Chunking by coarticulation in Music-Related Gestures

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Extended abstract

A central issue in the study of music-related gestures, both those of performers and those of listeners, is how we segment the stream of human movement and of sounds into somehow perceptually meaningful chunks. In this paper, we shall on the background of our ongoing work in the *Sensing Music-Related Actions* project[1] present a model for chunking music-related gestures based on *coarticulation*. We can define coarticulation as the fusion of otherwise distinct events, meaning both action events and sound events, into larger and holistically perceived chunks, e.g. as in the fusion of syllables into continuous articulatory movement and sound in language, or in the fusion of singular tone events into continuous sound-producing gestures and melodic or textural patterns in music. It is our hypothesis that coarticulation plays a crucial role in both the production and in the perception of music-related gesture chunks, and the aim of this paper is to present evidence for this based on recent research, including our own findings.

Coarticulation is a much-discussed topic in linguistics (Hardcastle and Hewlett 1999), but can also be encountered in other contexts such as in human movement science (Rosenbaum 1991). In music research, there are but a few studies of coarticulation, such as in piano playing (Engel, Flanders, and Soechting 1997) and violin playing (Wiesendanger, Baader, and Kazennikov 2006), but we believe coarticulation could be a very fruitful concept in music-related gesture research because it can account for the emergence of meaningful chunks on the basis of combined biomechanical and motor-control constraints, constraints that in turn also affect the perception of music-related gestures. In sound-producing gestures, there are biomechanical constraints such as in the need for moving effectors, e.g. fingers on a keyboard, to optimal positions before producing tones, hence of including singular key pressing finger movements into more superordinate trajectories of hand, arm, shoulder, and even torso movements for optimal execution, fluency, and energy-conservation as well as avoiding strain injury. There are also motor-control constraints at work in the need for planning fast movements in advance, i.e. envisage the entire sequence of individual tone-productions as one superordinate gesture. On the perceptual side, this coarticulatory inclusion of singular tone events affects both the perceived kinematics, i.e. the visual image of sound-producing gestures, and the perceived sound, i.e. the sequence of tones fused into a more superordinate gestalt. Such coarticulation is often reflected in sound-accompanying gestures that listeners make in dance or everyday listening situations.

Various cognitive science and human movement science findings seem to converge on a roughly 0,5, to 5 seconds duration range as optimal for what is perceived as meaningful

[1] http://www.hf.uio.no/imv/forskning/forskningsprosjekter/musicalactions/index.html

chunks (Godøy 2008), and from a musical point of view, this seems also be the range for coarticulation in music-related gestures. As for the start and end points of chunks, they may be quite clear in cases where there are strong qualitative discontinuities, e.g. rests or shifts in position, but less clear in cases of more continuous and smooth motion. One possible solution to this problem (inspired by coarticulation research in linguistics) is to regard gestures are goal-directed, i.e. that we have a succession of quite clear goal-points in our gestures, but where the trajectories to and from these goal-points may overlap such as to produce what appears as continuous, smooth or undulating movement trajectories (Godøy 2008). The idea of goal-points for gestures is also supported by human movement research where it is suggested that movement planning, control, and perception is a combination of discontinuous postures (or what is called key-frames in film animation) and continuous motion (or inter-frames in film animation) between these postures (Rosenbaum et al. 2007). In music, these goal-points are typically downbeats or other accented points in the music, points that may serve as orientation for both sound and movement. This means that the position and shape of the effectors at these goal-points, e.g. the position and spread of fingers, hands, arms, etc. in relation to the keyboard, drums, strings, bow, etc., are reference points (key-frames) in relation to the movement trajectories (inter-frames) between these reference points. This is in fact similar to the function of so-called phonemic goals (i.e. intended target sound) for coarticulation linguistics (Hardcastle and Hewlett 1999).

In our research on coarticulation, we have until now mostly focused on the sound-producing gestures of piano performance, however we shall also apply the methods we have developed to the performance on other instruments as well as to various sound-accompanying gestures. Our method consists in capturing various continuous gesture trajectories from different points on the hand, arms, and the torso of subjects, and then process and represent these trajectories in view of finding the relationship between singular actions and their coarticulatory inclusion in more superordinate gestures. Such motion capture does of course present several important technological challenges (Jensenius, Nymoen and Godøy 2008) as well as challenges in the processing of data. However, we believe our hypothesis of coarticulation in music-related gestures is well founded in past research as well as in our own research so far, and that our work on coarticulation can actually also be of help in studying the complexities of human gestures outside the domain of music-related gestures.

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