Peer-reviewed Paper

Exploring turn-taking in children’s interaction with a new music technology

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This study investigates empirically 4-8-year-old children’s interaction with a novel technology for music improvisation called the MIROR Impro. The technology is designed to ‘respond’ in a varied but stylistically consistent manner to the child’s playing. Looking at this interaction from a pedagogical point of view, informed by a socio-cultural perspective, we analyse (i) the basic turn-taking rationale of the technology; (ii) what characterises the turn-taking between child, technology and/or another child or an adult; and (iii) if and how the responses from the technology scaffold the child’s musical playing. The results show that while some children discover the turn-taking nature of the technology’s responses, some children need help in noticing this feature. The changing nature of interaction and turn-taking when the child plays the keyboard alone or with a peer or adult is also clarified. The children do not necessarily orientate themselves towards the rationale ‘inscribed’ in the technology, instead being focused on achieving other musical goals, e.g., playing a melody rather than improvising. The findings are discussed in terms of a more dialogical notion of musical development than traditionally conceived and the importance of the child’s previous musical experiences in relation to his or her activities with the new musical technology.

Keywords: early childhood education, musical dialogue, musical interaction, new technology, turn-taking

Introduction

Nowadays, children are surrounded by music most of their waking time, streaming from radios, televisions, cell-phones, computers and toys (Lamont, 2008; Young & Gillen, 2007). The musical society children grow up in today is considerably different from only a few decades ago. New technologies for listening to, producing, enjoying and learning music have arrived, and this has changed what is to be regarded as musical knowledge. As Crow puts it (2006, p. 123):

The technology’s ability to manipulate audio has meant that many people, who up until now did not perceive themselves to be musicians, can handle, create and communicate music using their
computers. They employ inexpensive music software and hardware, which does not require 'traditional' musical skills or conceptual understanding.

There are several software programmes that enable users, including young children, to create music from ready-made musical materials such as eJay and Band-in-a-Box. There is also software that is built upon traditional performance skills and the understanding of western cultural music notation, like Cubase and Sibelius (Crow, 2006).

This study will focus on children interacting with a new music technology called MIROR Impro that is currently under development. The acronym MIROR stands for Musical Interaction Relying on Reflection. The designers attempt to create a novel form of pedagogical software for improvisation, particularly in the context of musical education for young children. It is the latest prototype of Interactive Reflexive Musical System (IRMMS), originally invented at SONY Computer Science Laboratory in Paris (Pachet, 2004). This technology consists of a computer programme connected to an instrument (e.g., a keyboard). The child plays the instrument and then the technology plays back a variant, but stylistically consistent, response to the child’s playing. The system takes turns with the player, an idea that is based on the concept of music as a conversation (Walker & Belet, 1999). The computer system is able to introduce a feedback loop into the music production process as a question-answer interaction protocol (Pachet, 2004). There have been several previous studies wherein children interacted with the first prototype of IRMS, called the Continuator (Addessi & Pachet, 2005, 2006; Benghi, Addessi & Pachet, 2008; Ferrari, Addessi & Pachet, 2006; Young, 2006).

The rule of the game, so to speak, is the interaction that takes place between the user and the system, a musical dialogue. The system is programmed to stop when the user plays and to play when the user stops. “The IRMS detects phrase endings, then learns and produces a continuation” (Pachet, 2004, p. 7). Addessi and Pachet (2005, 2006) have, in their studies, drawn the conclusion that when the children stop and listen to the system’s reply it will help them to learn the implicit rule of turn-taking; and since the system repeats, using variations of what the child plays, they can establish a dialogue that can be compared with human interactions. The authors associate this interaction with the vocal relationship between mother and child that has been observed by Stern (1985) who describes the interaction structure as based on repetition and variation with pauses for readjustment and temporal dynamics. Bruner (1983) has also identified such structures in adult-infant interactions and describes them as games or mini-narratives. When it comes to the field of music, Imberty (2005) has made similar observations and he considers organisation over time as one of the fundamental elements of musical communication. Young (2005) observed comparable musical communication between young children and adults and she suggests that interpersonal dimensions of this kind are a potential source for young children’s creativity.

While there have already been some studies conducted with children using the Continuator, a prototype of MIROR Impro (e.g. Addessi & Pachet, 2004, 2005), additional studies are needed. From our point of view, there is still a need for the clarifying of issues of a pedagogical nature (e.g., the importance and role of the teacher). From a socio-cultural perspective on learning:
In the intent participation tradition, experienced people play a guiding role, facilitating learners’ involvement and often participating alongside learners—indeed, often learning themselves. New learners in turn take initiative in learning and contributing to shared endeavors, sometimes offering leadership in the process. (Rogoff et al., 2003, p. 187)

Departing from the designed intention of the technology (MIROR Impro) to fill the role of a more competent peer or facilitator of the child’s involvement in music improvisation (understood as a sequential turn-taking sound-making practice), the present article investigates empirically whether this assumption is sound, based on how children interact with the technology.

**Theory and method**

In this section we will present our theoretical points of departure from a socio-cultural perspective on children’s learning and development. We will also present the participants and the procedure used for the empirical study.

Previous studies on this technology have been analysed within a primary psychological framework, and what has become observable is the technology’s potential to afford a Flow experience (Csikszentmihalyi, 1990) and to engage users in musical conversations (Pachet, 2004). In the empirical study conducted here, we will focus on the children’s perspective (Sommer, Pramling Samuelsson & Hundeide, 2010) when exploring their interaction with the musical technology. How does the activity unfold as the child interacts with the instrument, the technology, and also a peer and an adult? To consider the children’s perspectives means to search for “children’s experiences, perceptions, and understanding in their life world” (Sommer, Pramling Samuelsson & Hundeide, 2010, p. 42). This raises several contemporary challenges posed by socio-cultural theory to research on children’s learning (Wallerstedt, Pramling & Pramling Samuelsson, 2011); two of them are of particular interest for this study. First, children’s knowing, as with all human knowing, is socially situated (Wells, 1999). Within this theoretical framework we cannot measure children’s knowing in general. Instead, the analysis concerns how this knowing is contingent upon how a certain task is communicatively framed. In the case of the specific technology of MIROR Impro, it refers to what the tool/software in the present situation affords and what aims it may scaffold (Wood, Bruner & Ross, 1976/2006). Second is the importance of analysing learning from the learner’s perspective. This theoretical notion is today widely shared in pedagogical research (e.g., Marton & Booth, 1997; Sommer et al., 2010; Säljö, 2000). An expression from a child, verbal or physical, is not seen as being more or less ‘proper’, it is presumed to be rational and relevant according to his or her understanding. This means that it is important to analyse how the child takes on the task she faces, rather than whether she answers or performs ‘correctly’ according to some predefined criteria.

A basic interest from a socio-cultural point of view is how people participate and change their participation in various practices (Säljö, 2000; Wood et al., 1976/2006). In exploring this interest in participation and interaction between people, as well as with artefacts, i.e., various cultural tools (Vygotsky, 1978), the
The concept of intersubjectivity is often used (Suthers, 2006). Rogoff (1990, p. 71) describes intersubjectivity as “based on a common focus of attention and some shared presuppositions that form the ground for communication”. Furthermore, as Rommetveit (1974) has emphasised, intersubjectivity in the sense of two (or more) people temporarily sharing perspective on something is necessary in order to be able to go on with a joint activity, rather than pursuing distinct lines of activities. In the present case, this issue becomes of interest because the technology as a ‘stand-in’ for another person is designed to support a certain kind of participation—turn-taking. The question whether the children actually respond to this in-built rationale, or come to pursue alternative modes of action, is pursued in the present study.

In the present case, the ‘content of learning’ built-in through the design of the technology, is turn-taking per se. The nature of children's participation by interacting and taking turns with other human beings is a well known part of the learning process of any content (Rogoff, 1990). However, in this case musical turn-taking is the underpinning idea in the design of the software, so turn-taking is intended to be the goal rather than the means of the child’s interaction. The practices of inter-subjective meaning making are found in potentially any and every kind of joint human activity (Suthers, 2006), but what we intend to study here is also the interaction between children and a ‘non-human-subject’, the computer. How, then, is the ground for communication established, as seen in how the child responds to the technology, and in her subsequent reasoning when interviewed by a researcher?

The empirical study

The examples of children using MIROR Impro that we will study here are taken from a larger data set. The children are 4-8 year-olds and take part either in a preschool or an after-school centre in Sweden. The after-school centre is located in a rural area while the preschool is located just outside a larger city. In total 12 children in preschool have participated and seven of them do not have Swedish as their first language. In the after-school centre eight children participated. The children have been interacting with the technology for up to three sessions each, alone or with a friend. In some cases, the researcher has also been interacting with the child(ren) during their play sessions or afterwards in stimulated recall interviews. The sessions have been video recorded and prevailing ethical guidelines have been followed. In total, the data consists of approximately four hours of video recordings from the preschool and four hours from the after-school centre. Interviews have been transcribed in full and the sessions where children are playing with the synthesiser and interacting with the musical technology are described in detail. When children are both talking and playing, verbal turns are numbered [1, 2, 3…] and musical dialogues [I, II, III…]. In the sessions children use a Korg X50 synthesiser connected to a loudspeaker and a computer running the software. The equipment is placed in one of the smaller rooms in the preschool or the after-school centre, for example the room they usually use for playing with dolls. None of the schools have an explicit music profile. The equipment is brought in by the researchers and is not normally used in the settings.

The aim of this study is to explore how children gain mastery and socially learn with the adult and their peers when playing with the keyboard and the software.
Examples from all types of data (see above) will be used here; in cases where an adult present, it is one of the researchers.

**Results**

In this section we will explore (i) how the children respond to the underpinning idea of turn-taking with the technology, (ii) how turn-taking, in the cases where it becomes established, is conducted between children or with an adult; and (iii) how the answers from the computer do or do not scaffold the children's own ideas of playing music.

*The answering computer from the children’s points of view*

Some children, both playing alone and with a friend, first react with surprise and what seems to be a positive feeling when they realise that the computer gives answers to what they play. Eric (7) and Emma (6) play for the first time in the after-school centre.

Excerpt 1: Eric (7) and Emma (6), session 1, Musical dialogues I-IX

Eric and Emma start playing glissandos. When they stop playing and the computer is answering, Eric makes dance moves and laughs. They go on playing clusters with both hands, like they were drumming on the keyboard. When the computer is answering, Eric ‘puts his hand on his forehead’ and laughs. Emma is also laughing. Eric plays a single cluster, Emma repeats and so does the computer. Eric is playing two clusters, Emma repeats and so does the computer. Eric then asks Emma ‘was it you that…? Wait, now I will do like this.” Eric plays clusters and glissandos and when he hears the answer he asks Emma, who is laughing, “was it you that played?”. “No”, Emma replies. They go on with playing clusters, laugh heartily and Eric says “Oh shit!” and Emma “let’s do it again”.

Eric and Emma spontaneously stop playing after a short phrase and become aware of the answer from the computer. Mehmet (5) does not. In his first session, the adult tells him to stop and listen.

Excerpt 2: Mehmet (5), session 1

Mehmet starts playing without any pause. He smiles and lets his fingers ‘walk’ over the keys. After about one minute, the adult says “let’s see what happens if you stop playing”. The computer starts playing and Mehmet looks confused. He looks at the computer and then points at the loudspeaker and asks “why does it mocking?” He points at a key in the bass register and comments “I haven’t played that one that many times”.

Eric and Emma as well as Mehmet consider what is happening and what the computer is doing. Eric and Emma find out that there must be ‘a third partner’ to their musical playing when Eric asks Emma if it was her that played and she replies no. Mehmet realises that the computer is mimicking him, but does not repeat his input exactly.
Even if the children do understand that they are playing with an answering machine, they do not always appreciate it. Sandra (8) and Anna (8) are being interviewed after they both have been playing individually with the system three times each. In the interview, they watch a video clip from one of Anna’s sessions.

Excerpt 3: Anna (8) and Sandra (8), interview

360 CECILIA: Yes. It seems like you are waiting for the computer to finish here?
361 Sandra: I didn’t do that.
362 CECILIA: Didn’t you?
363 Sandra: No.
364 CECILIA: How did you do then?
365 Sandra: When it was playing, then I played so I didn’t have to wait.
366 Anna: Sometimes I did that as well.

From the child's point of view, understanding the role of turn-taking does not necessarily equate to finding it interesting or as something to try to achieve. From a teacher's point of view, turn-taking could be said to be a pedagogical goal, but it could not be taken for granted that the children share this goal.

There were several children that never showed any interest in stopping and listening during the sessions. Frans (8) plays for the third time, sitting alone in the room:

Excerpt 4: Frans (8), session 3

When the researcher leaves and the door is closed, Frans hits his hands on the keys. He goes on playing a rhythmical theme that he previously has elaborated on. He varies a wide range of ways of playing; glissandos, walking movements in different rhythms and intensity, clusters etc., but he never waits for the programme to reply.

Different ways in which the turn-taking is organised between children or with an adult

Different resources are being used to set the turn-taking and to co-ordinate the playing between peers or between a child and an adult. In the case of Eric (7) and Emma (6), they use more or less subtle gestures as well as verbal communication. Three examples will be given below:

Excerpt 5a: Eric (7) and Emma (6), session 1, musical dialogue XI

Eric and Emma are hitting the keyboard with their hands, playing clusters. Eric is making noises while playing and he has a crazy look on his face. Emma looks at him and laughs. Eric lays his hand on her arm and they both stop playing.
Excerpt 5b: Eric (7) and Emma (6), session 1, musical dialogue XIII

Eric and Emma are hitting the keyboard with their hands, playing clusters. Suddenly Eric lifts up his hands as a signal to Emma that they should stop. Emma stops playing and they both laugh when the computer is answering.

Excerpt 5c: Eric (7) and Emma (6), session 1, turns 28-31

28 Emma: (Directed to Eric) can we play really fast and…
29 Eric: Really much!
30 Emma: Yes.
31 Eric: Ok.

This conversation is followed by Eric and Emma playing wild clusters in a fast and intensive way. Eric is even screaming when he plays. Emma tries to tell him to stop, but they do not stop until Eric suddenly raises his hands, a strategy that has been previously seen in their playing together. In the three examples (excerpts 5a-c) it became obvious that it is Eric that has the lead in their collaborative playing. To co-ordinate how to stop simultaneously in the improvised playing, he lays his hand on Emma’s arm (excerpt 5a) or raises his hands as a signal (excerpt 5b). Later on in the session, they increasingly try to plan for playing in certain ways and for that they use verbal conversations, as in excerpt 5c, when Emma takes the initiative.

When two children are playing the keyboard together, the question of turn-taking is quite different from when the child is playing alone with the system. When Eric and Emma are laughing (see excerpt 5b), it does not become clear if they find happiness through their engagement in doing this wild thing together, or if they appreciate the music from the computer. When a child plays alone, the only source of inspiration, except from the child him/herself, is the computer. It is shown in our data that the mirroring answer from the computer does not always fill the role of ‘inspiring partner’.

Excerpt 6: Sandra (8), session 3

The adult asks whether she can stay and listen when Sandra will play. She does not say anything, but nods. She plays some short phrases and says “but now it sounds the same”. The adult confirms with “mmm”. Sandra plays some additional phrases and the experimenter suggests, “Do you think you could make it sound differently?” Sandra says that she “do[es]n't know” and sounds rather uninterested. The experimenter suggests Sandra try. She plays a rhythmic sequence in an ‘upwards’ movement. She comments on the response from the computer, that “it was different at the end” (which is also consistent with the experimenter’s impression). Sandra plays some additional phrases and the adult asks “Was it the same now?” Sandra says “no” and “now it’s enough”.

In this case the adult tries to make sure that the child is aware of the answers played by the computer. This takes place in the child’s third session, so the child already has some experience of playing with the system. Sandra has not shown
any particular excitement so far. In Excerpt 6 it becomes clear that she takes notice of what the computer plays, but her interest is fading. The session is ended just after this, by her saying she does not want to play anymore.

Another way that the adult can interact with the child is by becoming engaged in the playing, not only in asking questions. In the following case, the adult becomes the playing friend.

Excerpt 7: Lisa (4), session 1

38 CECILIA: Shall we both play a bit with the computer?
39 Lisa: Yes!
40 CECILIA: [Plays distinctly with two fingers, one from each hand, for 2 seconds.]
41 Lisa: [Catches on and plays in a similar way, very briefly.]
42 CECILIA: [Marks the end of the phrase and waits for the computer.]
43 Lisa: [Mimics.]
44 CECILIA: [Plays the same phrase but very fast.]
45 Lisa: [Imitates simultaneously. Looks at Cecilia and smiles while the computer answers.]
46 Lisa: [Takes the initiative to play in a similar way once more.]
47 CECILIA: [Does not play. Instead waits for the answer from the computer which is rather long.]
48 Lisa: [Holds her hand away from the keyboard.]
49 CECILIA: [Plays only a few tones. Plays them again when there is no response from the computer.]
50 Lisa: [Plays a similar phrase.]
51 CECILIA: [Does not play along. Instead waits for the response from the computer. Plays in a similar way with both hands.]
52 CECILIA and Lisa: [A clear turn-taking sequence has been established between three ‘parties’: Cecilia, the computer, Lisa, the computer etc. Short sequences. A break when there is no response from the computer. Cecilia plays only one tone, Lisa plays only one tone. Cecilia plays softly, Lisa plays softly. Lisa plays with her whole hand again, Cecilia plays with her whole hands, Lisa does the same. Cecilia returns to playing single tones, Lisa does the same. Cecilia plays a glissando, Lisa plays single tones again. Cecilia plays a scale, Lisa plays a scale, but goes ‘up’ as well as ‘down’. Lisa plays with her whole hands.]

In the previous part of this session the turn-taking between Lisa and the computer had not been clearly established. When the adult joins in, the turns become shorter (turn 40), and Lisa looks pleased (turn 45). The adult does not give verbal instruction on how and when to stop playing, but does make a distinct end (turn 42); this way of playing is immediately taken over by Lisa (turn
43). In turn 52 a clear turn-taking rhythm has been established whereby both Lisa and the adult initiate trying new ways of playing. They play and then they listen. It must be noted that one of the clear differences between playing with another human being and playing with this software is that the human being is visible while the sound from the computer is not. Therefore, it is not clear whether what seems to be more attentive listening when playing with someone is actually more attentive watching. The ways of playing that are initiated by the adult in this case, and by a peer in the previous case of Eric and Emma, are auditory as well as visible. In software aimed at playing music, the turn-taking concept based purely on listening is easily taken for granted. However, turn-taking is here shown to be of a more multi-modal character.

*Different ways in which the idea of turn-taking scaffolds the musical interests of the children*

To understand analytically what the children want to achieve, if anything, while playing is sometimes difficult. In the cases where a child starts to play a certain melody, it becomes quite obvious that it is this particular melody he or she wants to play. Anna (8) is one of the children who have some experience playing the keyboard. She has a keyboard at home and her mother has helped her learn to play a few melodies. When playing with this system, she takes one of her melodies as a point of departure for her improvisation. She speaks about this in the interview after her sessions using the MIROR Impro:

Excerpt 8: Anna (8), interview

40 CECILIA: But, how, did you feel any difference when you played at home and when you played with this system?
41 Anna: Not that much. It was more like, here it answered.
42 CECILIA: Yes, exactly. Did you feel that it was fun or boring, or, like, or how did you feel about having someone that answered? Would you like to have that at home as well?
43 Anna: I don’t think I would, because it was quite annoying, but it was fun to play.
44 CECILIA: Ok, in what way was it annoying?
45 Anna: At home I use to play the whole song, and then I felt that it was quite annoying when it answered.

In another example, Lisa (4) says that she knows a song and the adult present in the session encourages her to try that song when playing with the system:

Excerpt 9: Lisa (4), session 1

26 CECILIA: Yes. Try to play that and see what the computer then plays.
27 Lisa: Shall I sing it at the same time?
28 CECILIA: Yes, if you want to.
29 Lisa: Yes. [Starts playing, but there is no sound.] No, there is no!
30 CECILIA: Oops, you have to play a bit harder.

31 Lisa: [Sings the well-known song “Little Cat” and plays one tone per beat with what appears to be random tones across the entire keyboard. She also plays with her fists. She stops.] I don't really know Little Cow [another part of the song Little Cat] [Stops playing. The computer responds. Lisa looks surprised.] Oh! [Laughs].

32 CECILIA: [Laughs.]

33 Lisa: [Appears to listen attentively to the response. She mimics a sound made by the computer] bang. Mother knows even better melody than I do. She can.

Lisa knows the song and can sing it, but she cannot play it on a keyboard. Instead, she ‘pretends’ to play by playing the rhythm of the song on any keys. Her intention to play this particular melody cannot be ‘read’ by the system, as it could be by an adult or a more experienced peer. The system can only learn from what the users actually play, not from what they say that they want to play. Here, the response by the system seems to be contrasting what she ‘meant’ to say musically, and therefore sounds odd (turns 31-32).

The children bring with them their previous musical experience in general (like Lisa using a song known from preschool practice) and keyboard playing in particular (like Anna using her knowledge of playing the keyboard learned at home). In these two cases the computer cannot be said to scaffold the children’s interest. However, the aim of the software is not to scaffold children’s ability to play keyboard, but rather improvisation as a more general ability. To analyse this issue requires a much deeper discussion of what the ability to improvise consists of than can be made here.

**Conclusion**

What we have been exploring here is the issue of turn-taking between children, between a child and an adult, and most importantly between children and a new prototype of technology designed for improvising music (MIROR Impro). The results demonstrate that many children show an understanding of the responding computer and react with surprise and enthusiasm, and sometimes with disregard. Some children do need help to become aware of the possibility of turn-taking with the system and they get this from an adult’s verbal instructions, as well as by collaboratively playing with an adult or a peer. When there are two users of the system at the same time, they use both physical and verbal resources to coordinate their playing, and to achieve inter-subjectivity that allows them to develop a joint activity (Rommetveit, 1974). Playing together with someone also affords visual impressions, while playing alone with the system is exclusively auditory. When beginning to explore the technology, children use their previous experiences: that is, they use some cultural tools (Vygotsky, 1978) as resources for their activity. In the examples studied here, the children use melodies known from home and from singing in preschool. However, their intentions to play these melodies are not ‘read’ by the system.
Musical knowledge development in Western culture has typically been regarded as an individual learning to play an instrument. This view is being reassessed as a result of an emerging interest in a more dialogic approach (Young, 2003) and new techniques (Crow, 2006). When seeing music as a kind of conversation, turn-taking becomes crucial, which is an underpinning idea behind IRMS and MIROR Impro. From the findings in this article, we can say that the participation of a more experienced peer (Rogoff, 1990), an adult or a teacher still seems to be very important, even with a turn-taking machine available. Some children obviously need help to discover the basic rules of both playing and of stopping to listen. But children sometimes also need help to see why this is interesting. Building on previous research relating to adult-infant interaction (Bruner, 1983), the dialogue approach to music can seem to be something ‘natural’ and innate that children will spontaneously develop. In contrast, our results indicate that children’s ability to improvise in dialogue with a computer is dependent on their previous experience and cultural tools (Vygotsky, 1978) already appropriated through participation in other musical settings. When learning is seen as a developed form of participation, as in socio-cultural theory, motivation and interest in the activity become crucial (Rogoff et al., 2003). From our findings it could be questioned if the children have the feeling of motivation in playing with the keyboard and the software, particularly in the way it is built into the system. For some children, that could be a reason for what seems like lack of interaction with the system.

As discussed by Crow (2006), it is a desirable endeavour to strive towards forming a music curriculum that is perceived as ‘authentic’ by pupils; however, it is not easy to say what the musical content should be. Letting children form their ‘own’ musical style with a computer programmed to respond to them with their own musical language may seem like the ultimate software to use in musical education. However, we raise the question: how authentic is this musical experience for children used to singing melodies in preschool and school; and listening to pop music on mp3-players and websites like YouTube?

To conclude: we want to point at differences that appear as problems when a technical ‘partner’ takes over the communicative part of another human being in musical turn-taking. A first problem is that a child with limited experience of playing on a keyboard can hardly be expected to have appropriated a musical language that could be compared with a human language. Hence, even if the child is capable of turn-taking behaviour with another person, he or she may not be able to do so, or may not want to do so, with musical technology as a partner. A second problem is that inter-subjectivity is something that needs to be achieved (Rogoff, 1990; Rommetveit, 1974; Säljö, 2000). But the shared presuppositions that form the ground for communication, and that characterise inter-subjectivity, are not negotiated gradually in the case of technology. Rather, the expected use is built into the system beforehand, and it is presumed that children identify and align with this expectation. As our study shows, this is not necessarily the case.

Acknowledgements
The work reported here is a part of a large-scale international study on children’s technology-transformed music learning entitled, Musical Interaction Relying on Reflection (MIROR), financed by the European Union FP7-ICT (Grant 258338). The trans-national project group is coordinated by Anna-Rita Addessi (University of Bologna, Italy), Francois Pachet (Sony Computer Science Laboratory, Paris), Bengt Olsson (University of Gothenburg, Sweden), Susan Young (University of Exeter, UK), Gualtiero Volpe (University of Genoa, Italy), and Christina Anagnostopoulou (University of Athens, Greece).

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