

Embodiment of Metrical Structure: Motor Patterns Associated with Taiwanese Music

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ABSTRACT

Sensory feedback, whether auditory, visual, tactile, proprioceptive and vestibular, enables music performers to perceive metrical structures of music better due to the multiple sources of information. Cognitively, humans tend to synchronize their body movements with beats they are listening to. Ontogenically, the ability to feel music through body movements develops at an early age. Physiologically, different mechanisms behind the feedback caused by body movements may result in different types of embodied expression of meter. Embodiment of metrical hierarchy can also be observed in the variety of beat-counting processes from different musical cultures, such as the art of conducting in Western classical music. In some Taiwanese music genres, musicians count beats with specific motor patterns. The present study used an accelerometer to examine the beat-counting movements in diverse music traditions: Taiwanese aboriginal music, *nanguan* music, and *beiguan* music, in comparison with the conducting movement in Western classical music. We hypothesize that different feedbacks induced by beat-counting movements reflect the hierarchy of beats in a measure. Our results suggest that the tactile feedback is in a higher hierarchy than proprioception, in which the zero-acceleration timing indicates the beat in some music traditions. If no tactile feedback occurs, the hand movement with downward velocity is on a higher hierarchical level than that with upward velocity.

Background

When playing musical instruments, musicians receive not only the auditory feedback, but also feedbacks from tactile, proprioceptive, and vestibular senses, which play different roles in the performance (Aschersleben, 2002). Auditory signals or body movements between beats help musicians count beats more precisely because the information from both auditory signals and movements filling in the blanks between beats make the music more organized (Wohlschläger & Koch, 2000). Human beings are able to synchronize their body movements with the beat of auditory stimuli (Phillips-Silver & Trainor, 2005), with the movement acceleration playing a central role in the process, for example, conducting (Luck & Sloboda, 2008).

From an ontogenical perspective, infants can already feel the rhythm and move with the auditory stimuli. The body movements made by adults also affect infants' rhythm perception (Phillips-Silver & Trainor, 2007). For adults, different body movements result in diverse rhythm perception (Repp 2005). Therefore, the interaction between movement and music not only develops early, but also plays an important role in the processing of music rhythm.

In different music cultures, musicians count beats in various ways. In Taiwan, several music genres have the tradition of using body movements to “reinforce” the metrical structure, such as *nanguan* music, *beiguan* music, and Taiwanese aboriginal music. The beat-counting movements are integral parts of these music traditions.

Aims

Based on generally observed phenomena and literature reviews, patterned body movements facilitate musicians' mental representation of metrical structures. Whereas the conducting movement in the tradition of western classical music has been widely studied, the tradition of beat-counting movements in other music genres has received little attention. The present study compares beat counting in different traditions. The major aim is to examine the hypothesis that different feedbacks induced by counting beats reflect the hierarchy of beats in a measure. If this hypothesis is valid, the secondary aim of our study is to find the hierarchy of different hand movements.

Method

We used an accelerometer to precisely measure the hand movements of beat counting traditions in musicians of four different music genres: Taiwanese aboriginal music, *nanguan* music, *beiguan* music, and Western classical music, followed by the analysis of the relationship between the metrical structure and the movements.

Musical excerpts from four music genres were chosen: Taiwanese aboriginal music, *nanguan* music, *beiguan* music, and western classical music. In all excerpts, each measure was divided into four beats (time signature 4/4)

Music was played using hi-fi equipment connected with a computer in a controlled room. Motion detection was accomplished by a one-dimensional accelerometer, and its signals were received by Biopac Student Lab PRO for off-line processing.

Participants were asked to listen to the same musical excerpt belonging to their respective training five times, and alternate between counting the beats with movements taught in their respective traditions, and manually marking the beat by pressing a specific key on a computer keyboard. The movements of the counting process were recorded by an accelerometer attached to the hand of the musician. The entire procedure thus consisted of “counting, marking beat, counting, marking beat, counting”, with the same music played for each stage.

The accelerometer signals were analyzed according to time. We focused on the phase relationship between beats and accelerometer signals. We also compared the different body movements in the four music traditions.

Results

The time course analysis of the accelerometer shows that the quasi-periodical beat-counting movements in four different music genres are diverse (See Figure 1).

The hand acceleration for aboriginal music shows the camel shaped data, which passes the zero at every first and third beat. The accelerometer recordings for both nanguan and beiguan music show almost vertical lines on the first beat that indicate a collision with tactile feedback. At the second and the fourth beats, nanguan and beiguan musicians show similar motor patterns, with the zero-acceleration timing roughly indicating the beat.

The accelerometer recording of conductors in western classical music shows very clear and similar peaks happening on every beat of each measure.

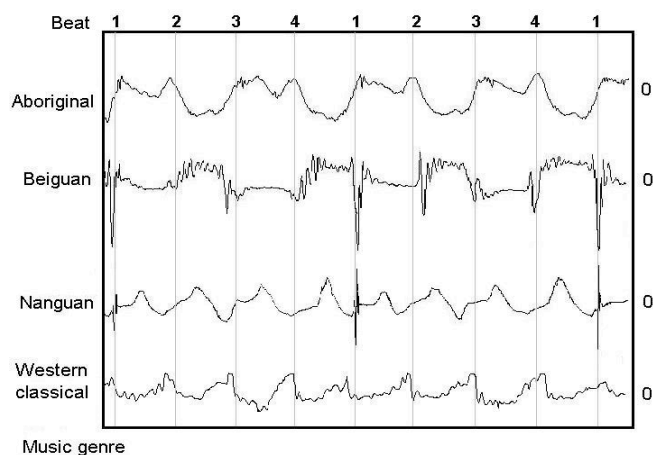


Figure 1. The time course of the hand acceleration of four musicians from different traditions: from top to bottom, aboriginal, nanguan, beiguan, and western classical music. The numbers on the top of this frame indicate the beats of two measures.

Taiwanese aboriginal musicians extend their arms behind their bodies on the first and third beats, and move them back in front of their bodies on the second and fourth beat. Therefore, the movements on the first and third beats are the same as the direction of the gravity since they are more important beats. Nanguan musicians clap their hands and beiguan musicians touch the desk on the first beat. Therefore, both movements result in a strong tactile feedback.

The data of the beiguan musicians on the second and fourth beats are very similar, a result of similar movements reflecting the same hierarchical level of the two beats.

In conducting movements, the acceleration always reached its maximum near or on the beat. The movement on the first beat corresponds to the direction of gravity.

The “beat-counting movement” of traditional Taiwanese musics plays an important role in their performance. However, they are seldom discussed and investigated. Here we examined the movements in aboriginal, nanguan, beiguan, and western classical music. In the nanguan and beiguan genres, the acceleration of the musicians’ movements when they count beats reflects the hierarchy of the beats, demonstrating that tactile feedback is on a higher hierarchical level than proprioceptive feedback.

The tactile feedback is on a higher hierarchical level than proprioception. If no tactile feedback occurs, the movement

corresponding to the direction of gravity is on a higher hierarchical level.

Conclusions

In the beat-counting tradition of Taiwanese aboriginal music/dance, *nanguan* and *beiguan*, the musicians receive tactile and proprioceptive stimuli through their hands. The present study suggests that the hierarchy of beats is embodied in the beat-counting movements, i.e., tactile stimuli > proprioceptive feedbacks of the downward hand movement > proprioceptive feedbacks of the upward hand movement. In the study of Taiwanese aboriginal dance in the Amis tribe, the hierarchy of beats is also embodied in the foot movement, i.e., forward weight transfer > backward weight transfer > foot tactile stimuli.

Many cultures have traditions of beat-counting through movements, which undoubtedly presents too vast a variety to be covered in one survey. In the present study, Taiwanese music genres were chosen due to the accessibility of our environment. In our experiment, we chose from Taiwan’s abundant music traditions the three most representative music genres, two from the Han Chinese culture and one from Austronesian culture. The musics and dances of other Taiwanese aboriginal cultures are worthy of further investigation. Currently, we do not investigate the steps and gaits in aboriginal dances. Further research should analyze the movements of the whole body instead of the hand movements.

Keywords

Metrical structure, embodiment, accelerometer, tactile, proprioception, Taiwanese music

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