academicJournals

Vol. 6(1), pp. 1-11, January, 2016
DOI: 10.5897/JMD2015.0035
Article Number: F75963457217
ISSN 2360-8579

http://www.academicjournals.org/JMD

Journal of Music and Dance

Full Length Research Paper

Expressing joy through hip-hop dance steps: Focus on new jack swing

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Received 5 January 2015; Accepted 22 July, 2015

This study aimed to differentiate hip-hop dance steps based on whether joy was expressed and explained their movement features using three-dimensional motion analysis. Ten male and female participants (26.9 ± 12.8 years old) were instructed to perform an 80-second hip-hop dance, and the step performed after 60 s (new jack swing) was analyzed. Discriminant analysis was conducted, and the differences in the motion feature values were calculated by establishing 34 variables related to time and space. Furthermore, correlations between major joint sites that contributed to differentiation and other variables were calculated. The results revealed the following three points: The discriminant analysis, which was used to predict whether there was emotion, correctly classified cases at a rate of 70% or higher in four stages, which were motion phases. When the differences in motion features by intensity were identified in Phase 2—the phase with the highest correct classification rate—significant differences were found in the mean of the height in the shoulders, the speed of the left acromion, the speed of the capitellum of the left elbow joint, the speed of the center of the left wrist joint, the speed of the lateral condyle of the left femur, the speed of the right acromion, the speed of the capitellum of the right elbow joint, and the flexion angle of the upper torso. Under Strong Emotion, the speed of the left elbow joint and the speed of the center of the left wrist joint had the highest correlation (*r* = 0.92). Based on these results, we can conclude that it is possible to express joy through hip-hop dance, and, in the case of new jack swing, emotional expression is related mainly to the speed of the upper limbs.

Key words: Hip-hop dance, dance step, emotional expression.

INTRODUCTION

Dance is a form of affective and intellectual emotion in which various emotions and thoughts are projected through rhythmical movement (H'Doubler, 1998). Today, dance has evolved into various forms—from folk dance to classical ballet and modern dance performed in the theater—as a primordial human act (Smith, 2010). Therefore, regardless of the dance genre, performers need to have a body that can convey emotion and thought through movement.

Hip-hop dance evolved as a part of hip-hop culture

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along with rap music, music graphic arts, and fashion among African American and Puerto Rican youths in the Bronx in New York City between the late 1960s and early 1970s (Rajakumar, 2012; Craine and Mackrell, 2010). It was also called street dance since young people danced to hip hop on the street. Hip-hop dance spread rapidly in the 1980s, partly because people began seeing hip-hop dance on MTV (Smith, 2010). In Japan, American hip-hop music was introduced in the mid-1980s, and the Japanese-rhymed rap music became popular, with its lyrics about youngsters' daily life, which led to the production of Japanese-style hip-hop music (Fischer, 2013). As for dance, the Japanese were influenced by the street dance shown in the movie *Flashdance* and by MTV, like the Americans. There was also a Japanese TV program called *Dance Koshien* after 1985, which was a dance contest targeted at Japanese high school students. With the accompanying increase in discos and clubhouses, it was clear that there was a dancing boom. In primary and secondary school, hip-hop dance was introduced in 2011 as “rhythm dance” and “modern rhythm dance” in physical education (Ministry of Education, Culture, Sports, Science and Technology, online). Therefore, it is important in hip-hop dance to teach self-expression through dance in addition to teaching the dance steps.

Regarding studies on emotions and movement, several have focused primarily on recognition by examining geometric shapes, facial expressions, posture, sign language, walking, gesture, and dance (Aronoff, 2006; Hietanen et al., 2004; Kleinsmith and Bianchi-Berthouze, 2013). These studies have confirmed that the emotions expressed in those forms are in fact conveyed to observers. For example, Aronoff (2006) reported that observers were able to recognize the roles of dancers in a video of classical ballet: characters were seen as threatening when their movement, pose, and the form of their arms were rigid, and gentle when their movement, pose, and the form of their arms were soft. In addition, a review conducted by Kleinsmith and Bianchi-Berthouze, (2013) on perception and recognition related to physical expression reported that physical expression is a powerful means of communication, and that many studies have shown that observers can recognize angry, happy, sad, and neutral emotions.

In many cases, the type of dance studied in the fields of non-verbal communication and human-computer interaction is modern dance. This emphasis comes from the differences between modern dance and those dances based on proper forms, such as the positions and steps seen in classical ballet, and is regarded as similar to natural human expression (Camurri et al., 2003; Sawada et al., 2003; Sawada, 2009; Sawada, 2010; Dyck et al., 2013). Among them, one study examined modern dance to differentiate emotions expressed by the same motion and showed the motion feature values. Camurri et al. (2003) differentiated emotions and showed the motion feature values by instructing dancers to perform four emotions (joy, anger, fear, and grief), using the same dance movement, capturing those movements, and composing them into silhouettes. This experiment reported that emotions were recognized by the observers in the order of grief, anger, joy, and fear. In terms of motion feature value, while the quantity of motion (QoM) of the overall movement for joy was lowest and the contraction period of the movement was shortest among all emotions, the QoM for grief was the highest, and its contraction period was the longest. The authors stated that the dance used in this study employed stereotypical postures and gestures without emotional expression. However, the specific choreography was not clear. Sawada et al. (2003) instructed dancers to express three emotions (joy, sadness, and anger) by moving the right arm, and then calculated the maximum speed, maximum acceleration, and the total moving distance of their finger position, as well as the motion feature value per emotion. The results showed that the three emotions differed significantly—the maximum velocity of the finger position was significantly faster for anger than for sadness and joy, the maximum acceleration was significantly higher for anger than for joy and sadness, and the total moving distance was significantly longer for joy than for sadness. As for differentiation by observers, the study reported that the observers were also able to differentiate these emotions and that the total moving distance and maximum acceleration affected the recognition of joy and anger, respectively; maximum acceleration and total moving distance also had a weak effect on the recognition of sadness. Furthermore, having asked skilled dancers to express three emotions (joy, sadness, and anger) in five seconds, Sawada (2009) calculated the volume of cuboids created by the maximum X, Y, and Z body part coordinates and the minimum X, Y, and Z body part coordinates, and conducted an ANOVA between emotions using the mean value of expression, the maximum value of expression, the change in the cubic volume, the maximum cubic volume, and the minimum cubic volume. Based on the results, Sawada reported that there were significant differences between the expressions of joy and other emotions. In addition, Sawada (2010) instructed novice dancers to use the right upper limb to express three types of emotions in two intensities (strong and weak) for three seconds to conduct a three-dimensional analysis; the results showed that the movement of the right fingertips was faster and covered a longer distance when a stronger emotion was expressed. However, when Sawada measured the minimum angle created by three sequential positions on the operation locus of the right fingertips, no interaction between emotion and emotional intensity, or a significant main effect, was observed.

These studies have shown the differences in expressing positive emotions (joy) and negative emotions (sadness and anger). However, since they analyzed only changes in the movement and posture of the right arm, they do not account for the emotions expressed through dance. These studies also do not show how the body parts of the performer are involved in expression. In addition, since studies other than those by Sawada et al. (2003) and Sawada (2009, 2010) do not describe the specifics of the movements, it is not possible to say that the dances used in the experiments can be applied in practical coaching, such as teaching dance to develop self-expression. Furthermore, the dance genre mainly studied is modern dance, and there do not appear to be studies on emotional expression through other types of dance.

As for analyzing movement in dance, Laban's theory is well known in the field of dance studies. Laban examined movement using Weight, Time, Space, and Flow as its components; he conducted motion analysis and successfully described movements by developing his own system, known as Labanotation (Hutchinson, 1977). Matsumoto (1988) aimed to link movement and image based on Laban's theory and demonstrated that there was a relationship between the quality of movement and emotional language. The study divided the components of expression quality into Time, Energy, and Design and asked the audience to rate their impression of the expressions using seven adjectives (natural, happy, flowing, lonely, solemn, sharp, and dynamic). Based on the classifications by Laban and Matsumoto, Sawada et al. (2003) and Sawada (2009, 2010) labeled Laban's Time, Weight, and Space as speed, force, and distance, respectively, when they calculated the motion feature created by emotional expression and identified a relationship between the emotion expressed using the upper arm and its movement. In addition, Dyck et al. (2013) instructed participants to use free dance to express emotions triggered by music (happiness and sadness) and calculated seven aspects (speed, acceleration, impact, smoothness, straightness, extension, and height) of various body parts (head, chest, arms, hands, hips, and legs) based on Laban's Effort and Shape. Aiming to develop subjective rating scales for dance, Izaki and Matsuura (2000) suggested that humans use the level of speed rather than acceleration to rate dance movements—based on the view that Weight in Laban's theory is the quality of movement—and used the absolute value of the mean speed as a parameter. These studies based on Laban's theory analyzed subjectively rated Weight and Flow by creating their own objective indicators; as such, their ratings vary. Therefore, based on previous studies, this study hypothesized that it is possible for hip-hop dance, which consists of various steps, to express emotion just as modern dance does. Joy was chosen as the emotion to study; this was because, as we see in folk dance originating from folk customs and culture, dances composed of various steps are lively activities in which the exercise itself is fun (H'Doubler, 1998).

To test this hypothesis, this study first established the Space- and Time-related variables of body parts that can be rated objectively, and calculated their motion feature values including and excluding emotion (No Emotion and Strong Emotion). Then, we examined the classification based on whether there was emotion in each stage. In addition, we aimed to explain emotional expression in hip-hop dance steps by examining the relationship between joint sites in the stage with the highest correct classification rate.

METHOD

Participants

The participants included ten males and females (five males and five females; mean age 26.9 ± 12.8; mean dance experience 4.6 ± 6.2 years) with experience in hip-hop dance, jazz dance, folk dance (*Yosakoi*), ballet, and modern dance.

Analysis of movement

To analyze the expressions of dancers during performance, the participants were instructed to perform an 80-second hip-hop dance prepared specifically for the experiment. This dance was composed of various steps. To identify the expression during this dance performance of new jack swing, the step-dance as a staple of the dance was observed in the movement and, just after the 60-second mark, was analyzed. New jack swing is a music genre that became popular in the late 1980s, and these steps are called new jack swing because they were often used to dance to this type of music (Nippon, 2014). It is performed by jumping on both feet to the right while opening both arms and then using the left arm to throw a punch to the right while making upper-accent rhythms with the hips. When moving to the left, the right arm throws the punch; thus, the step can be performed symmetrically. In this study, the step was defined to include the movement of the upper body, and the step performed by moving to the right was analyzed (Figure 1).

Procedure

In the preliminary experiment, among the emotions of joy, sadness, and anger, joy was chosen because the emotions caused a marked difference in movements. The participants were asked to dance once at one of two levels of intensity (No Emotion, Strong Emotion), and successful attempts were selected for analysis. Intensity was randomly assigned to each subject, and was taught just before the participants' performances. The participants were provided with enough time to practice an experimental dance in advance, and they were allowed to do it over if they made a mistake during the filming. When the dance movements were filmed, a person who had 16 years of experience as a dance instructor attended and only trials considered successful where those in which no mistakes were made in the steps. In addition, after the filmings, the performances were judged by three instructors with 15 years or more of coaching experience. In watching all the performances after they had been changed into stick pictures, those instructors were asked to judge by evaluating whether left and right steps were taken in the same way on a 5-point scale (1: not appropriate, 2: slightly inappropriate, 3: average, 4: somewhat appropriate, 5: appropriate). Upon calculation, the kappa coefficient was confirmed high (k =.71), so a set of steps done in the right direction was subjected to the analysis. During the experiment, the participants were instructed to dance to metronome ticks. The tempo was set at 90 bpm because when

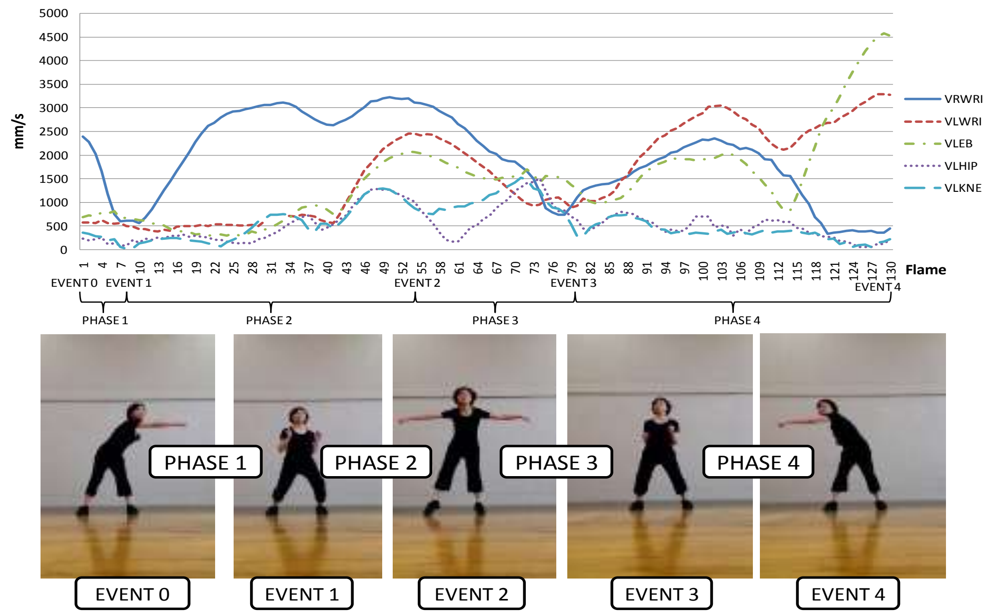

Figure 1. The movement and speed (ID.10) of new jack swing.

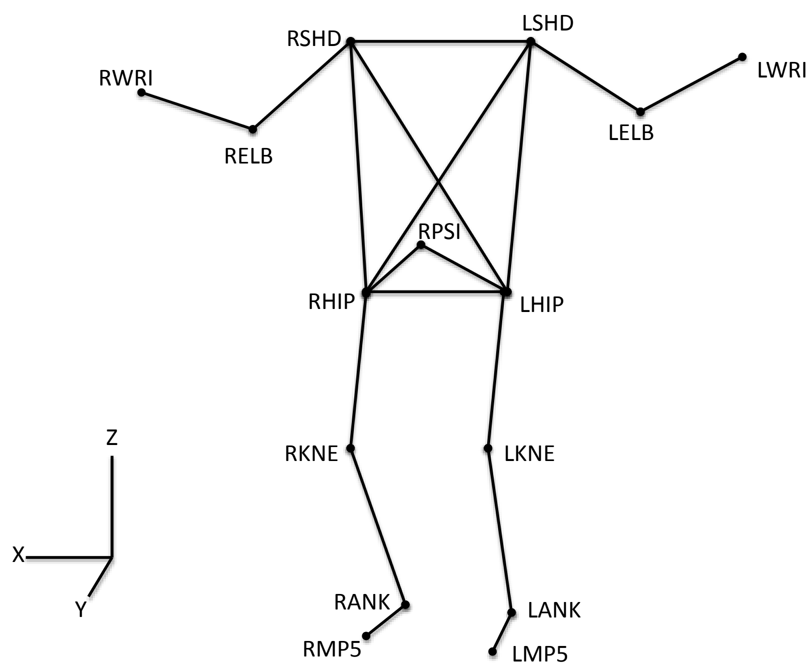

Figure 2. Marker setting points.

participants, in a preliminary experiment, were asked to choose either 90, 100, or 110 bpm, participants rated 90 bpm "the easiest to dance to."

Measurement method

Reflection markers were placed at 15 locations (right and left acromions, the capitellum of elbow joints, the center of wrist joints, center of greater trochanters, lateral condyle of femurs, the lateral malleolus of ankle joints, the head of the fifth metatarsals, and posterior superior iliac spines) (Figure 2). Videotaping was done in a room (6.78 m × 6.48 m) where six optical three-dimensional motion analysis systems (Vicon Motion Systems Lid) were set up to record at a sampling frequency of 100 Hz (Figure 3).

Defining stages and variables

Frames were divided into eight stages based on changes in the

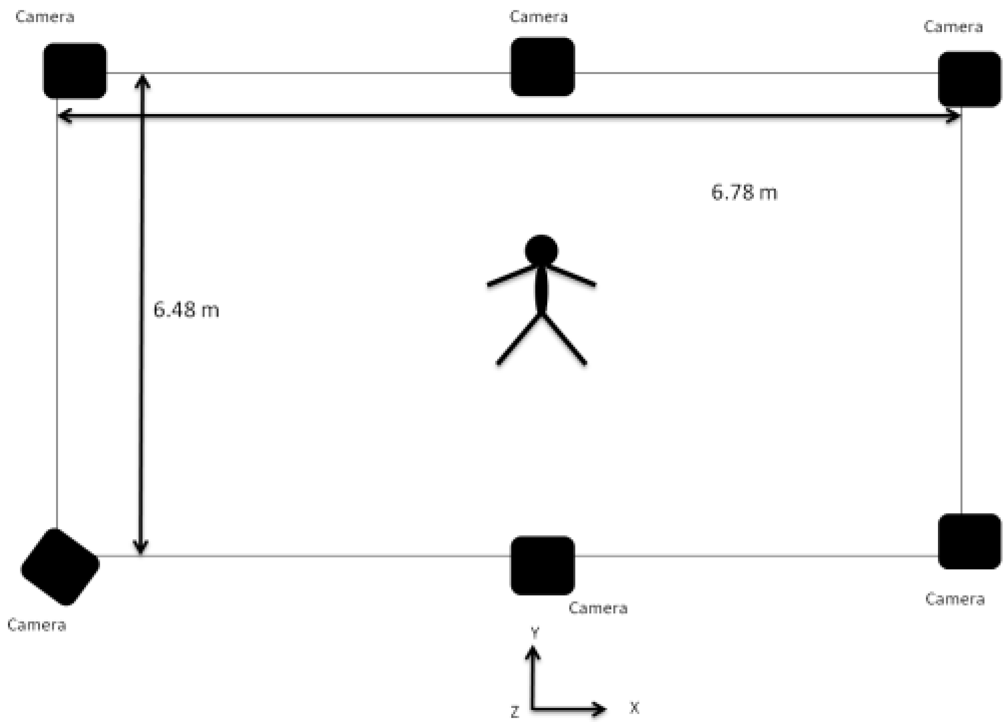

Figure 3. Camera placement.

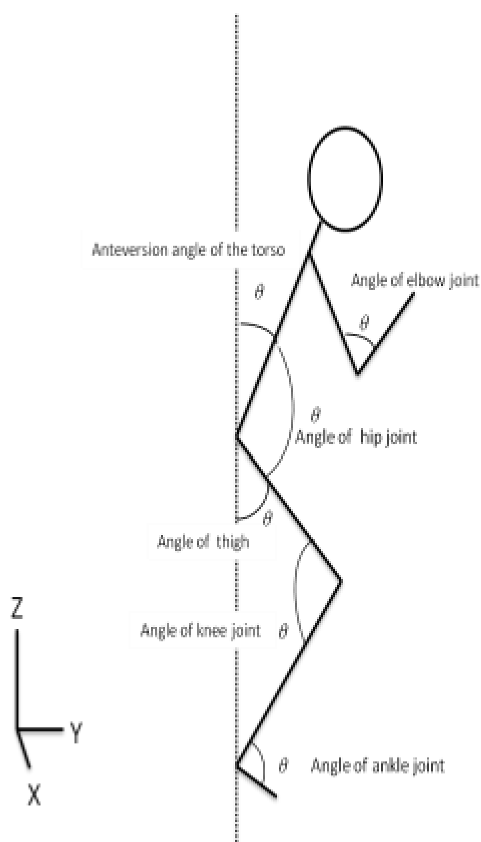

Figure 4. Definition of the angle for the whole body

distance between the right and left wrist joints in new jack swing (Figure 1). "Event" refers to a characteristic movement of the upper right and left limbs when one shifts position. "Phase" was defined as the movement occurring between the movement at the time of one event and the movement of the next event. The whole body was divided into the categories of right upper limb, left upper limb, lower limb, and trunk; and their speed, angle, height, and distance were measured based on the perspectives of speed and space. As predictor variables of speed, three-dimensional composite speed variables based on markers placed on the body, and the absolute value of the change in distance between markers were used. Furthermore, the followings were used as predictor variables of space: the mean of the height in the shoulders and the angles created by three marker points. The angles were set so that when the three markers were aligned, they would comprise 180 degrees, which would decrease as the line was bent (Figure 4). The details of the variables are shown in Table 1, where they are referred to by abbreviation. Events were regarded as postures during the movements, and 16 variables related to space were used. As for phases, 34 variables related to speed and space were used for movements performed between events.

Statistical processing

The captured images were processed by creating three-dimensional coordinates using motion capture platform software (Vicon Nexus) and defining the coordinates from the origin by setting the positive direction of the x-axis to the right of the subject, the positive direction of the y-axis to the front of the subject, and the upward direction of the vertical line as the z-axis (Figure 3). To uncover the motion features in eight stages based on whether there was emotion, we calculated the maximum value for each variable

Table 1. Space and Time Variables for the Whole Body.

Parameter	Descripton
Spatial variables for the trunk	
HSHD	Mean of the height in the shoulders
ARHIP	Angle of the right acromion, the center of the right greater trochanter, and the lateral condyle of the right femur
ALHIP	Angle of the left acromion, the center of the left greater trochanter, and the lateral condyle of the left femur
ATORS	Flexion angle of the upper torso(The flexion angle created by the vertical axis and the vector that is moving from the midpoint between the centers of the right and left greater trochanters to the midpoint between the right and left acromions)
Speed variables for the right upper limb	
SRSHD	Speed of the right acromion
SRELB	Speed of the capitellum of the right elbow joint
SRWRI	Speed of the center of the right wrist joint
Speed variables for the right lower limb	
SRHIP	Speed of the right greater trochanter
SRKNE	Speed of the lateral condyle of the right femur
SRANK	Speed of the lateral malleolus of the right ankle joint
SRMP5	Speed of the head of the right fifth metatarsal
Speed variables for the left upper limb	
SLSHD	Speed of the left acromion
SLELB	Speed of the capitellum of the left elbow joint
SLWRI	Speed of the center of the left wrist joint
Speed variables for the left lower limb	
SLHPI	Speed of the left greater trochanter
SLKNE	Speed of the lateral condyle of the left femur
SLANK	Speed of the lateral malleolus of the left ankle joint
SLMP5	Speed of the head of the left fifth metatarsal
Spatial variables for the right side of the body	
ARELB	Angle of the right acromion, the capitellum of the right elbow joint, and the center of the right wrist joint
ARKNE	Angle of the center of the right greater trochanter, the lateral condyle of the right femur, and the lateral malleolus of the right ankle joint
ARANK	Angle of the lateral condyle of the right femur, the lateral malleolus of the right ankle joint, and the head of the right fifth metatarsal
ARTHI	Angle of the center of the right greater trochanter, the lateral condyle of the right femur, and the lateral malleolus of the right ankle joint
Spatial variables for the left side of the body	
ALELB	Angle of the left acromion, the capitellum of the left elbow joint, and the center of the left wrist joint
ALKNE	Angle of the center of the left greater trochanter, the lateral condyle of the left femur, and the lateral malleolus of the left ankle joint
ALANK	Angle of the lateral condyle of the left femur, the lateral malleolus of the left ankle joint, and the head of the left fifth metatarsal
ALTHI	Angle of the left greater trochanter, the lateral condyle of the left femur, and the lateral malleolus of the left ankle joint

Spatial variables for the area between joints	
DWRI	Distance between the center of the right wrist joint and the center of the left wrist joint
DELB	Distance between the capitellum of the right elbow joint and the capitellum of the left elbow joint
DKNE	Distance between the lateral condyle of the right femur and the lateral condyle of the left femur
DMP5	Distance between the head of the right fifth metatarsal and the head of the left fifth metatarsal
Speed variables for the area between joints	
SDWRI	Speed of the distance between the center of the right wrist joint and the center of the left wrist joint
SDELB	Speed of the distance between the capitellum of the right elbow joint and the capitellum of the left elbow joint
SDKNE	Speed of the distance between the lateral condyle of the right femur and the lateral condyle of the left femur
SDMP5	Speed of the distance between the head of the right fifth metatarsal and the head of the left fifth metatarsal

and performed discriminant analysis using the stepwise method. Next, to uncover motion features based on difference in intensity, we chose the stage with the highest correct classification rate, calculated the maximum mean, and performed a paired t-test. Furthermore, we calculated correlations between the major joint sites contributing to discrimination and other variables. As a note, Event 0 was excluded from the analysis because it was the starting point of the movement.

RESULTS

Discrimination based on whether emotion was expressed

To explain the discrimination of movements based on whether there was emotion, we conducted stepwise discriminant analysis on the movements between Phase 1 (hereafter P1) and Event 4 (hereafter E4). As a result, the movement was classified as P1, P2, E2, P3, and P4 (Table 2). In terms of phase, SLWRI and ALEVB were extracted for P1 with a discriminant function of z = 1.22 × (SLWRI) -0.86 × (ALEVB) (Wilks's λ = 0.52, $p < .01$) and a correct classification rate of 70.0%. SLELB, DWRI, and DKNE were extracted for P2 with a discriminant function of z = 1.98 × (SLELB) -2.97 × (DWRI) + 1.75 (DKNE) (Wilks's λ = 0.31, $p < .001$) and a correct classification rate of 90.0%. For P3, SL SHIP and ARTHI were extracted, with a discriminant function of z = 1.03 × (SLELB) + 0.79 (Wilks's λ = 0.48, $p < 0.01$) and a correct classification rate of 85.0%. For P4, SLANK was extracted (Wilks's λ = 0.65, $p < 0.01$) with a correct classification rate of 80.0%. In terms of event, only E2 was classified. There, ALANK was extracted (Wilks's λ = 0.785, $p < 0.05$) with a correct classification rate of 70.0%.

Motion feature values by intensity and correlations in phase 2

To determine the differences in the predictor variables by intensity, paired t-tests were performed on the maximum means of each variable in P2, where the correct classification rate was the highest (90%) among the eight stages (Table 3). As a result, significant differences were observed in the following variables: HSHD ($t(9)$ = 8.15, $p < 0.05$), SLSHD ($t(9)$ = 16.41, $p < 0.01$), SLELB ($t(9)$ = 18.31, $p < 0.01$), SLWRI ($t(9)$ = 11.53, $p < 0.01$), SLKNE ($t(9)$ = 11.21, $p < 0.01$), SRSHD ($t(9)$ = 5.54. $p < 0.01$), SRELB ($t(9)$ = 6.75, $p <0 .05$), and ATORS ($t(9)$ = 5.47, $p < 0.05$).

Next, to explain the involvement of body parts based on whether there was emotion, correlations by intensity were calculated between SLELB—which was extracted in the first step through stepwise discriminant analysis—and 33 variables representing other movements throughout the body (Table 4). As a result, while a significant strong correlation was observed between SLELB and SLSHD (r = 0.77, $p < 0.01$), SLWRI (r = 0.67, $p < 0.05$), SLKNE (r = 0.73, $p < 0.05$), SRSHD (r = 0.67, $p < 0.05$), SRELB (r = 0.68, $p < 0.05$), and DWRI (r = 0.74, $p < 0.05$) for No Emotion, a significant strong correlation was observed between SLELB and SLWRI (r = 0.92, $p < 0.001$), SRELB (r = 0.72, $p < 0.05$), and DWRI (r = 0.67, $p < 0.05$) under Strong Emotion.

DISCUSSION

Emotions were discriminated by intensity in five stages at a rate of 70% or higher. In particular, emotion was discriminated in all phase stages. SLWRI and ALELB were extracted for P1. This implies that the difference in emotion was identified by the speed of the left wrist joint and

Table 2. Discriminant Analysis at Each Stage.

Predictor variable	Eigenvalue	Canonical correlation coefficient	Wilks λ		Coefficient of discriminant function	Correct classification rate
Phase 1	0.91	0.69	0.52	**	-	70.0
SLWRI	-	-	-	-	1.22	-
ALELB	-	-	-	-	-0.86	-
Event 1	*N.S*	-	-	-	-	-
Phase 2	2.24	0.83	0.31	***	-	90.0
SLELB	-	-	-	-	1.98	-
DWRI	-	-	-	-	-2.97	-
DKNE	-	-	-	-	1.75	-
Event 2						
ALANK	0.27	0.46	0.79	*	1	70.0
Phase 3	1.07	0.72	0.48	**	-	85.0
SLHIP	-	-	-	-	1.03	-
ARTHI	-	-	-	-	0.79	-
Event 3	*N.S*	-	-	-	-	-
Phase 4						
SLANK	0.53	0.59	0.65	**	1	80.0
Event 4	*N.S*	-	-	-	-	-

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Table 3. Descriptive Statistices by Presence of Emotion in Phase 2.

Parameter	Phase 2		*t*
	No emotion	Strong emotion	
	M ±***SD***	***M*** ±***SD***	
HSHD	1423.45±68.53	1447.78±75.25	8.15*
SLSHD	1134.46±338.29	1413.27±275.24	16.41**
SLELB	1792.64±274.51	2141.54±305.64	18.31**
SLWRI	1940.61±450.89	2496.45±825.18	11.53**
SLHPI	1061.43±274.12	1203.41±351.57	3.26
SLKNE	1102.84±250.26	1310.20±313.79	11.21**
SLANK	874.72±633.42	1241.12±492.26	3.56
SLMP5	1347.26±683.42	1386.94±591.52	0.05
SRSHD	1147.12±262.13	1367.40±335.60	5.54*
SRELB	1965.61±454.72	2227.10±390.63	6.75**
SRWRI	3127.80±779.72	3399.02±752.26	1.08
SRHIP	1114.17±233.10	1239.38±321.44	2.73
SRKNE	1160.80±287.81	1260.18±339.18	1.01
SRANK	1140.10±227.22	1032.52±237.66	1.42
SRMP5	1292.44±482.29	1165.88±457.52	0.91
DWRI	1274.01±53.27	1269.02±50.73	0.31
DELB	814.69±51.63	813.04±53.37	0.12
DMP5	696.41±71.79	699.97±89.87	0.04
DKNE	473.12±65.48	479.68±52.29	0.50
SDWRI	3629.48±844.22	4017.31±1575.31	1.49
SDELB	1299.26±340.80	1426.41±510.07	1.07
SDMP5	1066.85±620.90	967.67±594.50	0.63
SDKNE	527.28±266.32	596.42±349.26	1.60

Table 3. Cont.

ALELB	142.20±13.26	140.23±9.82	0.44
ALKNE	124.30±65.87	156.42±8.64	2.50
ALANK	93.25±50.53	124.19±12.13	2.92
ALHIP	164.81±8.52	163.53±9.83	0.72
ALTHI	20.97±9.27	20.91±8.06	0.00
ARELB	138.19±12.13	136.35±10.04	1.21
ARKNE	152.46±7.45	155.14±7.44	2.87
ARANK	126.62±7.33	128.95±7.28	0.89
ARHIP	166.41±8.13	166.44±8.49	0.00
ARTHI	20.41±9.51	18.42±7.90	3.43
ATORS	7.88±4.13	9.58±5.76	5.47*

*$p < 0.05$, **$p < 0.01$

the angle of the left elbow joint when the upper torso rotated from the left to the midsagittal plane. SLELB, DWRI, and DKNE were extracted for P2, and SLHIP and ARTHI were extracted for P3. P2 and P3 were movements in which the dancer jumped on both feet to the right while drawing the upper limbs out to the side from the elbow joints. Therefore, whether emotion was expressed at the start of the jump was identified by the speed of the left elbow joint, the distance between the wrist joints, and the distance between the knee joints. It also seems that the expression of emotion at the time of landing was based on the speed of the left greater trochanter and the angle of the right thigh. Given that SLANK was extracted for P4, we can say that the emotion expressed in the punching pose of the upper left arm was identified based on the movement of the lower limbs centering on the left ankle joint. Next, under events, whether emotion was expressed was identified only for E2. These results indicate that whether there was joy was determined based on the motion (phase) rather than the posture (event). Emotion was identified especially in P2, E2, and P3, which comprised the first half of the movements in the eight stages, at a rate of 70% or higher. This indicates that the dancers expressed emotion through new jack swing by simultaneously raising both elbow joints and stretching the wrist joints out at the time of the jump. Furthermore, we can say that joy was expressed in the motions (phase) rather than the postures (event).

Next, when the differences in variables were analyzed by intensity in P2—the stage with the highest correct classification rate of all eight stages—the results showed that HSHD, SLSHD, SLELB, SLWRI, SLKNE, SRSHD, SRELB, and ATORS had significantly higher values for Strong Emotion rather than No Emotion. These results suggest that the jump under Strong Emotion compared to No Emotion consisted of a faster elevation of the elbow joints, faster extension of the left wrist joint, and a forward-leaning posture. In addition, while SLSHD, SLWRI, SLKNE, SRSHD, SRELB, and DWRI were correlated with SLELB under No Emotion, SLWRI, SRELB, and DWRI were correlated with SLELB under Strong Emotion. Therefore, given that SLWRI ($p < 0.001$) and SRELB ($p < .05$) were correlated with SLELB under Strong Emotion, while No Emotion was related to both shoulders and both arms, we can say that there was a relationship between the presence of emotion and the speed of raising both elbow joints and extending the left wrist joint. Dyck et al. (2013) reported that, compared to sadness, happiness expressed in free dance was significantly faster in speed and acceleration, and the hand was always extracted for impulsivity (speed amplitude range), speed, acceleration, and extension (the distance to the upper limbs) compared to other parts of the body. The present study also showed that there was a significant difference in the speed of the right and left elbow joints under Strong Emotion compared to No Emotion. Asian folk dances seen in India, Bali, and Java also convey emotions to the audience and other dancers through hand gestures and the movement of the hand, including the nails (Dyck et al., 2013). Further, in terms of observers' perceptions, Izaki and Matsuura (2000) performed factor analysis on subjective ratings given by experienced dancers to assess the quality of a performer's movement and extracted four body parts (head and torso, upper limbs, right lower limb, and left lower limb) as predictors. Since this implies that humans distinguish the quality of movement based on four body parts, we can say that the upper limbs are important body parts in expression.

In the present study of new jack swing, a type of hip-hop dance step, we particularly examined the expression of joy. The results indicated that the presence of emotion depended on the speed of the right and left elbow joints and the left wrist joint, rather than on the lower limbs. In the context of dance, "step" refers to a sequence of foot movements that comprises a dance (Pollard and Liebeck, 1994). However, since dancing is a full-body exercise, stepping also involves upper body movements, such as arm movement and facial orientation. For example, a pas

Table 4. Correlation between SLELB and Other Variables in Phase 2

Parameter	SLELB	
	No emotion	Strong emotion
HSHD	0.60	0.41
SLSHD	0.77**	0.52
SLELB	—	—
SLWRI	0.67*	0.92***
SLHPI	0.55	0.00
SLKNE	0.73*	0.57
SLANK	0.13	0.62
SLMP5	0.13	0.44
SRSHD	0.67*	0.22
SRELB	0.68*	0.72*
SRWRI	-0.07	0.57
SRHIP	0.42	0.06
SRKNE	0.57	0.15
SRANK	0.28	0.48
SRMP5	0.27	0.23
DWRI	0.74*	0.67*
DELB	0.56	0.35
DMP5	-0.05	-0.02
DKNE	0.30	0.17
SDWRI	0.13	0.60
SDELB	0.30	0.42
SDMP5	0.23	0.61
SDKNE	0.24	0.40
ALELB	0.40	0.41
ALKNE	0.12	0.36
ALANK	0.12	-0.17
ALHIP	-0.34	-0.14
ALTHI	0.42	0.01
ARELB	0.10	0.41
ARKNE	0.14	0.23
ARANK	-0.08	-0.24
ARHIP	0.00	0.04
ARTHI	0.13	-0.23
ATORS	0.35	-0.11

$*p < 0.05$, $**p < 0.01$, $***p < 0.001$

de chat in classical ballet involves not only the feet but also arm movements, such as holding them in third position and en haut. Likewise, based on the fluid impression created by dynamic motion, hip-hop dance intentionally uses various parts of body. Arms, legs, and even the stern face are expressed as attitude (Rajakumar, 2012).

The results of this study, in examining the usability of new jack swing during instruction and implementation of expression, showed that instructors are capable of teaching students to express joy through objective indexes, which are the speed of the extension of bilateral elbow joints and the left wrist at jumps and forward-bent posture jumps, without relying on their personal ideas. With this knowledge, even inexperienced dance instructors can teach students accurately. Furthermore, because the instructions are standardized, it is possible to avoid confusing the students when one instructor replaces another. By directing students to express joy, instructors can make them move their arms more dynamically, and, conversely, when students are provided with specific ways to use the body based on the objective indexes of the expressions of joy, they can perform the movements accurately to express joy, regardless of dance experience or physique. According to Abdollahipour et al. (2015), in order to improve the movements or quality of apparatus gymnastics and classic ballet, external attentional focus such as putting stickers on the body, using metaphor, and imaging were effective for improving the performances. Therefore, the results of this study are practical for students in helping them pay more attention to the body parts, to ways of moving (speed), and to enhancing expression. In sum, our results show that self-expression through dance steps involves making specifiable, sequential feet movements along with the movements and postures of the upper body.

Since the results of this study showed that the dance composed of steps differed according to whether there was an emotional expression, the hypothesis was supported. Furthermore, since this study found that the movements of the upper limbs were involved in expressing emotion in the new jack swing, the results of previous studies were supported as well. Kleinsmith and Bianchi-Berthouze, (2013) argued that body expression perceptions and recognitions in the field of non-verbal communication can be applied to fields such as security, games and entertainment, education, and healthcare. Likewise, following the results of the present study, the analyzed steps can be used in the practice of teaching dance; however, a greater variety of hip-hop dance steps and a wider range of emotions need to be further examined in the future.

Conclusion

This study aimed to differentiate hip-hop dance steps based on whether there was an expression of joy and to explain their motion features using three-dimensional motion analysis. Ten male and female participants were instructed to perform an 80-s hip-hop dance, and the step performed after the 60-s mark (new jack swing) was analyzed. A discriminant analysis was conducted, and the differences in the motion feature values were calculated by establishing 34 variables related to time and space. Furthermore, correlations between major joint sites that contributed to differentiation and other variables were calculated. The results revealed the following three points:

1. The discriminant analysis used to predict whether there

was emotion correctly classified cases at a rate of 70% or higher in four stages, which were motion phases.
2. When the differences in motion features by intensity were identified for Phase 2—the phase with the highest correct classification rate—significant differences were found in the following variables: the mean of the height in the shoulders (HSHD) ($t(9) = 8.15$, $p < 0.05$), the speed of the left acromion (SLSHD) ($t(9) = 16.41$, $p < 0.01$), the speed of the capitellum of the left elbow joint (SLELB) ($t(9) = 18.31$, $p < 0.01$), the speed of the center of the left wrist joint (SLWRI) ($t(9) = 11.53$, $p < 0.01$), the speed of the lateral condyle of the left femur (SLKNE) ($t(9) = 11.21$, $p < 0.01$), the speed of the right acromion (SRSHD) ($t(9) = 5.54$, $p < 0.01$), the speed of the capitellum of the right elbow joint (SRELB) ($t(9) = 6.75$, $p < 0.05$), and the flexion angle of the upper torso (ATORS) ($t(9) = 5.47$, $p < 0.05$).
3. Under Strong Emotion, the speed of the left elbow joint and the speed of the center of the left wrist joint had the highest correlation ($r = 0.92$).

Based on these results, we can conclude that it is possible to express joy through hip-hop dance, and, in the case of new jack swing, emotional expression is related mainly to the speed of the upper limbs.

Conflict of Interests

The authors has not declared any conflict of interest

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