USE OF SOUND-ACTION ANALOGY IN MUSIC COGNITION RESEARCH

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Abstract

While auditory characteristics of sound have been one of the major topics in music cognition research, especially since the second half of 19th century, motions causing, mimicking and tracking sound have not been exploited enough until recently. Today, combining topics such as 'embodiment', 'imagery' and 'musical gestures' with use of technological tools available allow researchers to conduct systematic studies at these topics.

This paper explores the use of sound-action analogy in music cognition research, giving examples from various approaches and discusses how its potential could be used in music cognition.

Keywords: music cognition, musical gestures, motion, motor imagery, embodiment

1. Introduction

Sound is a physical as well as auditory phenomenon. Although being limited mostly pitch- and intensity-centered, auditory characteristics of sound have been one of the major topics in music cognition research since the second half of 19th century, with significant contribution by Helmholtz. Meanwhile, the fact that sound being a motion and being closely related with other motions causing, mimicking and tracking has not been exploited enough. However, emerging research areas such as 'embodiment', 'embodied music cognition' and 'musical gestures' enable researchers to explore the potential in this area with technological tools available such as motion detecting sensors, fMRI technology etc.

This paper explores the use of sound-action analogy in music cognition research, giving examples from different approaches and discusses how its potential could be used in music cognition research practice.

2. Sound and Action as Energy-Motion Trajectories

Approaching sound and action as energy-motion trajectories is an effective example of developing such an analogy. Basic implication of such an approach is similar categorization of sound and action. In the recently emerging field of musical gestures research, scholars developed various categories to explore the dynamics of musical gestures of performers and the relationship between these gestures and performance. Jensenius et al (2010: 13-35) developed four functional categories of musical gestures based on the work of Gibet (1987), Cadoz (1988: 71-93), Delalande (1988: 85-111) and Wanderley and Depalle (2004: 632-644), namely sound-producing gestures, communicative gestures, sound-facilitating gestures and sound-accompanying gestures. Godoy (2010) used the sound-action categories suggested by Schaeffer (1966) which also correspond to biomechanically distinct action strategies as impulsive (discontinuous effort), sustained (continuous effort) and iterative (rapid series of impulses). The latter action categories do not apply only for sound-producing gestures but to other categories of gestures as well.

These categorizations imply two important aspects about sound and action. Firstly, equivalent categorization of sound and action is an important sign for the intimate relationship between sound and action. Secondly and more importantly, application of action categories to non sound-producing gestures show that there is a much deeper relationship between sound and action than their causal relationship. In other words, gestures of performers do not only cause sound, but they also track, mimic and interact with sound as well in a complicated process.

Another implication of the 'sound and action as energy-motion trajectories' approach is use of compatible tools available for both. While the physical signal characteristics of sound could be analyzed with high technology hardware and software tools for a long period of time, technology for tracking actions with sensors has been developed especially in the last decades, as sensor technology became available with its affordability, capabilities and cross-platform usage in computers. Such an example could be given from a study (Jensenius 2006: 499-502) of a clarinetist performing Clarinet Sonata Op.120, No. 1 in F minor by Brahms. Figure 1 shows motiongram and spectrogram of the performance. With motiongram, vertical movement of the clarinet bell, and the movement of the center of gravity of the performer could be tracked.

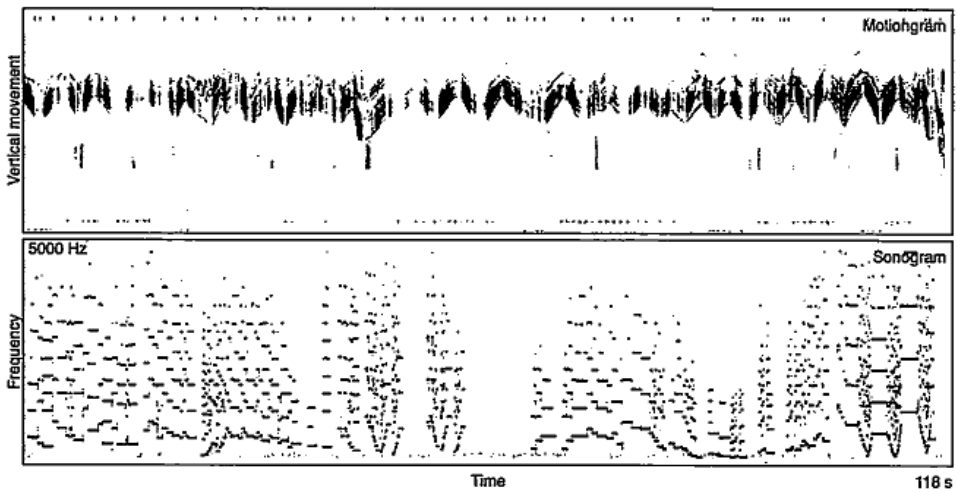

Figure 1. Motiongram (top) and sonogram (bottom) made from a video recording of a clarinet performance at a study by Jensenius (2006: 499-502).

With such available tools, we could analyze sound and action on the same graphical interface with available mathematical and statistical tools.

3. Sound is a Good Transducer of Action Information

An important sign of the intimate relationship between sound and action emerges from the fact that sound is a good transducer of action information (Godoy 2010). As human beings start to develop ecological knowledge of sound features as part of their survival instincts, subjects showed great success in identifying sound producing actions and materials across various studies (Rosenblum 2004:219-248; Neuhoff 2004). Research fields of ecological psychology and psychoacoustics

exploring our massive ecological knowledge and its relationship with cognition processes offer great potential for the research areas of music cognition such as musical listening based on general ecological knowledge of sound sources.

An example for the use of ecological psychology in music cognition research could be Gibson' s key concept 'affordance'. Gibson (1977) sees perception as a continuous and mutual relationship between the organism and environment and uses the term 'affordance' to explain perception process being strongly linked with opportunities for action in the environment of an organism, which include everything that organism can do (e.g. a cup affords drinking or handle affords holding, etc.). This example shows that while we listen music, so many actions are involved which function as affordances in our cognition process. So, approaching sound as a good transducer of action information will bring the concept of action into an active state within the music cognition process.

4. Relationship between Musical Imagery and Motor Imagery

The concept of imagery is another aspect in sound-action analogy, which is closely related with previous section. Based on the motor-mimetic hypothesis, Cox (2011) argues about musical imagery is partly motor imagery and proposes 18 principles about embodying of music. The strong version of the hypothesis by Cox holds that there is little or no musical imagery that does not involve motor imagery. While the analysis of all these 18 principles is beyond the scope of this work, I would like to focus on his Principle 6: 'Imagined actions are informed by performed actions'. Giving examples from various experiments, he explains that imagining performing an action is strongly dependent on the experiences of actually performing that action and imagining will be more accurate as one has more experience performing that action.

For example, Calvo-Merino et al (2005: 1243-49) have showed that motor-related brain areas are strongly activated if the observed activation is closer to subject' s experience. Repp and Knoblich (2004: 604-09) had pianists compare recordings of their own performances and recordings of the same works performed by other pianists and they found that pianists were better at recognizing their own performances.

In Drost et al' s study (2005: 1376-89), pianists and guitarists played a series of isolated major or minor chords, while at the same time a distractor of a task-irrelevant major or minor chord were given played on another instrument, that was either congruent (minor/minor, major/major) or incongruent (major/minor, minor/major) with the chord they were about to play themselves. Five timbres were used, namely piano, organ, guitar, flute, and voice (as recordings of the actual instruments and human voice). For pianists, significant interference effects occurred only with the keyboard instruments and not with the others. Analogously for guitarists, significant interference effects occurred only with the guitar chords. The overall effect was amplified by the fact that the participants had little or no experience with the other instruments. From a mimetic perspective, the stimulus in the timbre of their own instrument was the sound of other people doing something directly familiar, while the remaining stimuli were the sounds of other people doing something less directly familiar. However, they also mention that lack of direct experience does not mean that the imagery drops to zero and state that if we are interested in something, we always have some idea what it must be like, even we have no experience in performing that action.

Godoy (2010) uses 'mental imagery' as a term emphasizing our capacity for having internal images of the world. He discusses functional equivalence between real-world perception and action, and imagined perception and action and states that mental imagery makes use of much of the same neurobiological apparatus as real perception and action considering relevant experiments. He gives examples from experiments by Haueisen and Knösche (2001: 786-792) showing that when professional pianists listen to piano music, there is an activation of the motor control apparatus in the brain as if they themselves were playing piano.

An emerging research field related with the musical imagery being partly action imagery is the field of 'Embodied Music Cognition'. An inspiring summary about the concept of Embodied Cognition is given by Godoy in his article 'Images of Sonic Objects':

"The basic idea is that whatever we perceive or think is correlated with mental simulations of body movement, both those of other people (Wilson and Knoblich 2005) and of our own prospective movements (Gallese and Metzinger 2003), and with simulations of what we believe are the cause, and even tactile, kinematic features of what we perceive. " (Godoy 2010:54-62)

This definition gives an inclusive scope of the embodiment of cognition process and it could be used as a guideline for the sound-action analogy as well. As mentioned in the previous section, mental imagery and simulation of movement, both ours and others, and from the past, present and future, plays an important role in the cognition process.

5. Grouping Mechanisms in Sound and Action

Another interesting topic related to sound-action analogy is grouping mechanisms in sound and action. Godoy (2010) talks about the interaction between perception and action cycle and states that there is now a considerable amount of research that supports the idea of perception-action interaction in all human activity (Gallese and Metzinger 2003: 338-65). However, he adds that what seems to have received less attention is the continuum/discontinuum in this interaction process; we need to segment the stream of sound into chunks in order to decide what are the sonic events and what are the gestures that correspond to these sonic events. This means that in the perception-action cycle, we have to insert points or group the actions or action imageries discussed correlated with the sonic output.

When listening to unfamiliar music, we obviously will do this chunking and gesture assignment in retrospect, except in cases where the type of music is very predictable, whereas in familiar music, we may also do this prospectively and we may think ahead in terms of gesture chunks before we actually hear the sound. But in all cases, we will tend to associate continuous sound with action-units, and hence we will always find an element of discontinuity in the perception-action cycle.

According to Snyder (2000), short term memory is often regarded as having a duration in the roughly 5 seconds range, which is similar to the duration of a sound object defined by Schaeffer (1966). Also in human movement research, there seems to be a preference for action durations in roughly 2 to 3 seconds range.

6. Discussion and Conclusion

This paper focused on the sound-action analogy in music cognition research and tried to combine various uses of this analogy to show its potential in music cognition research. As mentioned above,

taking sound and action as energy-motion trajectories yields similar categorization for sound and action and enables compatible tools for both, such as temporal graphical analysis with the use of statistical methods. While similar categorization supports integrated research between sound and action, using gestural responses to given sounds by subjects with the graphical representation of sound and action could lead to models such as 3D timbral space models by McAdams (2008:35-67) using similarity responses of the subjects.

Besides categorization and availability of analytic analysis methods, we have great ecological knowledge of sound and action as part of adaptation to our environment which plays a vital role in our music cognition processes. Relevant research fields such as ecological psychology and also recent field of ecological psychoacoustics could support development of systematic research between sound and action.

Concepts such as 'imagery', 'mental imagery', 'motor imagery' or 'motor-mimetic imagery' could help in building a solid connection between sound and action. Godoy' s discussion (2010) about 'functional equivalence of real world perception and action, and imagined perception and action' could be related to Fales' s term (2002: 56-95) of 'perceptualization' where the distance between real and perceived domains was the source of the paradox of timbre.

Applications of a systematic music cognition research based on sound-action analogy could be used in various fields of music cognition. While the analysis of music performances exploring the interaction between the performer and sonic output and the role of articulations during this interaction could be an obvious output, results of such a research could be used in more passive listening modes such as that of the concert audience or mp3 listener. The role of instrument affordances in our music cognition could be a more specific research subject. Also, with the similarity in the timescale of it, exploration of grouping mechanisms of sound and action in an integrated study could be another specific field to be explored. Besides these examples, if our musical imagery is partly motor imagery as stated by Cox (2011), sound action analogy could be used in almost every field of music cognition research.

There is an intimate relationship and interaction between sound and action from the physical domain extending through ecological and psychological domains and using available technology and various approaches, systematic integration of this analogy to music cognition research has great potential in explaining our complex processes of music cognition.

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