Two Directions for Skill Development of Basic Latin American Dance Movements

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Abstract

Latin American dancing expression relies on Cuban Motion (CM) to captivate audiences with its powerful, enchanting, and beautiful expressions. We researched how skilled dancers' CM movements influence audience perceptions. We compared CM movement and evaluations between different skill levels. From previous research, we hypothesize that expert's CM is symmetrical and involves whole-body coordination. Result showed that the heel and other body parts were coordinated in the R-L direction and that the hip trajectory in the horizontal plane was highly circular. However, contrary to the hypothesis, the symmetrical feature of the CM's hip trajectories of experts was divided into two groups: symmetrical / asymmetrical expert. In the evaluation results, the symmetrical group was evaluated higher for factor of Aesthetics and Dynamism, while the asymmetrical group was lower.

Keywords: Latin American dance, skill development, movement trajectory, whole-body coordination, evaluation

Introduction

Since ancient times, dance has been popular as a human cultural activity with a wide range of purposes and styles, such as religious ceremonies, means of socializing, and entertainment (Kataoka, 1991). Dance is a visual and dynamic expression of the body, and beautiful dance expression moves many people. Various questions arise here. What are the characteristics of beautiful movement in dance? By what kind of mechanics of the body is the movement performed? And how does the movement relate to the audience's impression? These questions have been addressed in previous studies on dance but have been examined separately. This is a comprehensive and exploratory study of these questions.

First, what are the characteristics of the beautiful movement performed by a skilled dancer? Previous study of dance movement and evaluation suggests the elements of movement that are evaluated positively: movement that the evaluator perceives as less feasible (Cross et al., 2011), movement performed in a large space (Calvo-Merino et al., 2008), and movement performed smoothly (Bronner & Shippen, 2015). On the other hand, the trajectory of motion has not been sufficiently studied, even though it should contribute greatly to the impression of a dance. One of the dance expressions in which the trajectory of movement is important is the Latin American dance Cuban Motion (CM). The characteristic of Latin American dance is performed by man-woman pairs. The man leads the woman, and she responds to his lead, i.e., they are constantly communicating with each other about their dance motions through their bodies. Therefore, basically every step has not only visual beauty but also interbody functionality. CM is the most central movement in Latin dance. It is an alternating bending and straightening of the knees and rotation of the hips around the spine. CM is defined in instruction and practice by the trajectory of the hip, which is the primary movement body part (Marco et al., 2004). Especially in Rumba, every step is danced with it. To figure out the above question, we focused on the Hip trajectory.

Then, what movement features of the expert's CM make a good impression on the audience? We compares CM movements at different skill levels focusing on the hip trajectory. Hip trajectory is characteristic of Latin American dance and contribute greatly to the impression of the dance. Previous studies suggests that symmetry is involved in judgments of beauty and preference for static visual stimuli. They have found that symmetry is a predictor of aesthetic preference and attractiveness for visual stimuli in static objects such as pictures and designs (Jacobsen. T & Höfel. L, 2003; Jacobsen et al., 2006), in simple visual patterns such as point clouds (McManus, 1980; Wagemans, 1997; Ramachandran & Hirstein, 1999), and in body part and facial features (Di Dio, Macaluso, & Rizzolatti, 2007; Rhodes, 2006; Thornhill & Gangestad, 1994). In the context of dance, Orgs et al. (2013) suggest that aesthetic evaluation was higher for postures that maximized spatial symmetry. In other words, symmetrical movement may be preferred in dance, which is a visual and dynamic form of expression. We hypothesize that in the CM, skilled dancers may have more symmetrical body movements than unskilled dancers.

The second question is how is proficient movement performed? This is an important question considering the smoothness and symmetry of the movements described above. Movement studies of proficient physical skills showed that a consistent pattern of intrabody coordination emerges in proficient individuals. A study of voluntary rotation motions in belly dance (Tournillon & Siegler, 2021) found that rotation of the pelvis on the horizontal plane and rotation of the upper trunk were consistently coordinated in an opposite phase pattern. Chang et al. (2020) also reported that in the basic movements of the cha-cha-cha of Latin dance, the sum of the amplitudes of the major joint angles such as neck, shoulder, and hip increased as a function of expertise and the

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degree of intrabody coordination got stronger as proficiency increased. Based on them, we hypothesized that skilled dancers would have higher whole-body coordination in CM. We further hypothesized that skilled dancers would show coordination especially between the feet and the upper body in CM, because in Latin American dance, it is considered good to transmit the reaction force from the floor to the upper body with the feet.

The third question is what features of movements does an expert's CM make a good impression on the audience? We referenced the following previous studies to identify validated evaluation items for the Latin American dance evaluation. Kawano et al., (2022) investigated the relationship between the movement characteristics and the factor of Aesthetics evaluation of the upper limb movements. The results showed that upper limb rotation, speed and amplitude contributed to the factor of Aesthetics as evaluated by beauty, preference, interest and goodness. Izaki (2004) tested the validity and reliability of evaluation words for dance movements by investigating evaluation for 8 different types of movements created from various emotions. This study suggested that the evaluation scale of dance movement consists of the factors such as Temporality, Spatiality, and Dynamism. Based on these studies, we determine to evaluate CM from these several factors like Aesthetics, Temporality, Spatiality, and Dynamism. While all the above factors are important in the expression of Latin American dance, Aesthetics and Dynamism are considered to be more important in the basic movement expression. Because CM is one of the smallest dance movement and the participants performed the CM tasks at a constant tempo, and therefore the timing of the movements is monotonous and does not use a large space. Therefore, we hypothesized that the factors of Aesthetics and Dynamism would be higher in the evaluation for expert's CM.

We consider that this study can propose a useful method to investigate the movement trajectory, whole-body coordination, and relationship movement features and evaluation. However, we need to be careful about the generalization of the result to the Latin American dance because of the limitation of the sample size.

Methods

Experiment 1 :Movement Feature of Cuban Motion

Participants 6 professional dancers (P1~P6) and 6 amateur dancers (A1~A6) participated to Experiment 1. With odd numbers indicate male participants, and with even numbers indicate female participants. As mentioned in introduction, the sample size was limited because it was difficult to ask busy professional dancers to participate in the study. Professionals were required to have a certified dance teacher or to have competed in the professional Latin American section in official competitions. Amateurs were defined as those who had at least one year of Latin American dance experience and did not qualify as professionals. For the amateur participants, we obtained

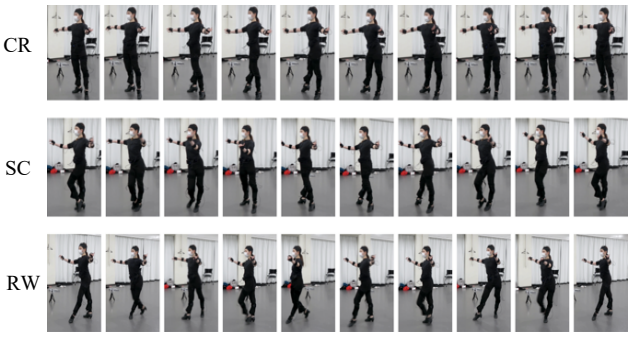

Figure 1: Sequential photos of each step

the cooperation of members of the dance sports club of Kobe University. For the professional participants, the mean age was 41.17 ± 11.88 years and the mean years of dance experience was 16.17 ± 7.99 years. All amateur participants were 21 years old and had an average of 3 years of dance experience. A1-A2, A3-A4, P1-P2, and P3-P4 usually dance in pairs. We enlisted the help of a diverse types of professionals because we wanted to examine a variety of examples of skillful dancers. In this study, we excluded data from participants that included measurement error trials (A5, P1, P2, P6). All of these errors were caused by motion capture drift. P3 and P4 are mainly engaged in dance instruction. They often model basic motions in front of students and often conduct both male and female roles. P5 is mainly perform in a dance show and specializes to lead women in his performance.

The participants read an information notice carefully and completed an informed consent form approved by the Human Ethics Committee of Graduate School of Human Development and Environment of Kobe University.

Experimental setup The body motions were recorded by the motion capture (Shadow Motion Capture System), using 17 inertial sensors with a sampling frequency of 100 Hz. OptiTrack Camera (V120: Trio) was synchronized to the mocap for 3D configuration. A video camera (SONY, FDR-AX45) was used for video recording.

The participant wore wearable sensor of Mocap and his/her usual dance shoes. We measured the motion data in an environment where the participants could check their own motions in a mirror to make the environment similar to their usual dance practice. We used the same rumba music (96 BPM, "Fields of Gold (Rumba)" Watazu, 2018) for all trials.

Procedure The task included 3 dance steps (see Figure 1): Cuban Rocks (CR), Side Cucarachas (SC), and Rumba Walks (RW), which correspond to applied Cuban Motion. CR and SC are R-L motions, and RW is forward-backward motion. The participants performed 5 trials for each step, with each trial lasting 8 measures (each trial took approximately 18.5 seconds). To minimize the impact of non-torso motions that is not based on CM, we instructed participants to keep their elbows naturally elevated during the task and not to unnecessarily change their neck or head angle. This study focused on CR to investigate the features of the most basic motion.

Analysis We used MATLAB(R2021a) and R (2022.12.0+353) for data processing. We used 3rd-order Butterworth low-pass filter (cutoff frequency: 10 Hz) for smoothing to focus on the main motion of CM rather than the small fluctuations. We marked the separations for each cycle of movements on the software (Mokka: Motion kinematic & kinetic analyzer).

Since CM is often described by focusing on the Hip trajectories on the horizontal plane in Latin American dance, we carefully observed them. Then, to quantify the characteristics of pelvic trajectories, we analyzed them from two indices: the Shape similarity and Circularity of the R&L Hip trajectories. For these analyses, the shape of the Hip trajectory was identified by convex hull (MathWorks, 2023). We used Procrustes analysis (MathWorks, 2020) to investigate the Shape similarity. In this study, we superimposed the centers of gravity of the shapes of the R&L Hip and rotated the shapes so that the squared distance between the R&L shape (several points of the shape) was minimized. We did not standardize the size in order to examine trajectory symmetry, including size. For ease of understanding, we used the inverse of the sum of the squared distances of these points as a measure of Shape similarity.

Next, to visualize the network of whole-body coordination for R-L motion of CM, we made Figure 6 (in the Results) with reference to Bashan et al., (2012). We conducted cross-correlation analysis and extracted the correlation coefficients between body parts that were greater than or equal to 0.70. Further, to exclude any apparent correlation between body parts, we calculated the baseline of the correlation coefficients. We generated the virtual data set by trial shuffling within participants, and calculated the correlation coefficients. Then, we drew only correlation lines with actual values higher than 95% confidence intervals of the virtual data set with blue lines. And orange arrows connect body parts with a correlation coefficient of 0.70 or higher and a lag value of 0.20 seconds or higher. These orange arrows are pointing to the body parts that is moving ahead of the other.

Then, we examined the relationships between the above two results. We conducted Linear Mixed Modeling (LMM) with the Shape similarity as the objective variable, P5/others, pro/ama and the mean of cross-correlation between Heels and other body parts (CcrHeel) as fixed effects, and participants and trials as random effects (Table 1 in Results). Further, we conducted LMM for Circularity of R&L Hip trajectories with Circularity as the objective variable, P5/others, pro/ama, R/L, CcrHeel and pro/ama × R/L as fixed effects, and participants as random effects (Table 2 in Results). We described the reason for using P5/others as the fixed effects in the results.

Experiment 2 : Evaluation of Cuban Motion

Evaluator 3 professional dancers (age : 48.00 ± 17.69 years) with Latin American dance competition experience (Latin dance experience:19.33 ± 6.03 years, competition experience: 8.67 ± 5.13 years) participated in the evaluation experiment. Hereafter, we called these 3 participants as the "evaluators".

Procedure We generated the videos for evaluation using the markers of the motion data taken in Experiment 1 (for 8 participants of Experiment 1 : except A5, P1, P2, and P6,5 trials each, 40 images in total) on Mokka to uniform the format of all the videos (see Figure 2). Previous study about dance evaluation have applied the similar method (using only markers) to represent human motion (e.g. Torrens et al., 2013 ; Brown et al., 2005).

We used a 19 word pairs of four factors to subjectively evaluate the observed motions. The factor of Aesthetics included 4 word pairs: "beautiful-ugly," "like-dislike," "interesting-not interesting," and "good-bad" used in previous studies (Kawano et al., 2022). And we added "bewitching-poor," which is said to be important in Latin American dance expression to this Aesthetics factor. The factor of Temporality included 3 word pairs: "accented-smooth," "sudden-sustained," "rhythmic-monotonous," the factor of Spatiality included 6 word pairs: "big-small," "high-low," "round-sharp," "curved-straight," "balanced-distorted," "symmetry-asymmetry," the factor of Dynamism included 5 word pairs: "strong-weak," "dynamic-static," "unambiguous-flat," "tense-relaxed," "heavy-light," by the motion rating scales by Izaki (2004). We omitted some word pairs considered less important for Latin American dance. All items were rated on a five-point semantic differential scale (1 = "very ugly" to 5 = "very beautiful"). Similarly, we set the scores of 2 and 4 as "slightly" and 3 as "neither."

Every evaluator participated on Google Form on his/her own laptop computer. As the practice evaluation, they evaluated the motions in videos that were not included in this experiment on a 19-word evaluation scale as dummy evaluations before starting. The evaluators then evaluated above 40 videos on a 19-word evaluation scale. We randomized the order of the 40 videos for each evaluator.

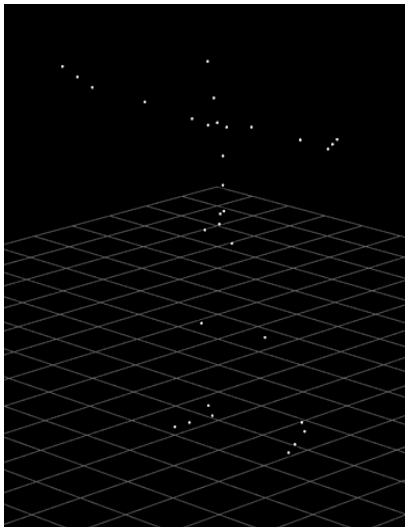

Figure 2: Image of the video used in the Experiment

Results

The body parts and corresponding names used in the analysis of this study are shown in Figure 3. The body part names mentioned below followed those in Figure 3.

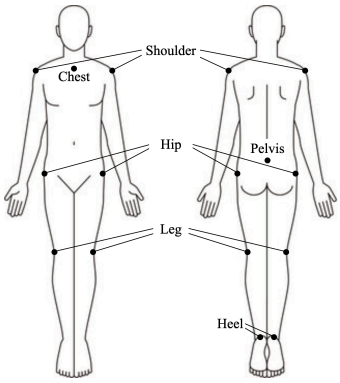

Figure 3: Names of body parts and corresponding body parts used in the analysis of this study

Results for Movement Analysis of Cuban Motion

Figure 4 shows the trajectories of the R&L Hip, Pelvis on the horizontal plane for one cycle of CR for each participant. For all participants, the trajectories of the R&L Hip are ellipticathe, pelvis moves mainly in the R-L directions. It is observed that professionals move pelvis back and forth less than amateurs. All ama and P5 showed that the L Hip moved back and forth more than the R Hip, with P5 being the most pronounced. P3&P4 are observed to have approximately symmetrical R&L Hip trajectory.

Figure 5 shows the results of the shape of the R&L Hip trajectories described above. Shape similarity was high for P3 and P4, while P5 was extremely low. The results of P3 and P4 supported the hypothesis, while that of P5 indicate the opposite. These results suggested the possibilities that P3-P4

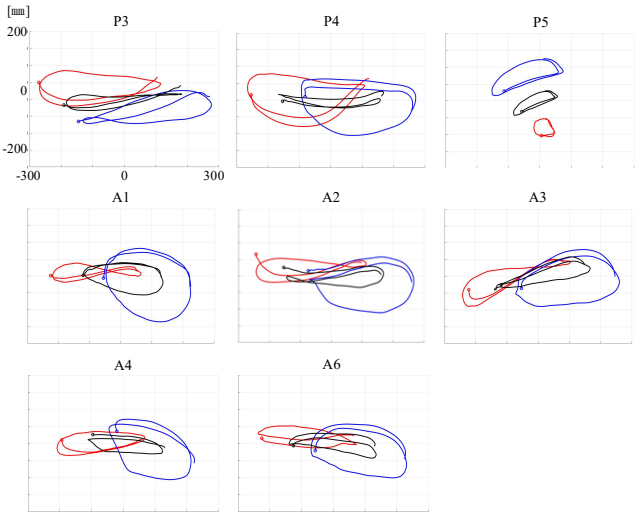

Figure 4 :Trajectory of R&L Hip, Pelvis on horizontal plane

The horizontal and vertical axes of the figure indicate R-L, and front-back, respectively (the orientation is different only for P5). The red line indicates the R Hip, the blue line the L Hip, and the black line the Pelvis.

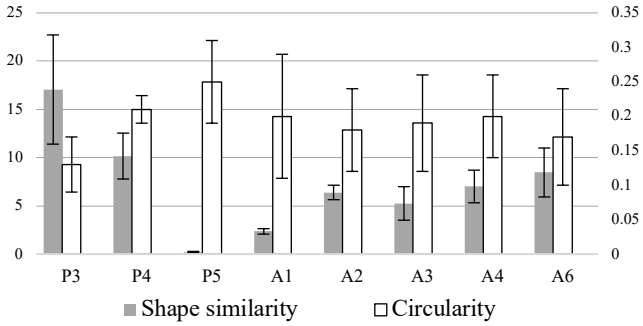

Figure 5: Shape similarity and Circularity of R&L Hips trajectory

Shape similarity in Fig.4 is the reciprocal of the value calculated by Procrustes analysis for the R&L Hips trajectory shapes. Higher values indicate that the R&L Hips trajectory shapes were similar. Circularity was calculated circularity of the R&L Hips. Higher values indicate that the trajectory was more circular.

/ P5 represent different direction of expertise development. The shape similarities of amateurs were all in the middle of these two kinds of professional groups. As mentioned in method, P3 and P4 were a dance pair and therefore had similar motion characteristics. The significantly lower Shape similarity of P5 could be attributed to its specialization in leading women. Latin American dance is danced in pairs. When holding with a partner, the two dancers do not position in front of each other. Rather, they position so that the right half of the partner's body is in front of them (half of the body is shifted to the left). The left side can then use more space than the right side, which may be the reason why the left side has a larger Hip trajectory of P5. In this study, we measured solo motion, but there is the possibility that the dancer always

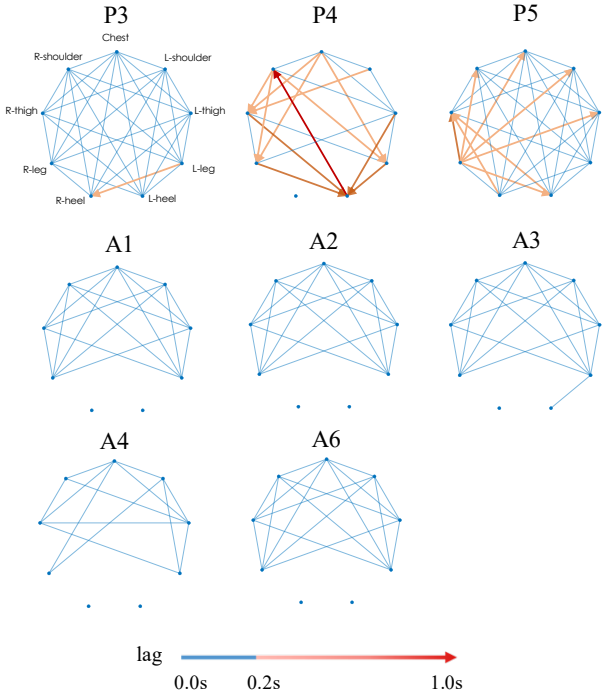

Figure6: R-L motion of whole-body coordination network

has the tendency to use the body as they dance in pairs. These trends are also seen in amateurs, and amateurs may perform like P5 in the future if they put more effort into dancing with their partners and their skill level develops. Circularity was high for P5, but no significant trends were observed between the professional and amateurs overall.

Figure 6 shows that Professionals showed more strong correlations between Heels and other body parts, whereas amateurs did not show strong correlations between them. Professionals also showed more body parts in a correlated and lagged relationship. Coordination between Heel and other body parts may indicate an effective use of the leg turnout (abduction). Turnout means the rotation of the feet facing outward. Turnout is one of the basic techniques in Latin American dance which is used as the main technique in ballet (Unten, 2012). These results suggest that the coordination between the Heels and other body parts may be related to skill improvement in CM.

Table 1: LMM for Shape similarity of R&L Hips trajectory (8participants, 40objects)

	Estimate	Std. Error	P value
Intercept	0.26	2.99	0.93
P5/others	-15.05	2.11	**0.005**
pro/ama	7.49	3.18	**0.02**
CcrHeel	8.25	4.00	**0.04**

We apply LMM to investigate the relationship between the shape of the Hip trajectory and the coordination between Heels and other body parts. Table 1 shows the results of the LMM for the Shape similarity of the R&L Hip trajectories. The results show that P5 had significantly lower Shape similarity than the other participants. Also, Shape similarity was higher in pro than in ama. The positive relationship between Shape similarity and CcrHeel (Table 1) suggests that P3 and P4 skillfully use heel and other-whole-body coordination to draw a symmetrical Hip trajectory.

Table 2: LMM for Circularity of R&L Hips trajectory (8 participants, 40 objects)

	Estimate	Std. Error	P value
Intercept	0.14	0.03	<0.001
P5/other	0.08	0.02	**0.05**
pro/ama	0.07	0.03	**0.03**
R/L	0.13	0.01	**<0.001**
CcrHeel	-0.02	0.05	0.59
pro/ama × R/L	-0.17	0.01	**<0.001**

Table 2 shows the results of the LMM for Circularity of the R&L Hip trajectories. P5 had higher Circularity than the other participants. The result show that Professionals had higher Circularity than the amateurs. This result may reflect the smoothness of their motions trajectory than the amateurs. Further, this may reflect the smoothness of the Hip motion. The L Hip had higher Circularity than the R Hip. The reason for the higher Circularity on L than R may be due to the higher degree of freedom of motion on the L side, as mentioned above. Regarding the interaction between pro/amateur and R/L, amateurs had higher Circularity on the L than on the R, but there was no clear R-L difference for professionals.

Results for Evaluation of Cuban Motion

Table 3: Linear mixed model for each factor of Evaluation for Cuban Motion (8 participants, 3 evaluators, 40 objects)

	Aesthetic		
	Estimate	Std. Error	P value
Intercept	3.87	0.29	<0.001
P5/other	-1.03	0.24	**<0.001**
Pro/Ama	0.35	0.12	**0.003**
	Temporality		
	Estimate	Std. Error	P value
Intercept	2.56	0.18	<0.001
P5/other	-0.08	0.15	0.61
Pro/Ama	-0.03	0.08	0.72
	Spatiality		
	Estimate	Std. Error	P value
Intercept	4.10	0.53	<0.001
P5/other	-0.33	0.34	0.33
Pro/Ama	0.35	0.17	0.37
	Dynamism		
	Estimate	Std. Error	P value
Intercept	3.10	0.21	<0.001
P5/other	-0.94	0.16	**<0.001**
Pro/Ama	0.36	0.08	**<0.001**

Next, we show the results of the evaluation experiment. Table 3 shows the results of the LMM. The objective variable was the average evaluation score for each factor (aesthetics, temporality, spatiality, and power), the fixed effects were P5/others, pro/ama, and random effects were the raters. The effect of P5, which was a special case of expert in movement analysis, was also added to fixed effects in order to check the effect of the specific expertise development. About the factor of Aesthetics and Dynamism score, the professionals were higher than the amateurs. On the other hand, about the same factors, P5 was significantly lower than the other participants. The hypothesis was supported for the pro-ama comparison, but the opposite was indicated for P5. There was no clear effect of any of the fixed effects on the factors of Temporality and Spatiality. For the factor of Temporality, this may be because shape similarity and circularity are indicators that exclude time course aspect. Also, for the factor of Spatiality , this may be because Cuban Rocks is a simple and repetitive movement, which is unlikely to produce differences in the Spatiality aspect.

Discussion

Two Directions of Skill Development for Cuban Motion

In the movement analysis, we found that in the R-L

movement, professionals performed smooth Cuban Motion by coordinating the heel with other body parts. Furthermore, their hip trajectory was more circular than that of the amateurs. In contrast, the symmetrical feature of the hip trajectory, the main part of expression in Latin American dance, was divided into two groups (symmetrical trajectory: P3, P4 / externally asymmetrical trajectory: P5). These results suggest that professionals share the same body use in terms of whole-body coordination and smoothness of the hip trajectory. Still, the direction of expression in dance is differentiated. As mentioned above, these results can be interpreted when we consider Latin American dance as a pair dance that creates beautiful sand movements with partners.

Although this result contradicts the hypothesis, it is possible that in pair dancing, asymmetrical body movements of two individuals are combined to produce symmetrical and beautiful movements. If so, this result gives us some insights: The unit of dancers is important aspects when people see and evaluate their dance movements (Of course, some dancers like P3 and P4 might conduct beautiful movements both in solo and pair.) Although the present study was limited to solo movements, it would be possible and beneficial to conduct similar studies in future in pairs and compare the results with those of solo movements. P3 and P4, which had higher symmetry of the Hip trajectory, also had higher ratings of the aesthetic and force factors for the movement. This result may be related to the results of Brown et al, (2005). It was suggested that symmetry movement may lead to higher evaluation. This is useful information for dance trainees or teachers. On the other hand, P5 had lower ratings for the same factors and was dichotomized in the same way as the results of the motion analysis.

On the other hand, P5 was rated lower for the same factor, and was dichotomized in the same way as the results of the movement analysis. Although this result contradicts the hypothesis, it is possible that in pair dancing, asymmetrical body movements of two individuals are combined to produce symmetrical and beautiful movements. This is a remarkable result. Although the present study was limited to solo movements, it would be possible to conduct similar studies in future pair dance demonstrations and compare the results with those of solo movements.

Table 4: Summary results for each indicator in professionals

	P3, P4	P5
Shape similarity	high	low
Circularity	high	high
CcrHeel	high	high
Evaluated Score of Aesthetics & Dynamism	high	low

The results of these two groups are summarized in Table 4. In this study, we found that the skilled Cuban Motion that gives a good impression to the audience is a symmetrical and circular Hip movement with the coordination between Heel and other body parts in the R-L direction (such as P3, P4). On the other hand, another possibility was suggested: Cuban Motion with asymmetrical Hip movement may give a good impression in pair dancing instead of solo dancing, if it is accompanied by Heel-other-part coordination and circular Hip movement (such as P5).

Limitation of this research

The sample size of this study was insufficient due to limited number of professional dancers. Further, this study divided these few numbers of professionals into two groups. Therefore, the generalization of the findings is limited. In the future, it will be important to gather more professionals to check the validity of these results. Further, Khatchadourian (1978) stated that dance is a temporal and dynamic art that consists of a continuum of human body movements, and that the temporal element cannot be ignored when discussing dance. In the future, we would like to research the relationship between the evaluation and indicators that include temporal elements, such as the relationship between rhythm and movement in dance.

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