MOTION CHARACTERISTICS AFFECT EVALUATION BY JUDGES IN HIP-HOP DANCE: KINEMATIC ANALYSIS OF STEP MOVEMENT

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The purpose of this study was to extract motion characteristics closely related to high evaluation by judges, through a comparison of "side-step" movement between eight expert and eight non-expert dancers. Their step motions were captured and the head trajectory relative to the centre of mass, face inclination, and time lags among neck, trunk, hip and knee angles were calculated. As a result, a quarter cycle of phase delay between the neck motion and other body parts were observed for the expert dancers. This delay resulted in a large displacement of the head relative to the centre of mass and a large range of motion of the face inclination. The face inclination was highly correlated with the judging score (r = 0.869). Thus, it is assumed these motion characteristics are the most important element of the side-step movement that induces a better impression of judges.

KEY WORDS: hip-hop dance, step movement, evaluation by judges.

INTRODUCTION: Although hip-hop dance was initially performed freely in street environments, there is increasing global interest in staged hip-hop dance competitions. However, the way of evaluation in the competitions yet lacks objective criteria and relies on personal impressions of judges. Finding a criterion for objective evaluation in hip-hop dance performance has been recognized as very complicated task that gathered little attention of researchers. Recently, Sato et al. (2014) found consistency in the evaluation of hip-hop dance performance among experienced judges. That implies that judges unconsciously focus on some kind of common motion characteristics which distinguish dancer's skill level.
Step movement is a fundamental but represents eye-catching feature of hip-hop dance. Of various steps, "side-step" is one of the most fundamental techniques. The side-step movement is a combination of the basic rhythmic movement with the steps towards left and right. Although there is one study (Sato et al., 2015) that analysed the basic rhythmic movement, the side-step movement has never been studied to the best of our knowledge. As most hip-hop dance maneuvers include step movements, understanding the attractive feature of the side-step movement in dancers of various skill levels would be very useful information for dancers, instructors and also judges. The purpose of this study was, therefore, to extract common motion characteristics of the side-step which closely related to the evaluation by judges in hip-hop dance genre.

METHODS: The participants were eight expert (experts) hip-hop dancers, eight non-expert (non-experts) hip-hop dancers and nine experienced judges. The experts were prize-winning dancers of national level competitions and had 8.4 ± 3.8 years of the hip-hop dance experience. The non-experts had 1.4 ± 0.5 years of the experience. The judges had 6.2 ± 2.1 years of the experience of the judges and evaluated the performance of all dancers. The experimental procedure of the study was approved by the Nagoya University, and written informed consent was obtained from each participant before the experiment.
In the basic rhythmic movement, dancers are bouncing up and down repeatedly by flexing and extending neck, trunk and lower extremity. The side-step movement is a combination of this movement and sideway steps using lower extremities. The side-step movement with a metronome pulse of 100 beats per minute was selected as the experimental task (Figure 1). The dancers were asked to repeat the movement 10 times. Their movement were captured using a ten-camera motion capture system (Vicon MX, Vicon, UK) sampled at 120Hz. Each

dancer wore a black leotard, and spherical markers (10mm diameter) were attached on the skin or the clothing over 49 anatomical points.

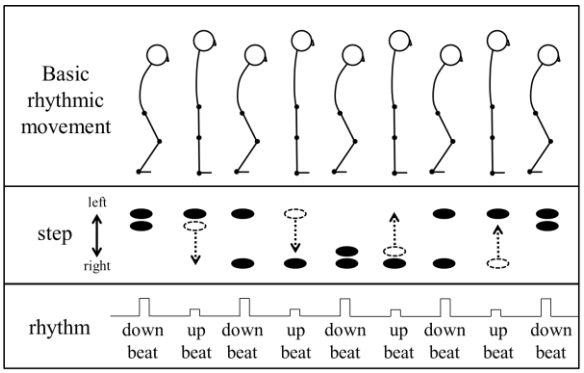

Figure 1: Schematic description of the side-step movement. The side-step movement is a coordinated behavior that contains the basic rhythmic movement and sideway steps.

After the measurement, nine experienced judges evaluated the performance by observing the stick figure animation on the computer display instead of direct observation of the dancers' motions to minimize the effect of judges' subjective bias. The judges observed the animation in random order, and then the performance of each dancer was graded on a scale of one to ten, in which the ten was the highest rank. Also they were prohibited sharing the information related to their own rating for each dancer with the other judges.
The body centre of mass (COM), the trajectory of the top of the head relative to COM (THCOM), and the flexion/extension joint angles of the neck, trunk, hip, and knee were calculated from the non-smoothed raw data. The range of motion (ROM) of the face inclination angle to the Z-axis in the global coordinate system was also computed. As those kinematic parameters are periodic data, the time lag of peak of each joint angle (time lag) was also calculated.
Statistical differences of the average time lag values and of ROM of the joint angles between the groups were examined using unpaired t-test. Pearson correlation coefficients were also used to examine the relationship between the resultant score of the judges and the kinematic parameters. Significant probability levels were less than 0.05.

RESULTS: As shown in Figure 2, the trajectory of THCOM showed appreciable differences between the groups, in which the experts showed distinctively larger displacement than that of the non-experts.

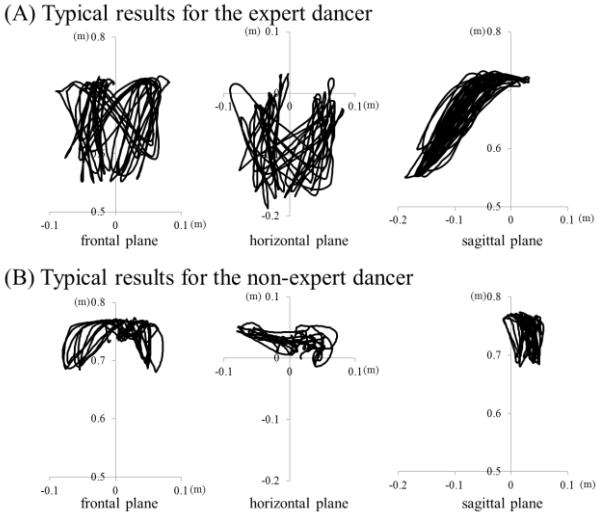

Figure 2: Typical example of the trajectory of the top of the head relative to COM of expert (A) and non-expert (B) dancers within the frontal, horizontal and sagittal planes.

There were no significant differences in ROM of the angle of neck and trunk, however, as shown in Figure 3, the experts showed significantly smaller ($p < 0.05$) time lags for the neck-trunk, the neck-hip and the neck-knee, compared with those of the non-experts. The time lags observed for the non-experts correspond to a half cycle of the movement and those of the experts correspond to a quarter cycle, approximately.
Regarding the relationships between the judging score and the measured variables, the ROM of the face inclination angle was the highly correlated with the judging score ($r = 0.896$, $p < 0.05$, Figure 4).

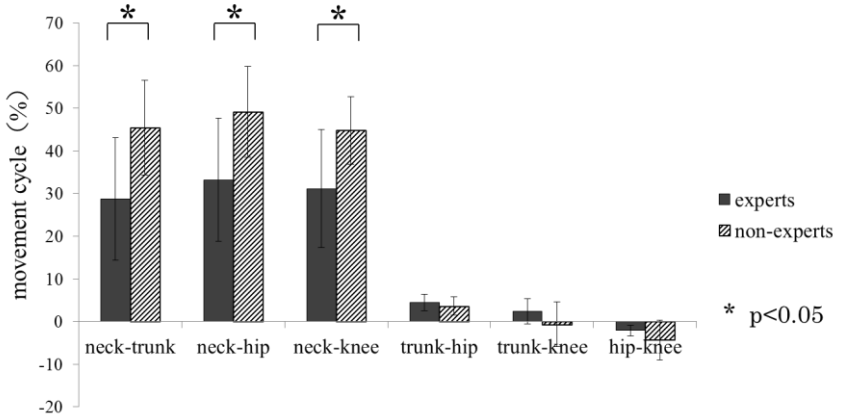

Figure 3: Comparison of the time lags in the joint angles for every combination (neck angle, trunk angle, hip angle and knee angle).

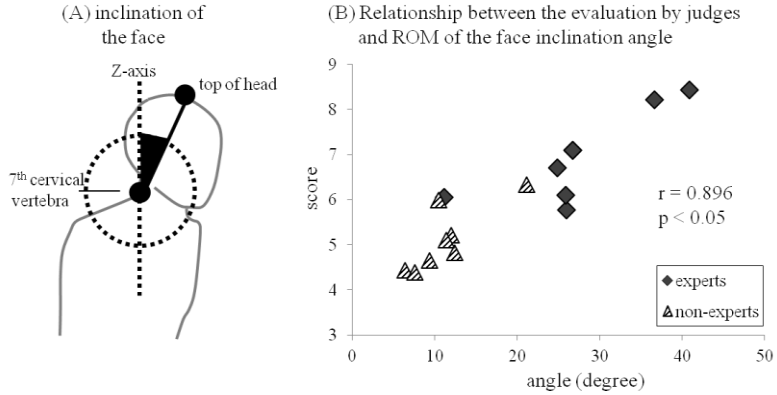

Figure 4: Definition of the face inclination angle (A) and the relationship between the range of motion of the face inclination angle and the score by judges (B).

DISCUSSION: In this study, we hypothesized that the side-step movement of expert hip-hop dancers had some common motion characteristics closely related to the resultant judging score. Our hypothesis was supported by several measurable features of the side-step movement.
The displacements of THCOM within the three orthogonal planes of the experts were distinctively larger than those of the non-experts. Although it is assumed that the joint angles of neck and trunk affect the displacement of THCOM, their range of motions were not significantly different between the groups. It is worth noting that there are significant differences for time lags between the neck and the lower part of body (Figure 3). The neck angular motions of the non-experts were in antiphase to the motion of the lower part of body. This motion feature most likely prevents their topmost part of body (head and face) to draw a large trajectory, which resulted in distinctively smaller THCOM trajectory (Figure 2). In contrast, a quarter cycle phase delay was observed in the experts. In the basic rhythmic movement (Sato et al.,2015), it was confirmed that a quarter cycle phase delay produce a loop motion of the head. The given result of the phase delay for the side-step movement is in good agreement with that of the basic rhythmic movement. Similar to the basic rhythmic

movement, a quarter cycle phase delay between the head and other body parts most likely contribute to make a larger trajectory of the head. It is likely that the judges tended to put a greater emphasis on this type of sequential motion between the head and trunk.
Furthermore, because ROM of the face inclination angle was highly correlated with the judging score, it could be considered that the judges tend to pay attention to the face or head of a dancer. These results indicated that the movement of the distal end of the body, such as the head relative to COM, is the most important element of the side-step movement, and is most likely influential on visual observation of the judges thereby yielding a higher resultant score.

CONCLUSION: In the present study, we succeeded in extracting common motion characteristics of the expert dancers in the side-step movement of hip-hop dance, which may affect the evaluation by judges. Expert dancers have approximately a quarter cycle phase delay between the motion of the neck and those of the other body parts, and this slight phase delay most likely produce a larger movement of the head relative to COM and a larger change of the face inclination. Moreover, it is considered that these characteristic head motions would be very influential to the evaluation of the judges. Those results would provide fundamental information to develop a new, efficient teaching method in hip-hop dance.

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