CHILDREN CONFRONTING AN INTERACTIVE MUSICAL SYSTEM

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ABSTRACT

Many approaches have been proposed to develop and use software technology for musical education. However, the impact on actual musical pedagogy of these works is relatively poor. We claim that the main reason of this limited impact is the lack of collaboration between the system design and educational communities.

Our project deals with an area still under-studied, that of *interactive musical systems*, and investigates in what ways they can affect the learning and the musical creativity of children. In particular, we chose to study young children, 3/5 years old, because in this field, the problem of the interaction between child and machine takes on a fundamental role in the learning process. An experimental protocol was established to observe selected conducts in children confronting an interactive musical system. We used a particular system, the Continuator, able to produce music in the same style as a human playing the keyboard, like a sort of sound mirror (Pachet 2002).

1. BACKGROUND

As recent research indicates, the relationship between new technology and learning is gaining more relevance in the field of music education (Webster 2002; Folkestad 1996). Many approaches have been proposed to develop and use software technology for musical education. Many research communities have indeed been involved in different aspects of the relation between software technology and music education (e.g. Camurri & Coglio 1998; INA-GRM, La Musique Electroacoustique 2000; IRCAM-MusicLab 2002). However, the impact on actual musical pedagogy of these works is relatively poor. Today, the penetration of music software in educational settings is almost non-existent and, on the other hand, an archaic conception of music education still characterizes the pedagogical music software.

We claim that the main reason of this limited impact is the lack of collaboration between the system design and educational communities. More precisely, the community of ITS (Intelligent Tutoring Systems) is mainly interested in the issues related to designing novel systems that integrate pedagogical goals in musical systems. These systems may contain technical and conceptual innovations, but they are not actually used because they do not take into account the educational and psychological perspectives, from the start. On the other hand, experimental psychologists have mainly studied the impact of *existing music software* on music education.

State of the art

It is impossible to draw a complete list of projects and approaches to using software technology for music education. However, we can list some criticisms that we think apply to most of them, in terms of their applicability in actual pedagogical musical settings:

- The issue of **fixed musical objectives:** Most of the pedagogical software are programmed with fixed musical objectives in mind: to practice ear training, chord recognition, rhythm identification and replication, etc. Even if the pedagogical objects are reasonable and can be justified, such a systematic approach to musical training is difficult to impose, especially on young children. The lack of flexibility of this “closed-world” approach has been acknowledged in Artificial Intelligence, but such a paradigm shift has not yet been turned into practical solutions.
- The issue of **adaptation** to learners: It has long been recognized that teaching should be learner-centred in order to be efficient. However, the integration of a “model of the learner” in actual pedagogical software usually amounts to no more than the use of a primitive choice list (e.g. to select the “level of difficulty”).
- The issue of **attractiveness:** For young children (e.g. 3 year olds), the issue of attractiveness is crucial. Attractiveness should not be reduced to some marketing tricks (e.g. infancy interface), but should be incorporated into the pedagogical tasks as well as in the working of the software.

2. THE PROJECT

Our project proposes to design a novel approach to musical interaction software based on a systematic collaboration between system design, cognitive science and experimental psychology and education. In particular, the project deals with an area still under-studied, that of *interactive musical systems*, and investigates in what ways they can affect the learning and the musical creativity of children. We chose to study young children, 3/5 years old, because in this field, the problem of the interaction between child and machine takes on a fundamental role in the learning process. Imberty (2002), in accordance with the psychologist Daniel Stern (1995), describes the musical development of young children as based on the vocal play between child and mother (lallation, baby-talk), characterized by the mechanism of repetition and variation. The point of interest is to verify what type of music development arises when this interaction takes place not between two human subjects, but rather between a child and a machine (the "new brainframes", De Kerckhove 1991).

We have performed some experiments in the domain of children and music improvisation. We used a particular system, the Continuator, able to produce music in the same style as a human playing the keyboard, like a sort of sound mirror (Pachet 2002). This system is based on the notion of Interactive Reflective systems. The core concept of this approach is to teach powerful – but complex – musical processes (such as tonal harmony, improvisation, etc.) indirectly by putting the user in a situation where these processes are performed not by the user (like in traditional master / slave approach) nor by the machine (like in some ITS approaches), but by the *actual interaction* between the user and the system. The system's ability to imitate the style of the human playing the keyboard, can be interpreted through the Theory of Flow introduced by Csikszentmihalyi (1990). The notion of Flow describes the so-called "optimal experience" as a situation in which people obtain an ideal balance between skills and challenges. We can think of the Continuator as a Flow machine, in the sense that it produces a response corresponding to the skill level of the user.

A preliminary study has been conducted in Paris with eight children of 3 and 4 years, who were invited to play a keyboard and then, the keyboard connected to the Continuator (Pachet & Addessi 2004). The design of the Continuator as a Interactive Reflective system, and its interaction with the children, very similar to the human interactions, suggested us a second experimental protocol which was trialled in Bologna (Italy), by systematically observing selected behaviours of the children: listening, music style improvisation, attention span, turn-taking, symmetrical communication, facial expressions. Therefore our project about child and musical machine is characterized by the following elements:

- The **system** chosen for our experiment avoid the monotony of mere repetition.
- The relationship between musical education and new technologies is examined from the point of view of the **interactivity**.
- The age of the children that we intend to observe, **3/5 years**, is still quite under-studied.

Aims

From a pedagogical point of view, the general aims are to define some hypotheses about the nature of child/computer interaction, to understand in what way the children relate with the interactive musical systems, and how the interactive systems can be used in the educational field to stimulate creativity and the pleasure of playing.

Method

We used the observation methodology. The observation setting was carried out with 27 children of 3 to 5 years, in an kindergarten. We used a Roland ED PC-180A keyboard as the interface for the Continuator. Three sessions were held once a day for 3 consecutive days. In every session the children were asked to play in 4 different ways: A) just with the keyboard, B) with the keyboard and the Continuator, C) with another child, and D) both with another child and the Continuator. The tasks were given in random order. All the sessions were recorded on video. The attention span of the children was measured for each task. Two case-studies were observed and analyzed (Addessi & Pachet 2003). Successively, the most interesting conducts were selected to be tested also on the other children by means an observation grid.

Results

The data analyzed until now show a certain number of results, relating to the development of interesting music interaction between children and system. Different modes of explorations, increase of time of attention, development of analytical behaviors, concentration and listening were observed.

- **The Life cycle of interaction**: Generally speaking it was possible to observe an initial dynamic curve of the interaction that moves from *Surprise* (the *Aha effect*), to a different phases of *Excitement*, C*oncentration and analytical behavior, Invention, Relaunch*.

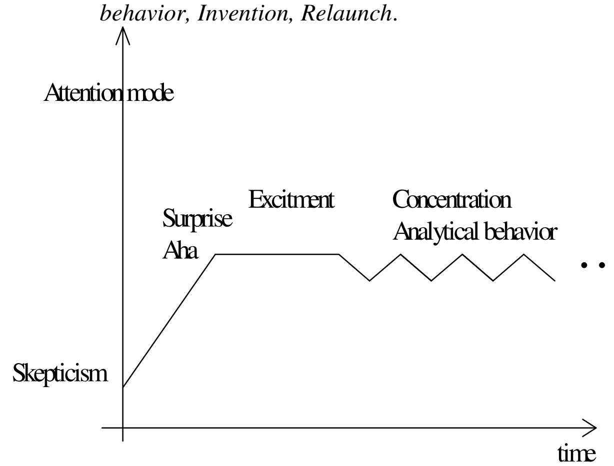

Figure 1: A tentative sketch of the "life cycle" of the interaction mode with the Continuator.

- **Repetition/variation**. We observed that e real dialogue between the child and the system actually begins as soon as the child recognizes something from his own proposal in the reply of the system, and tries to answer in the same way: by repeating and varying what he has just heard from the system. A similar structure has been observed by Stern (1995) and Imberty (2002) in the vocal relationship between mother and child.

- A preliminary analysis of **improvisations** revealed rhythmic and melodic patterns, synchronization on the same pulse, forms of song and accompaniment, individual improvisation styles, brief formal constructions based on imitation, repetition, alternance, contrast. Every child show individual musical style.

- The analysis of **attention span** (the time of every task) shows a significant difference between tasks with system (B and D) and without system (A and C). The multivariate analysis of variance (MANOVA) was carried out on the repeated measure factors (within) Session and Task, taking the lengths of the tasks as the dependent variable. A significant effect was seen for the

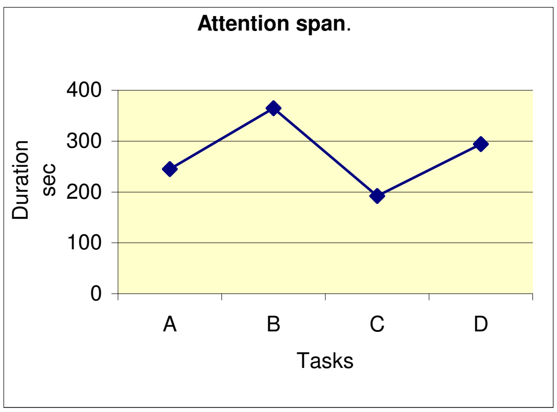

Figure 2: Mean values for the four tasks in the three sessions taken as a whole.

factor Task ($F=5.15$; $p<.05$). The paired t tests showed the differences between task A and task B to be significant ($t=-3.79$, $p<.01$), as well as the differences between tasks B and C ($t=3.21$, $p<.05$). Borderline values of significance were seen for the differences between tests C and D ($t=-2.30$, $p=.05$). These data show how most children reach a stable level of attention characterized by a strong intrinsic motivation. The system therefore appears to motivate also children working in pairs, thus stimulating the socialization of the musical experience (joint attention).

- The **listening** conducts are concentrated, analytical, but also symbolic and creative. The children also listen carefully their own productions, that is one of the main aims of music education (Delalande 1993).

- The children learn the **rules** of the system, and learn to teach these roles to the friends and to the system self. They also create rules.

- **Interaction**: We observe some kind of *turn-taking*, *role-taking*, *attachment* (Bolwby) and *affective sintonization* (Stern), that show how this interactive system generates very complex reactions, where the children are expected to form judgements about 'Self' and 'Other'', also in musical meaning.

Figure 3: Some examples of interesting interactions: a) Surprise and Aha Effect; b) Excitement; c) Attentive Listening; d) Joint Attention; e) Improvisation.

- **The Theory of Flow**: In the children's behaviour it was possible to recognise the characteristics of "optimal experience" described Csikszentmihalyi (1990): distractions are excluded from the consciousness, action and awareness are merged, there is immediate feedback to one' s actions, step by step, the activity becomes autotelic.

3. CONCLUSION

The data analyzed until now would suggest that the Continuator is able to develop interesting child/computer interaction, very similar to those of humans, as observed in the infant-adult communication (Stern 1995, Imberty 2002), but with a more mechanical and computational approach (De Kerckhove 1991, Turkle 1984), that would explain why the children found it so exiting. From a pedagogical point of view, one of the most result is that this system is able both to develop very attentive listening, creative musical behaviors, and personal musical style improvisation, based on the ability and musical knowledge of the children. The results also suggested some reflections on what the human can learn about themselves by observing this system, e.g. the method to teach music improvisation. Therefore the data allow us to understand not only some mechanisms of child/computer interaction, but rather something about the nature of human interactions.

We are now analyzing systematically all children that took part in the experiment, by means an observation grid. Observation of a larger sample would give more significance to the results. As such, the Continuator is only one instance of a larger class of system that could be called "reflective", i.e. in which users can play with virtual copies of themselves, or at least agents who have a mimetic capacity and can evolve in organic fashion. We claim that most of the interesting properties studied in our experiments probably come from this particular characteristic.

In light of these results, the project foresees the experimentation of new variants of reflective interactive musical systems. The aims are to establish a "spiral organization" between system design and implementation and psychological experiments, to develop new musical reflective systems, based on the experience with the Continuator, and to perform psychological experiments in different countries in order to assess the pedagogical value of these systems. We believe that the approach consisting of integrating closely psychological experiments with system design is very productive and should be pursued.

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