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Interacting with music mediation technology for hearing impaired – first tests with normal hearing subjects.

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ABSTRACT

Interaction with embodied mediation technology for musical activities is a fairly young but intriguing research domain that requires building and testing of paradigms. In this paper an experimental framework is presented that has been used to test subject's sense of embodiment in sound identification and creation. A preliminary experiment is described that is part of an ongoing series of studies set up to evaluate embodied mediation technology, test methodologies and interfaces for user-oriented approaches to embodied music cognition. Thirty-three users interacted with the embodied music interaction (EMI) tool that is prototype software implemented in-house for a real-time interactive music system. The ultimate goal of this system under development is to open new doors to music creativity, for example for musical interaction between normal-hearing people and hearing-impaired individuals with cochlear implant (CI). Being a device that is easy to handle and that provides an experience of embodiment makes the EMI tool a powerful instrument. However, several challenges still have to be overcome for achieving such goal, both technically and methodologically. The presented experimental framework supplies support for the investigation of user's sense of embodiment and definition of issues that need to be improved. Results show that the sense of flow and presence points out the importance of the possibility of corporeal activity in an embodied music environment.

Keywords

Embodied Music Interaction – Music Mediation Technology – Corporeal Articulation – Action-Perception Coupling - Flow – Presence

I. INTRODUCTION

The presented study is situated in a broad field of empirical research relating to theoretical and methodological questions of embodied interaction with music through body movement and the use of mediation technologies. Drawing upon recent trends in embodied music cognition research (Leman, 2007), corporeal articulation or understanding through creative movement, has emerged as integral to delve into a new action-oriented approach to a spectrum of possibilities, such as musical creativity, performance and education.

We take on an integrative approach with a set pattern as a way of sharing problems and finding solutions. The followed pattern draws together a number of threads in embodied music cognition and musical creativity. Types of issues to which it applies are for example, sound perception, composition, performance, social interaction, gaming and learning.

The research described in this paper is part of a long-term investigation that aims at designing embodied music interaction tools that establish an interactive and social experience for different groups of users. Such practice relies as much on the user's enthusiasm to explore the sonic landscape as on the ability to deploy the mediation technology and on the awareness of flow (being absorbed) and presence (being there). Theories of flow (e.g. Csíkszentmihályi, 1988) and presence (e.g. Ijsselsteijn, 2001) are usually typified as belonging to psychological rather than to embodied music cognition research. One of the problems is that in general, experience of flow and presence is approached as a product solely of the mind (e.g. Ijsselstein and Riva, 2003). Our assumption is that a system that combines the role of corporeal articulation and the use of mediation technology will enhance embodied interaction with music.

Presence is often described as the immersion into a virtual environment, whereas flow refers to an experience of immersion into an activity (Weibel et Al., 2007). While the concept of presence focuses more on technological characteristics, the concept of flow focuses more on task characteristics. Contrary to the fact that flow and presence share similarities such as intense feelings of involvement, until today little attention has been paid to the connection between the two concepts. After all, flow and presence research in music is still at an early stage of development. Studies are needed that integrate diverse insights relevant to understanding the concepts of flow and presence from different areas such as embodied music cognition and music mediation technology. Even if it is known that technology of music mediation allows a more fluent interaction between subject and music, feelings of absorption or being there are not intrinsically bound to technology. Moreover, current design of interfaces often leads to experiences of disembodiment.

Our study proposes an experimental framework that is an alternative model of interaction, which draws on aspects of corporeal articulation and action-perception coupling. In this line of research we examine to what degree a heightened sense of embodiment involves a feeling of active presence and flow in a music world that is directly experienced.

II. EXPERIMENTAL FRAMEWORK

As an initial study toward improving EMI tools, users' experience, perceived attractiveness of the system and the appreciation of the sound were tested.

A. Experiment setup

The pilot experiment was carried out in the IPEM laboratories under controlled circumstances. Subjects were standing in front of a console with a computer on which the EMI software was installed and a laptop with an on-screen manual that supports the use of the system. Next to the console was a board with writing paper. During the actual performance of the tasks participants were wearing

headphones. In each hand they had a movement sensor (Wii Remote) that was used as an input device (Figure 1).

Figure 1. Global view of the experiment setup showing a subject (left) interacting with the EMI tool (computer), guided by an on-screen manual (laptop) and assisted by the experimenter/tutor.

B. Participants

Although the final version of the tested application aims at supporting musical interaction between normal-hearing people and hearing-impaired individuals with cochlear implant, the preliminary test involved 33 normal-hearing subjects who interacted with the system in an individual condition. Contacts for involving deaf persons with and without cochlear implant have been made, but before these people can come into play prospective research exploring normal-hearing peoples' reactions and well-tested tools is required. Because the cochlear implant converts sound into electrical pulses, which are injected directly into the auditory nerves, the cochlear stimulation strategy needs a well thought of approach.

C. Method

Our integrative approach for the evaluation of the current version of the EMI tool was based on incorporation of three methods that are:

- Observation by an evaluation team of experts (i.e. 1 MA student in musicology, 2 software developers and 1 experimenter/tutor).
- Video recording of the performance.
- Pre- and post-questionnaires probing background, experience, personality and usability of the system.

D. Embodied Music Interaction tool (EMI)

Developing new tools for music creativity through embodied mediation technology that allows communication and social interaction between normal-hearing and hearing-impaired performers brings about technological and cognitive problems. Although it is documented that cochlear implants do not prevent users from appreciating music, one of the most common complaints of cochlear implant users is that music perception is poor (Laneau et Al., 2004). Therefore a major challenge for musicological research is to design a system that provides users with sounds that are attractive to both groups and that supports embodied interaction.

The development of our embodied music interaction tool is still in an early stage. In our study we used test version 3.3 of the EMI software. The tool was developed at IPEM upon the Max/MSP platform. It captures Wii Remote actions performed by the subject/performer. The interactive visual interface consists of three windows containing textboxes, buttons and events according to the different tasks (see below).

The first pane is the setup window. Second, the user is confronted with the 'make sound' window (Figure 2). Third, the composition window is presented to the user (Figure 3).

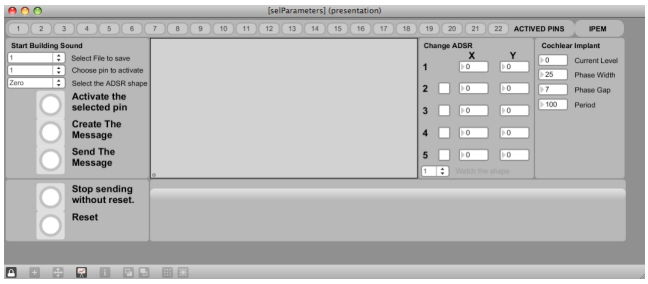

Figure 2. Visual interface of the EMI tool window for the 'make sound' task.

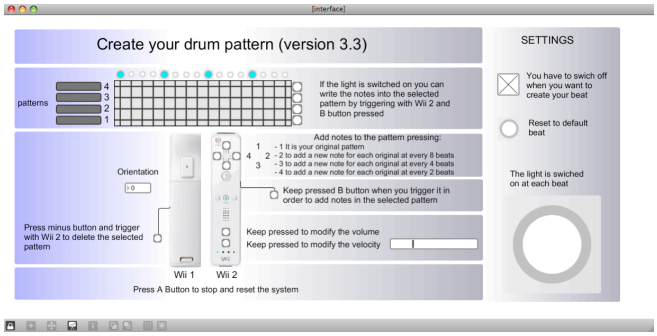

Figure 3. Visual interface of the EMI tool window for the creation of drum patterns.

E. Procedure and tasks

The experiment follows a set pattern in 5 parts. Firstly, prior to their participation in the actual study, participants completed a background questionnaire. Secondly, in a 10-minute introduction, the experimenter explained the tasks and gave a short demonstration of how to use the sensors and the visual interface. From the third part on all communication was non-verbal. Participants were invited to wear headphones as a simulation of being a hearing-impaired person whose electronic hearing device is connected to the application. In that way we could encounter possible problems or points of special interest related to the communication with cochlear implant patients. Fourthly, in the main study session, which lasted around 15 minutes, participants had to interact with the music system using Wii Remote's movement sensors. The main study session comprised 3 tasks:

- Composition of sounds to play with
- Combination of these sounds into a four-voiced rhythmic pattern
- Manipulation of volume and tempo

To end with, they were requested to fill in a detailed post questionnaire that probes their experience during the experiment, the usability of the system, and their perception of their personality.

III. RESULTS

In what follows first a brief overview is given of descriptive analysis of the pre-questionnaire. Then, we describe subjects' experience of flow and presence according to the analysis of ratings in the post-questionnaires. Finally we summarize findings of the observations.

1) Background information

From the background information we learn that 73 % of the participants in the experiment were students, aged between 20 and 30 years, of the departments of musicology and audiology of Ghent University. 85% were musically educated, with duration from 3 to 20 years and all of them play a musical instrument. With regard to their dance behaviour 63% said they dance regularly (from a few hours per week to every day). From the test group only 2 persons said they use game consoles very much, 63% never seem to play games and 33% tend to use game consoles less than once a week.

2) Experience of flow and presence

The post-questionnaire focussed both on users' understanding and experience of embodied interaction using the current version of the EMI tool. Subjective experience of flow and presence, usability of the system and personal characteristics were probed. Subjects had to rate 36 verbal descriptions of presence and flow experiences on a five-point Likert scale.

Flow was assessed using flow conditions, characteristics and consequences such as skill and challenge, clear goals, clear feedback, activity-consciousness, and loss of self-consciousness (Csíkszentmihályi, 1990).

Notable results are:

- Clear goals: 94,4% of the subjects said that they found the given information (manual and tutor) on the system useful.
- Clear feedback: 76,5% understood the mapping between the sound and the movement.
- Activity-consciousness: 91,2% realized that they were using sensors and 79,4% found it difficult to concentrate.
- Self-consciousness: 76,6 % was thinking about their actions during the performance.
- Autotelic: 67,6% said they would recommend the tool to others.
- Challenge: 61,7% found that the application was stimulating their creativity.

The results found hold a dichotomy indicating that the subjects are interested in the system but experienced difficulties with its usability.

Similar output was found for characteristics of presence. Subject's experience of presence was approached using the same description set that was mapped to the factors (Witmer and Singer, 1998) that influence presence, namely control factors, sensory factors, distraction factors and realism factors.

Distinguished findings are:

- Mode of control: 88,2% report that it took time to be able to use the system.
- Consistency of information: 76,5% understood the mapping between the sound and the movement.
- Interface awareness: 91,2% realized that they were using sensors.
- Meaningfulness: 79,4% found the application useful.

Presence experiences of media characteristics (Lombard and Ditton, 1997) form (e.g. richness of the medium, interactivity, responsiveness) and content (e.g. meaningfulness, creativity) are diametrically opposed to each other.

3) Observations

The expert team that observed the participants and video recordings identified interesting issues that result in questions for clarification.

A first problem concerns the interface design and how it can reduce the current need for a lot of (verbal) explanation. The complexity of the whole setup (2 computers, three interfaces, many buttons, board with writing paper, 2 Wii remotes) influenced participant's behaviour and creativity. The strong accentuation on how to use the system directed attention towards the technology.

A second issue that needs further clarification is the choice of remotes. During the experiment it became clear that using two Wii remotes, one in each hand, was rather confusing. The experimenter had to introduce tricks (e.g. no longer hold the first Wii) and quite often he had to take over and demonstrate once more how to handle the remotes. This led to breakdowns in the experience of the participant and once again directed their attention to the technology. The subjects involved argued that they were absorbed in the near-motionless contemplation of the computer screen.

IV. DISCUSSION

The key advantage of our integrated experimental framework is that it is designed to test a broad range of user capabilities that might improve communication ability and music creativity for and between different types of user groups.

Given the early stage of exploration, this study just reports on normal-hearing subjects using the current EMI system in an individual condition.

With respect to observed difficulties it was for example clear that most participants found the given tasks rather hard. The problem encountered revolves around the apparent lack of human presence and involvement. More specifically, it spins around the relationship between the performer's experience, the interaction medium and the visual interface. Although most participants (88,2%) agreed that a certain time was required to be able to use the system adequately, the application was not considered to be too difficult or too easy. This finding suggests that the EMI tool established a balance between challenge and skills. In line with this, participants experienced a certain incentive to be creative.

In our experimental framework attention is paid to the coupling of flow and presence as a valuable top down strategy for the design of embodied music interaction tools. However, in this experiment flow experience was not very much observed during subjects' performances. This phenomenon is explained by the fact that goals and feedback were not clear and unambiguous every step of the way. The deficiency of clear feedback between motor input and sonic output has resulted in a disassociation of performer from performance

medium. The focus of subjects' attention was on technology and there was even not one participant who reported not being aware of using sensors. To enable the illusion of non-mediation and let participants concentrate on the sound scaping and pattern composition, the usability of the system needs to be improved. For example, by means of an interface that affords the required actions without the need for lots of explanations. Especially with regard to the adaptation of the system to cochlear implant patients, the use of easy comprehensible icons, accurate size of fonts and other objects, and possible integration of sign language should be considered.

Because the Wii remotes are currently sheer triggering devices, further research will lead to the use of sensors as articulation devices. That is as a medium that enables users to generate music on the basis of corporeal articulation through which the perceived motion in the music is meaningfully translated into a personal repertoire of body movements. The body movements will then serve as trigger mechanisms for sound scaping and pattern composition. In other words, the body will become the trigger device.

V. CONCLUSION

The results of our first tests confirm the importance of an integrative approach that is concerned with embodied interdependency between user and music mediation technology. The methodology of integrative approach brought significant objectives for future research to the foreground, such as the strategy of coupling flow and presence to improve the design of embodied music interaction tools. Our study shows that there is a considerable scope for embodied mediation technology for music creativity to enhance and renew music interaction behavior.

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