expressions.

The parameters observed were:

- Presence and quality of control: weak, moderate or high
- Presence of motifs, their duration and type
- Emotional reactions: laughter, vocal utterances and facial expressions
- Time spent in parallel activities: which activities and what reactions happen during those extra-session time

The difference between intentional and non-intentional can be obtained through the assessment of various parameters, particularly direction of gaze and control of velocity. It can also be evaluated through repeated sound patterns where the graphical feedback is not what is actively followed.

The percussive motifs are the ones that stand as products unequivocally due to intentional activity. The creation of e.g. parallel graphic traces that are translated into parallel chromatic scales can make us question whether the intentionality was directed towards the graphic or music composition.

Although it is clear that there is an organized sound pattern, it is not absolutely evident if it was made in order to create a particular graphic effect or a particular sound effect. Nevertheless at this moment a pattern defined as a musical motif is created.

With this interface it is possible to evaluate the preference of the participants toward graphical or musical composition.

We can conclude that the participant of this study reveals a higher aptitude to the sound composing. This could be because of his low vision, low dexterity and/or due to his natural aptitude.

The quality of the musical expressions is assessed by its degree of complexity and sophistication.

Alternating between two motifs consecutively would already be considered a sophisticated musical pattern.

In drawing the quality can be assessed by the use of a greater amount of resources for its achievement, namely different sizes of trace or patterns of colours and more accurate representative drawings.

Results showed that the child increased the frequency of his interactions (Figure 2). Intentionality was preserved even when visual feedback was removed. Indicators of enjoyment and motivation increase across sessions and were mainly associated with intentional activity.

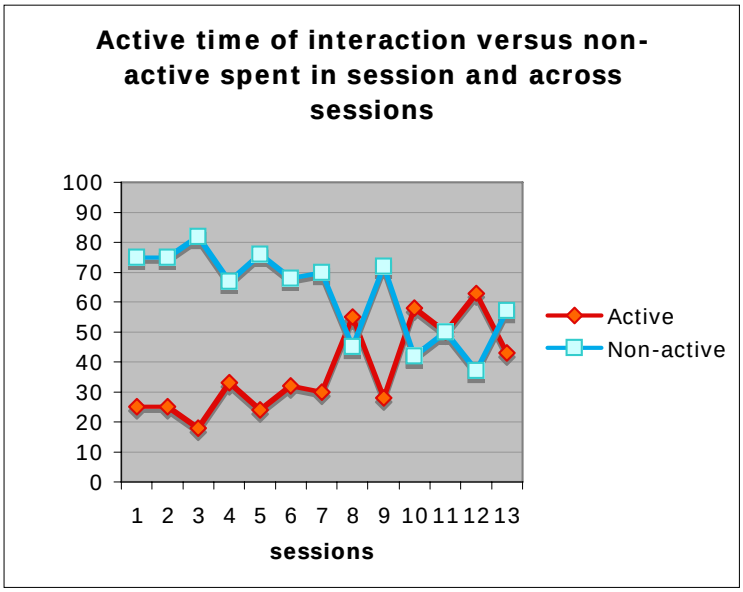

Figure 2 Active time spent on sessions versus non-active

The percentage of motifs increased across sessions (Figure 3). Regarding the quality of motifs, the data indicates that the child was producing more accurate and sophisticated patterns in later sessions.

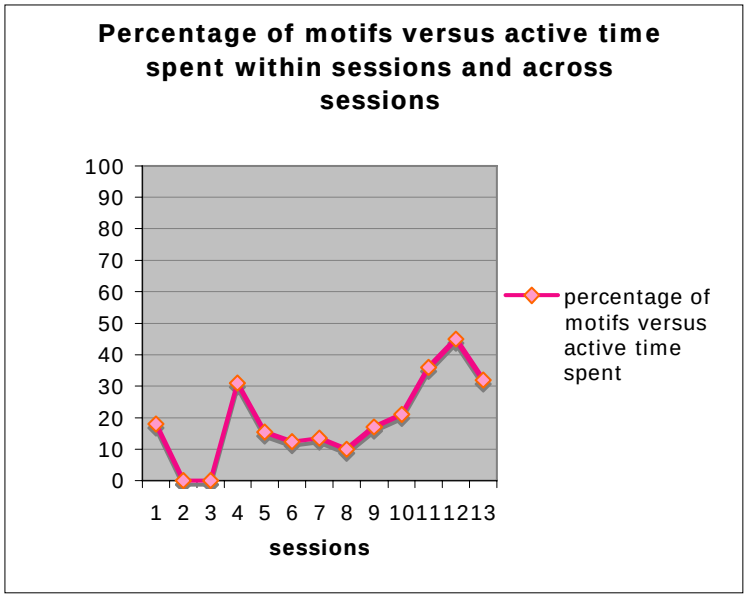

Figure 3 Percentage of musical motifs: across session analysis comparing the total time of being active with the time of musical motifs produced.

The analysis of the data suggests that parallel activities played a supportive role in the maintenance of engagement with the interface.

The multidisciplinary team therapists at the Rehabilitation Centre reported several parameters of progress in a scale from one to five points as can be seen in the next chart:

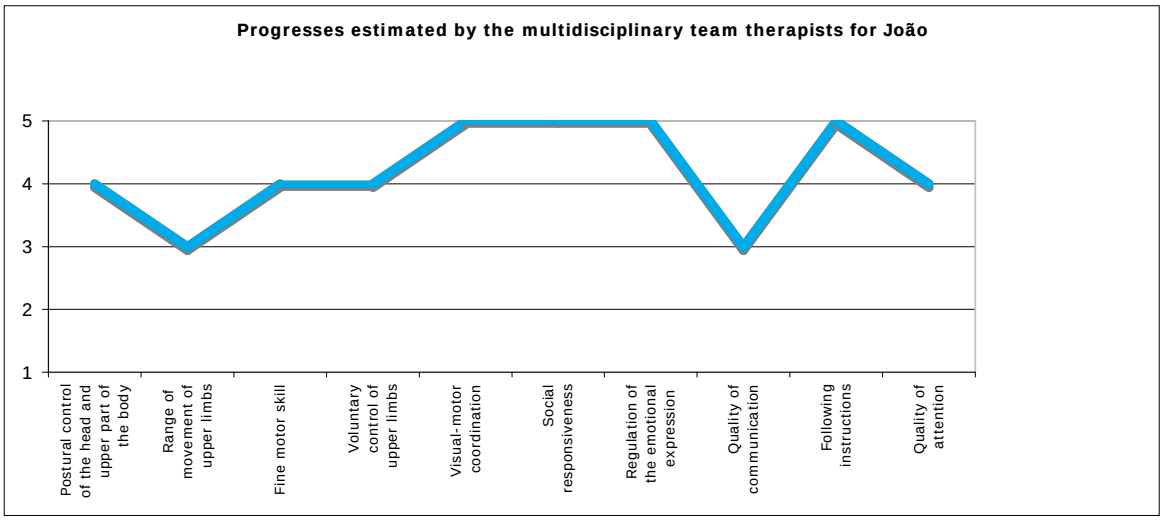

Figure 4 The multidisciplinary team therapists estimated progresses for various parameters in a scale ranging from one to five points

This report was answered bearing in mind not only the results obtained with the sessions but also the potential of the use of this interface for this child on a permanent basis. According to their estimates, progress was very satisfactory (5 points) for social responsiveness, visual-motor coordination, regulation of emotional expression and following instructions; quite satisfactory (4 points) for postural control of the head and upper part of the body, fine motor skill, voluntary control of upper limbs and quality of attention; satisfactory (3 points) for the range of movement of upper limbs and quality of communication.

4. Discussions and conclusions

In this study musical intentionality seems to be achieved and increasingly promoted with duration of participation: Brooks (2004) observed, “Longer interactions usual lead to a desire for subsequent interactions which stimulate, resulting in motivations of behaviour being generated” (p.18).

Since musical units were initially obtained with the support of graphical feedback, it can be stated that graphical intentionality is also involved in the child’s activity. Preservation of previous motifs when graphics are removed suggests that image feedback is not necessary for maintaining musical structure. However, it may happen, in some cases, that the creation of original motifs requires graphical support. This hypothesis should be tested.

This interface was used with a child with low mobility of upper limbs that reduces his capability of drawing representative figures. Therefore, it would be interesting to compare the use of this system in a systematic way for children with different aptitudes and abilities.

It is possible to create systems more directed towards the artistic expression that each individual is able to express. This ability can be due to a natural aptitude or to the physical or cognitive impairments that the client may possess. Thus, for example, for a blind person it would be interesting to develop a mapping of space through events like sounds and smell, which happen in determined locations in space. This would provide a feedback that promotes space mapping through artistic expression, giving the visually impaired the acquisition of improved skills and the opportunity of doing so within the aesthetic experience.

In this study the intentional relates directly to the capacity for-, and the will to-, control the feedback. The will to control is due to the motivation the child feels in creating work of his own that gives him instantaneous fun and self-achievement. If in this child it is possible to improve his mobility, quality of attention and quality of life in general using such interface, it is possible to specify developments for people with other special needs.

To assist developing a broader span of mobility impairments, special interfaces can be built and other types of interaction used. For instance the use of non-intrusive technology for movement detection is one of the applications that could be used by a larger spectrum of people with disabilities. In order to meet the preferences and abilities of

the participant of this study the multidisciplinary team of therapists and family identified the use of computer mouse and keyboard as one of his favourite activities

Results suggest that enhancing artistic expression may improve motor and cognitive skills. The use of aesthetic resonant environments offers opportunities for artistic expression for people with disabilities. These opportunities must be considered as a means to improve quality of their life. The qualitative report that was composed by the multidisciplinary team of therapists state at the importance of the inclusion of this kind of activities in a permanent basis at the Centres of Rehabilitation in Portugal.

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