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MUSICAL GESTURES AND EMBODIED COGNITION

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ABSTRACT

In this keynote, musical gestures will be discussed in relation to the basic concepts of the embodied music cognition paradigm. Video examples are given of studies and applications that are based on these concepts.[1]

1. INTRODUCTION

Interactive music systems have both a technological and experiential component. The technological component is concerned with the tools that translate human movements into manipulations of sounds. The experiential component is concerned with the intended control of the tools, which is accomplished through gestures. In this keynote, we mainly focus on the later component, as we believe that a good understanding of it is a prerequisite for a successful tool development.

Recently, the foundations of musical gestures have been reconsidered, and new viewpoints have been inspired by the insights from research on embodied music cognition (Godøy and Leman, 2011). The goal of the keynote is, firstly, to clarify the concept of musical gestures in relation to the basic concepts of embodied music cognition, secondly, to consider a number of implications for technology development (Leman, 2007). To illustrate that point, a number of video excerpts will be shown and discussed.

I should add here that in the paradigm of embodied music cognition, it is assumed that cognition is more than just mental processing and its corresponding brain activations. Indeed, music cognition is considered to be situated (i.e. embedded in an environment), and enacted (i.e. put into practice through action) (see Varela et al., 1991; Barsalou, 2008). The embodiment hypothesis refers to an action-oriented basis for making sense of our environment. In that context, we consider the former focus on music and mind within in a broader perspective that puts emphasis on embodiment, action, and consequently, gestures.

[1] This text is a modified version of a chapter that will appear in the book M. Lesaffre and M. Leman (eds.), "The power of music – researching musical experiences", Leuven: ACCO, 2012.

2. BASIC CONCEPTS OF MUSICAL EMBODIMENT

The paradigm of embodied music cognition is based on a number of concepts, related to: (i) the body as mediator, (ii) the gesture/action repertoire, (iii) the action-perception coupling, and (iv) the link with subjective experiences, such as intentions, expressions, empathy, and emotions. Let me introduce these concepts and discuss how musical gestures are related to them.

2.1. Body as mediator

The body of a person can be considered as the mediator between the person's environment and the person's subjective experience of that environment. This viewpoint is widely known (e.g. Merleau-Ponty, 1945), but it always needs a careful explanation. Indeed, the role of the body is particular in that it causally connects with a physical environment as well as with an experience (of the subject who owns that body). The physical environment can be described in an objective way (e.g. the waveform of the music on my sound recorder). The experience can only be described in a subjective way (my subjective feeling in response to the music on my sound recorder). Similarly, musical gestures can be described in an objective way as movement of body parts, but they have an important experiential component that is related to intentions, goals, and expressions.

2.2. The action/gesture repertoire

When the body acts as a mediator between our environment and the experience, it will build up a repertoire of gestures and gesture/action consequences. Such a repertoire is called a gesture/action-oriented ontology. It is the set of commands and their perceived outcomes that is somehow kept in memory and used for the next action and the interpretation of the next perceptions.

The repertoire is based on the idea that humans interact with the environment on the basis of actions, that is, movements that are made to achieve a particular goal, such as access to resources, or access to other persons. The repertoire can also be considered as the reservoir of experiences. This repertoire thus comprises connections between commands, sensations of the external world through our senses (exterioception), but also sensations of our body movements (proprioception) and of our body state (interioception). Musical gestures form the core component of this repertoire.

2.2.1. Gestures

Interestingly, the concept of musical gesture applies both to sounds as well as to body movements (Godøy & Leman, 2010). For example, in a study on guqin performance (Henbing and Leman, 2007), it was possible to show that sonic gestures (identified in music) reflect sound-producing gestures (hand movements), and that these gestures can be understood as concatenations of more elementary gestural components. The rules for combining elements of this alphabet are defined by natural constraints (i.e. physical, physiological limitations) as well as cultural constraints (preferred movements). More recently, Desmet et al. (2012) studied clarinet playing gestures in relation to musical intentionality and expressiveness. Leman and Naveda (2010) studied Samba dance from the viewpoint of spatiotemporal representations.

2.2.2. Entrainment

The research on entrainment considers how resonant systems adapt their synchronization with each other. Traditionally, this work has a more exclusively focus on timing aspects in relation to synchronization, such as the tempo and phase during synchronization tasks in music playing or dancing.

2.2.3. Gestures and entrainment

In several more recent studies conducted at IPEM, we consider the idea that gestures may condition entrainment, and therefore, that the focus of entrainment should be broadened to include a spatiotemporal dimension that is rooted in bodily gestures. Such an approach may lead to a gestural topology of point clouds, a concept that has been introduced by Naveda and Leman (2010) and further developed in Maes et al. (submitted). Typically, with gross motor gestures that subsume a particular repetitive choreography, there is a large spatial region where the body part can be at a particular point in time, which ensures tolerance for synchronization variability, and therefore some flexibility in entrainment.

In contrast with these gross motor gestures, fine motor gestures require a more precise spatiotemporal deployment. This happens when people interact with a music instrument. In that case, there is less tolerance for synchronization variability, and less flexibility in entrainment. Just consider the fact that rehearsals of music ensembles often aim at getting the synchronization right.

2.3. The coupling of action and perception

From the previous paragraph it is clear that the gesture/action repertoire forms part of a more complex mechanism that controls the interaction between environment and subjective experience. This mechanism, also called, the action-perception coupling system, or the action-perception engine, is responsible for prediction and, as we will see, also for issues that involve musical intentions (musical action-goals).

Understanding the components and the dynamics of the action-perception coupling system is a hot research topic in modern cognitive science (see Wolpert et al., 2011). In general terms, it makes sense to consider at least two mechanisms for learning, which I call the sensorimotor loop and the action-perception loop. The sensorimotor loop is a low-level loop where the motor activity is basically driven by sensory input from the environment. In contrast, the action-perception loop is a high-level loop that involves the gesture/action repertoire. The two loops are not exclusive and they can run in parallel. For example, in producing a sound on the clarinet, the sensorimotor loop can maintain the control of the mouth and breath in relation to the sound production, while the action-perception loop can use the repertoire of learned fingering patterns (that have been practiced earlier) as a global controller for the expressive production of the sound. As such, the assumption is that action and perception are controlled by an action-perception coupling system involving different loops.

Interestingly, the prediction principle also works the other way around. When a person perceives a certain sound, the person may rely on previously learned action-outcome knowledge in order to assume the action for the sound. The latter principle is indeed fundamental in our approach because it explains why interaction is embodied. This principle, which is comparable to a Bayesian inference in statistics, also offers a key to modeling our multimodal (sound-gesture) interaction with music. Typically, when an every-day sound is heard, the person will tend to act in relation to how that sound is produced. In contrast, when an abstract sound is heard, the person will tend to act in relation to particular parameters of the sound that can be reproduced by movements (such as general contours).

2.4. Musical intentionality, expressiveness, and empathy

Our research at IPEM has contributed to the idea that music may establish an intentional layer of communication between listener and player. This intentional layer provides access to the (assumed) goals of the music. It is based on an action-perception coupling system that tends to use actions as causes of perceived patterns, thus turning perceived sound patterns into action patterns that could have caused the perceived sounds. This mechanism forms the basis of a number of social phenomena of music, ranging from empathy to social bonding.

3. THE ROLE OF TOOLS

Finally a word should be said about tools. Tools are of outmost interest to us for two reasons. Firstly, with tools, we can study the characteristics of the action-perception coupling system. For example, during piano playing, the action-perception coupling can be disturbed by using a headphone that introduces an auditory delay. In order to be able to cope with the music playing, the agent may have to change the usual strategy for predicting the consequences of his actions. The change of strategy may reveal the mechanisms that underlay the coupling system. Secondly, with tools, we can build new applications that intervene with the action-perception coupling system. One example is DJogger (Moens et al., 2010) that extracts the tempo of your walking and provides music at the same tempo of the walking tempo. Humans tend to entrain and thus walk in phase with the musical pulse. Typically, they minimize the prediction error of the walking pulse until it fits with the musical pulse. IPEM has developed tools for different domains such as music education, therapy or entertainment. During this keynote, several examples will be given and further discussed

4. CONCLUSION

The paradigm of embodied music cognition provides an interesting viewpoint on musical gestures. It assumes that music is based on a tight relationship between sounds and experiences that are mediated by the body. Apart from the research that aims at understanding this phenomenon, the goal is to be able to control the nature of this complex phenomenon, and apply this control in applications for music education, health, art and other domains.

The paradigm of embodied music cognition provides an approach of how to deal with the experiential component in interactive music systems. The research field is likely to become an important partner of technology-driven music research.

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Marc Leman is "Methusalem" research professor in systematic musicology and director of IPEM, Dept. of musicology, at Ghent University. He has a background in musicology, philosophy and computing. He has about 300 publications, including the books "Music and schema theory" (Springer, 1995), and "Embodied music cognition and mediation technology" (MIT Press, 2007). He did pioneering work in the epistemological and methodological foundations of computational modeling and embodied music cognition. In 2007 he became laureate of the Methusalem for his project on musical embodiment. During the free time (if any) he plays trumpet in jazzcombos.