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Synopsis and Response Report of Music from Motion: Sound Level Envelopes of Tones Expressing Human Locomotion by Anders Friberg, Johan Sundberg, and Lars Frydén

This paper investigates the relation between music and motion in human perception. Friberg, Sundberg, and Frydén investigate if the original motion quality of different gaits transferred to music sound, whether they can be perceived and distinguished by listeners. They use a force platform, which measures the ground reaction force by the foot, to record the vertical force curve during gaits, and mapped the vertical force curve into a sound level envelope. The peak value of the vertical force curve corresponds to 0 dB, and zero force to 64 dB. Each tone is synthesized by using pitch G<sub>3</sub> (196 Hz) with an organ timbre from a Yamaha FB01 synthesizer. Each gait is transferred into a sequence of tones with four inter onset intervals (IOI): original tempo, slow tempo with 25% longer than the original, fast tempo with 25% shorter than the original, and a standard tempo with IOI of 820 ms. Six different gaits are generated by two participants: one professional dancer and choreographer who improvises the dance steps in response to three different musical excerpts, and one untrained person who demonstrated three different types of walking: a *forceful* energetic type, a *forceless* tired type, and a *solemn* type.

Three perceptual experiments are conducted to explore whether different types of musical tones with different sound envelopes can be traced back to the types of motions on which they are based, and whether the music tones generated by different gaits can be distinguished one from another. In order to find out if the stimuli possesses any motion quality at all, the authors ask listeners to describe the stimuli using any words in Experiment 1. They find that a total of 25% of the non-blank answers explicitly refer to motion. They also found that the variance of motion words depends more on the type of gait than the tempo. Other observations include: (1) responses to the tones with standard tempo contain less motion references than others; (2) responses to solemn walking types also contain less motion references; (3) the faster the tempo, the more the motion references; (4) jumping is the most frequently mentioned motion reference for *forceful* and *forceless* walking, while walking is the most common reference of *solemn* walking and *dance type 1*, and dancing is the primary reference for *dance type 2* and *3*. The results of experiment 1 indicate that the tone sequences derived from the gait patterns can be distinguished and categorized in terms of motion types.

In Experiment 2, the listeners are asked to provide literal descriptions of a group of pre-selected motion words. The results show that 71% of all responses have direct references to motion, and 49% of these can be classified into one of the five main motion categories. Furthermore, the authors conduct Experiment 3 to see if different motion qualities are perceptible in the locomotion patterns. This time, listeners are asked to rate each stimulus along 24 adjective scales, somewhere between none and extreme. The results are analyzed by principle component analysis, and four main factors generated by PCA corresponding to Swift-Solemn (factor 1), Graceful-Stamping (factor 2), Limping-Forceful (factor 3), and Springy (factor 4). The results show that the six gait patterns are described by listeners using related factors: a *forceful* pattern is perceived as swift; *forceless* as swift, sometimes forceful, but not springy; *solemn* as solemn, graceful, forceful and not springy; *dance 1* as solemn, stamping, forceful, and not springy; *dance 2* as limping and springy;

and *dance 3* as solemn, gracious, somewhat limping and springy.

In conclusion, the authors claim that all three experiments indicate that the motion character of a gait can be conveyed to a listener by the sound level envelope of tones. In addition to the observations described above, the authors summarize the relation between pattern shapes, tempi, and listeners' motion word responses. For example, the pattern shape of one smooth hump with moderate or slow tempo is often perceived as walking. They also mention some other factors that may affect listeners' answers, such as listeners' cultural background and their mental differentiation between rhythm and motion.

Generally speaking, it is a well organized paper. The authors explain clearly why they want to focus on motion in relation to music, what their hypotheses are, how they conduct the experiments, and how the results confirm their hypotheses. Studying if music tones can be used as a transmitting medium for human locomotion is a very interesting research idea. They also provide a very convincing example to introduce their research question: the fact that people can tell who is approaching by the sound of the person's gait. However, their method of generating the tone sequences is too simple. One tone sequence only contains a single pitch repeated of a fixed tempo while other information, such as timbre and frequency energy, is not discussed. Furthermore, a sequence of repeated tones is quite different from music in practice. It would be more appropriate to regard the tone sequence as a sound fingerprint of the gait, not as a musical representation. It is also important to note that, in the experiments, asking listeners to describe tone sequence in words adds another mediating factor to the analysis: the understanding and grasp of the language. Finally, the percentage of motion word responses does not appear to be high enough to convincingly support the authors' main idea.