J Nonverbal Behav (2013) 37:107–121
DOI 10.1007/s10919-013-0148-y

ORIGINAL PAPER

Development of the Movements Impressions Emotions Model: Evaluation of Movements and Impressions Related to the Perception of Emotions in Dance

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Published online: 1 February 2013

Abstract The purpose of this study is to specify the characteristics that contribute to the perception of emotions expressed through dance movements and to develop an emotional model to show the relationships between impressions and the characteristics of expressive body movements. Six dancers expressed three different emotions through dance: joy, sadness, and anger. Observers ($N = 192$) rated both their impressions (33 dimensions) and the dance movements (26 characteristics) of 18 dance performances. The results showed that the observers could accurately perceive the emotional meanings expressed in the dances. The impressions of Dynamics, Expansion, and Stability—and the evaluated movements of Frequency and Velocity of Upward Extension, Frequency and Velocity of Downward Movements, Turning or Jumping, and Body Closing—were extracted via factor analysis as determinants of observers' impressions of emotional expressions in dance. Additionally, covariance structure analysis and discriminant function analysis indicated that the emotional expressions of the dances expressing joy, sadness, and anger are each associated with particular factors. Through these analyses, we developed the Movements Impressions Emotions Model for dance.

Keywords Emotion · Expression · Dance movements · Identification · Impressions · Movement characteristics

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Introduction

Recognition of others' emotions is a necessary part of communication. Research has shown that the conveyance of emotion through nonverbal modes of facial or vocal expressions, posture, gestures, and body movements is as important as verbal information (Clarke et al. 2005; Coulson 2004; De Meijer 1989; Dittrich et al. 1996; Ekman and Friesen 1971; Montepare et al. 1987; Montepare et al. 1999; Wallbott and Scherer 1986). On the other hand, expressive gestures, movements, and posture have received less research attention than emotional representations in facial expressions. However, we communicate, give, tell, read, see, and feel not only through facial expressions, but also through many different forms of body movements and physical actions. Incidentally, there are few situations in everyday life in which only bodily expressions are perceived. When conversing with a partner, both voice and gestures are recognized, and facial expressions are recognized simultaneously with bodily expressions.

Recently, research focusing on combined perception among facial, vocal, and bodily expression (de Gelder 2006; Rozin et al. 2005) has attracted attention. There have been reports that emotion recognition in voices is affected by discrimination of facial expressions; further, if voice emotion cannot be clearly discriminated, emotion perception is influenced by bodily movements (de Gelder et al. 1999; van den Stock et al. 2007). Research on the recognition of facial and vocal expression and bodily movement examines the simultaneous perception of these factors and the impact of perception and recognition on each. Because each expression has distinctive characteristics, it is important to consolidate information and recognize the voluminous amounts of information included in the emotional expression of body movements.

Studies of the nonverbal expression of emotions have examined various aspects of body movements. Movements are literally in flux, constantly evolving and changing. Therefore, the contents of series of movements, in addition to instantaneous movements, need to be grasped. For instance, consider the case of shaking one's head. If we shake our heads vertically, people understand this as nodding, which suggests consent and agreement and is an indispensable tool for communication. On the other hand, to express denial and refusal, we shake our heads horizontally. Regardless of the fact that these two movements are physically similar, we perceive and recognize diverse meanings through them. More detail is provided in studies of emotion and expression by Wallbott and Scherer (1986). In this research, observers were instructed to watch actors who were expressing emotions and to judge their movement behavior as "fast," "expansive," "energetic," "active," or "pleasant." The results indicated that sad acting contained behavior cues representing "not fast," "not energetic," and "unpleasant" and that angry acting contained cues representing "fast" and "unpleasant."

De Meijer (1989) showed that the general features of body movement contributed to the identification of emotions on the basis of actors' expressions. Each movement was classified in terms of seven general dimensions: trunk movement, arm movement, vertical direction, sagittal direction, force, velocity, and directness. Observers rated the compatibility of each movement according to each of 12 emotion categories. The results for trunk movement showed that stretching predicted joy, sympathy, interest, etc.; on the other hand, bowing predicted such emotions as grief, anger, and fear. The trunk movements of stretching and bowing were thus found to discriminate between positive and negative emotions.

Wallbott (1998) found that high activity and large, expansive movements expressed joy and anger in the performances of actors. Montepare et al. (1999) showed that not only young adults but also elderly persons could identify joy, sadness, and anger from gestures and they took their cues from the form, velocity, frequency, and volume of movement to decode these emotions. Walking is a form of movement that is part of daily life, and it is also related to human emotions. Montepare et al. (1987) and Montepare and Zebrowitz-McArthur (1988) showed that observers could discriminate emotions expressed by gait characteristics such as the amount of arm swing, stride length, heavy-footedness, and walking speed; Sasaki (2005) replicated these findings and categorized these indicators as emotional gait characteristics. The clues for emotional identification on the basis of walking are posture, tempo, gait pace, and timing of heel and toe release from the ground.

Other studies on the relationships among emotion, gesture, walking, arm movements, and dance have used point-light displays of biological motion to indicate how observers perceive emotion (Clarke et al. 2005; Dittrich et al. 1996; Pollick et al. 2001). For example, Pollick et al. (2001) used point-light displays of knocking and drinking arm movements to show that subjects can perceive a range of internal states from these actions. Dittrich et al. (1996) showed that surprise, fear, anger, disgust, grief, and joy could be identified when dancers were portrayed by point-light displays. Humans can perceive emotions from movements with reduced bodily information in point-light displays.

Dance is an art that expresses emotions, feelings, thoughts, etc. through the body. Dance includes more overdramatic movements than does daily life so that it will have the power to "speak" directly to people. This "speech" contains the message of the dancer, who expresses his/her feelings and thoughts. In turn, certain personal feelings may be evoked in the observer who appreciates the dance: he/she may comprehend the thoughts of the dancer who is expressing his/her feelings or otherwise experience a variety of feelings and thoughts. These interactions between those who express and appreciate dance enhance its significance and deepen it as an expressive activity. Dance movements have received a great deal attention in studies of body movement because their characteristics are intentionally used to convey various emotions (Boone and Cunningham 1998; Camurri et al. 2003). Emotional expression in dance contains a wealth of information that can be used to identify emotions.

Some studies have analyzed and focused on the relationships between impressions and movement characteristics according to the spatial and temporal features of dance movements. Matsumoto (1987) investigated the relationship between feelings and movement characteristics using three elements: time, energy, and design. Observers evaluated dance movements that expressed seven feelings and classified their impressions on the basis of the three elements. Their results showed that expressions of happy feelings involved relatively many changes and were typified by high speed, high energy, skipping, jumping, and turning; on the other hand, expressions of lonely feelings were characterized by low speed, low energy, and bending and stretching. In another study, observers displayed the recognition that dances of joy contain open, freely conducted movements and that dances of sadness lack energy (Brownlow et al. 1997). In contrast, Camurri et al. (2003) developed the automatic recognition system, in which emotionally expressive movements can be categorized in terms of four dimensions: weight, time, space, and flow (based on Laban 1963). For example, the expression of joy was associated with a high number of changes in the tempo of movements or extended movements from the center of the body. The expression of sadness involved long durations and continuous tenseness of movement. The expression of anger was associated with a high number of changes, dynamism, short durations of movements or movements with short stops, and high tenseness in movement; the tension builds up and then explodes in such expression.

Kamisato and Hoshino (1999, 2000) and Kamisato et al. (2004) used factor analysis to categorize the movement characteristics and impressions of traditional Japanese dance movements. Their results showed that movement factors such as smoothness, rise, accent, and dynamics, were involved in traditional dance. They analyzed the relationships between impressions and movement characteristics in terms of the spatial and temporal features of the trajectories of the limbs. Sawada et al. (2003a) found a relationship between emotional expression and arm movement characteristics using kinematic data. They found that three parameters of movement characteristics (speed, force, and directness) were useful for discriminating various emotional expressions inherent in arm movement. Sakata and Hachimura (2007) reported a relationship between the physical features of dance movements and KANSEI information, which measures emotional responses. Their research suggested that dancing and acting according to each of the seven motives (happy, lonely, sharp, solemn, dynamic, flowing, and natural) proposed by Matsumoto (1987) involves different levels of velocity and acceleration of limbs, length, and center movement. Thus, many studies have reported that we are capable of identifying emotional expressions in dance and that body movements in dance have characteristics that convey particular emotions.

The preceding summary represents the relationships between dance expressions and impressions (Camurri et al. 2003; Matsumoto 1987; Kamisato and Hoshino 1999, 2000; Kamisato et al. 2004) and those found between emotional dance expressions and movements using quantitative data (Sawada et al. 2003a, b; Sakata and Hachimura 2007). However, how can observers recognize these emotions, and what impressions are created from the production of emotional expression by movements? What types of cues are recognized through body expressions? Previous studies have elucidated many factors, but few studies have focused on impressions, movements, and perception of emotions in dance in a single study. Thus, a main purpose of the present study was to explore the relationships among these various components to understand more clearly how emotions displayed through dance are seen by observers. We developed an emotional model to show the relationships between impressions and expressive body movement characteristics that are evaluated by observers. We used exploratory factor analysis and covariance structure analysis to develop the model and checked the results by discriminant function analysis to show how the recognition of emotions affects the impressions formed by observers.

Method

Observers

A total of 192 observers (mean age = 21.4 years; 60 male and 132 female) participated in the experiment. They were novices in terms of dance, and their experience in this area consisted of viewing dance on television and/or dance training in physical education classes.

Dance Displays of Emotion

Six female dancers (mean age = 23.0 years) were asked to display emotions through dance. All were expert dancers with an average of 15.4 years of experience, and they had all received prizes in dance contests; their expertise was in the genres of modern dance and classical ballet. The dancers were asked to express three instances of each of three emotions (joy, sadness, and anger) through dance; each of these emotions was to be expressed for 5 s. Dancers often count eight counts (beats) as one phrase, which is the smallest unit in dance; it is possible to convey an expression through dance even in the course of one phrase. Because one phrase generally lasts about 5 s, that duration was used for each expression trial. The dancers were instructed to use their entire bodies during the dance but not to use any facial expressions. We therefore recorded 54 expressions (3 emotions $\times$ 3 instances $\times$ 6 dancers). Before recording, the dancers were allowed to practice their performances without any time restrictions; further, if they made any errors during the taping of the trial footage, we re-recorded the expressions. Each expression was recorded by a fixed digital video camera viewing a 2 $\times$ 2 m square of dance floor.

To select appropriate dance expressions to represent the three emotions fairly, we first checked to see that the dances were conducted without facial expressions and removed one dance that featured a facial expression. In addition, the six female dancers judged the validity of the expressions: they watched the dance footage and were instructed to select the dance that featured the most expressive example of each emotion for each dancer. Thus, the 18 highest-ranked expressions were selected for use during the experimental trials (each dancer's best expression of joy, sadness, and anger $\times$ 6 dancers).

Further, informed consent was obtained from all of the dancers prior to their participation in the study. The study was approved by the Ethics Committee of Tokyo Institute of Technology in Japan.

Procedure

Observers sat in front of a monitor on which the dances expressing emotions were presented. The distance between the observers and the monitor was about 2 meters, and the size of the monitor was 1.5 $\times$ 2 m. Three of the 18 dance expressions, each representing one of the emotions were presented in a random order to each participant; immediately after each dance expression, the observer completed a response sheet. The observers had 120 s to watch each expression repeatedly and complete the corresponding response sheet. The questionnaires for emotion identification, impressions, and evaluated movements are described below.

Measures

Emotion identification

Observers were asked to watch the dances and to rate how compatible each emotion (joy, sadness, and anger) was with each dance on a 5-point scale (1 = *not expressive*; 5 = *expressive*).

Impressions

Impressions are those associated with the dance expression images presented to observers. After the observers watched the dances, they rated their impressions on a bipolar 5-point scale (1, 5 = *expressive*; 2, 4 = *fairly expressive*; 3 = *neither*) by the semantic differential method (Osgood et al. 1957). The impression items included 26 items from Matsumoto (1987) and Zukawa (1995); the items were constructed by extracting pairs of adjectives, adjective verbs, and adverbs from dance works and rating them on scales; we added seven further items on the basis of advice from expert classical ballet and modern dancers. These 33 items were: speedy–slow, accent–smooth, rhythmic–monotonous, strong–weak, heavy–light, large–narrow, big–small, open–closed, up–down, lateral–vertical, rounded–linear, regular–irregular, sudden–constant, balanced–unbalanced, steady–unsteady, usual–unusual, positive–negative, happy–unhappy, lonely–not lonely, sharp–dull, energetic–depleted, flowing–jerky, complex–simple, dynamic–static, sharp–flat, tense–relaxed, accelerated–decelerated, discontinuous–continuous, unequal–equal, pointed–rounded, symmetric–asymmetric, extended–flexed, and high–low.

Evaluated movements

Evaluated movements are items rating the movement characteristics of bodies; they are not physical data but rating data from observers. The observers were asked to watch the dances and to rate their movement characteristics on a bipolar five-point scale. Twenty-six movement items from Izaki and Matsuura (2000a, b) were used to describe movement characteristics in dance. These items were: head-turn up, head-bend down, arms-flex, arms-extend, arms-rise, arms-drop, legs-flex, legs-extend, legs-rise, legs-drop, body-lean sideways, body-bend forward, body-bend backward, walk, run, roll, jump, turn, slip, go down, return, go forward, go diagonally forward, sidle, go backward, and go diagonally backward. The observers rated the frequency and velocity of each of these items; higher rating scores on the five-point scale indicated more frequent/faster movements.

Data Analyses

First, to examine whether the observers were able to identify each emotion that the dancers intended to express, we conducted a two-way within-subjects ANOVA comparing the mean scores for perception of emotion with each intended emotion. Second, we conducted a factor analysis among the 33 impression items and 26 movement items. The factor analysis was conducted with promax rotation. Third, to find the relationships between factors determining the perception of emotional expressions, we conducted a covariance structure analysis using factors extracted from the factor analysis. Structural modeling can show how the observed impressions and movement factors relate to the categorization of perceived emotion. Finally, we used a discriminant function analysis to show how the identified factors discriminate between the categories of perceived emotion. Discriminant analysis represents a grope with the goal of determining the categories that comprise independent variables; it is possible to define a function to conduct the grope using the independent variables.

Results

Emotion Identification

To examine whether the observers were able to identify each emotion that the dancers intended to express, a two-way within-subjects ANOVA (Perceived emotions × Intended emotions) was performed to compare the mean values of emotion perception for each intended emotion.

The results are shown in Table 1. The interaction between perceived emotions and intended emotions was significant [$F(4,764) = 344,64$, $p < .01$], and the main effect of perceived emotions was significant [$F(2,382) = 9.22$, $p < .01$]. For the dance expressions conveying joy, sadness, and anger, there were significant main effects of perceived emotion [$F(2,382) = 463.63$, $p < .01$; $F(2,382) = 227.19$, $p < .01$; and $F(2,382) = 108.18$, $p < .01$, respectively]. Scheffe's post hoc tests showed that the perceived emotion score for joy was significantly higher than those for sadness and anger ($p < .01$), that the

Table 1 Means and standard deviations for the perceived emotion related to the intended emotion of the dance expressions. *Mean* ± *SD*

Intended emotion	Perceived emotion			*p*
	Joy	Sadness	Anger	
Joy	4.30 ± 0.88	1.69 ± 0.93	1.75 ± 1.09	Joy > sadness** Joy > anger**
Sadness	1.98 ± 1.07	4.24 ± 0.88	2.28 ± 1.18	Sadness > joy** Sadness > anger**
Anger	2.46 ± 1.13	2.69 ± 1.21	3.95 ± 0.93	Anger > joy** Anger > sadness**

** $p < .01$

score for sadness was significantly higher than those for joy and anger ($p < .01$), and that the emotion score for anger was significantly higher than those for joy and sadness ($p < .01$). Thus, the results indicate that the observers accurately perceived the intended emotions behind the dancers' expressions in this study.

Factor Analysis of Impression

The 33 impressions items were checked and selected on the basis of their means and SD values. Seven items whose range of mean ± 1 SD fell outside of the score range (1–5) were excluded from the subsequent analyses because of possible floor or ceiling effects or skewed distributions. A factor analysis was conducted with promax rotation on the remaining 26 items. Three factors were extracted according to their interpretability, yielding a cumulative contribution ratio of 64.59 %. The eigenvalues of the first–third factors were 5.73, 2.81, and 1.80, respectively. After eliminating items whose factor loadings were $\leq$.40, a scale of 16 items with a three-factor structure was obtained (Table 2).

The first factor, which encompassed items such as pointed–rounded, sharp–dull, energetic–depleted, and strong–weak, was interpreted as representative of intensely moving the body in response to changes; we named this factor Dynamics. The second factor was comprised by items such as large–narrow, extended–flexed, lateral–vertical, and high–low; it was considered to evoke a spatial image. We named this factor Expansion; it was considered suitable to discriminate the direction of expansion because the mean scores on the items involved in this factor were all greater than 3. The third factor included such items as regular–irregular, unequal–equal, complex–simple, and symmetric–asymmetric; it was interpreted as evoking an image of balanced movement and harmonious expression. This factor was named Stability.

Cronbach's α coefficients were obtained to confirm the internal consistency reliability of the derived 16-item impression scale. The α values were .92, .71, and .68 for the first–third factors, respectively.

Factor Analysis of Evaluated Movements

The 26 movement items were checked and selected on the basis of their means and SD values. Fourteen items whose range of mean ± 1 SD fell outside of the score range (1–5) were excluded from the subsequent analyses because of possible floor or ceiling effects or

Table 2 Factor loadings of impression items for emotional dance expressions

Items	Factor 1	Factor 2	Factor 3	Communality
Pointed–rounded	**.91**	−.22	−.06	.78
Sharp–dull	**.89**	−.02	.08	.82
Energetic–depleted	**.82**	.20	−.07	.75
Strong–weak	**.78**	.26	−.05	.75
Rounded–linear	**−.78**	.46	−.06	.66
Sharp–flat	**.74**	.18	−.03	.64
Tense–relaxed	**.74**	−.37	.11	.58
Accelerated–decelerated	**.67**	.37	−.16	.65
Large–narrow	.00	**.68**	−.08	.44
Extended–flexed	.03	**.59**	.27	.53
Lateral–vertical	−.20	**.58**	−.13	.31
High–low	.20	**.53**	.21	.50
Regular–irregular	.03	.15	**.72**	.61
Unequal–equal	.16	.09	**−.69**	.44
Complex–simple	.01	.14	**−.51**	.23
Symmetry–asymmetry	.07	.16	**.46**	.31
Sums of squares of loadings	5.42	2.32	1.24	
Correlation matrix				
Factor 1	–	.23	.20	
Factor 2	.23	–	.30	
Factor 3	.20	.30	–	

The factor loading matrix is displayed into blocks each factor in order of higher loading, and the loading absolute value of more than 0.4 is highlighted in bold font

skewed distributions. A factor analysis concerning frequency and velocity was conducted on the remaining 12 items with promax rotation. Four factors were extracted according to their interpretability, yielding a cumulative contribution ratio of 59.84 %. The eigenvalues of the first–fourth factors were 6.74, 3.35, 2.37, and 1.91, respectively. The result was a scale of 24 items—12 items each regarding frequency and velocity—with a four-factor structure (Table 3).

We called the first factor Frequency and Velocity of Upward Extension; it was interpreted to represent extensions and upward movements of the head and four limbs. The second factor was named Frequency and Velocity of Downward Movements; it represented bending and downward movements of the head and four limbs. We termed the third factor Turning or Jumping, as it evaluated turning and jumping movements. The fourth factor was called Body Closing, as it represented the frequency of dropping and flexing movements of the four limbs.

Cronbach's α coefficients were obtained to confirm the reliability of the derived 24-item movement scale. The α values were .81, .82, .79, and .66 for the first–fourth factors, respectively.

Covariance Structure Analysis of Impressions and Evaluated Movements

From what kinds of movement recognitions are impressions developed, and in what ways do they affect the perception of emotions? In addition, what sorts of differences are there in the relation between movement recognition and impressions within each emotion? A

Table 3 Factor loadings of evaluated movement items for emotional dance expressions

Items	Factor 1	Factor 2	Factor 3	Factor 4	Communality
Legs-rise-frequency	**.91**	−.19	−.13	.18	.67
Legs-extend-frequency	**.83**	−.10	.03	.08	.63
Legs-rise-velocity	**.77**	.17	−.14	−.11	.74
Legs-extend-velocity	**.73**	.19	−.07	−.16	.73
Arms-extend-frequency	**.62**	−.17	.06	.19	.35
Arms-rise-frequency	**.56**	−.14	.28	.26	.43
Arms-extend-velocity	**.50**	.33	−.01	−.02	.50
Head-turn up-frequency	**.47**	−.23	.39	.18	.42
Arms-rise-velocity	**.45**	.39	.07	−.03	.53
Head-turn up velocity	**.41**	.24	.10	−.16	.40
Head-bend down velocity	−.22	**.77**	−.17	.22	.60
Arms-flex-velocity	−.24	**.76**	.30	.08	.58
Arms-drop-velocity	−.01	**.68**	−.05	.26	.53
Legs-flex-velocity	.04	**.66**	−.05	.08	.46
Legs-drop-velocity	.26	**.57**	−.03	.31	.59
Head-bend down frequency	.15	**.40**	.06	−.06	.30
Turn-frequency	−.16	−.16	**.76**	.00	.58
Turn-velocity	−.04	.21	**.67**	−.12	.51
Jump-frequency	.31	.01	**.60**	−.17	.59
Jump-velocity	.20	.31	**.54**	−.22	.62
Legs-drop-frequency	.27	.11	−.06	**.64**	.46
Arms-drop-frequency	.09	.25	−.15	**.59**	.45
Arms-flex-frequency	−.27	.10	.46	**.54**	.53
Legs-flex-frequency	.03	.21	−.12	**.50**	.31
Sums of squares of loadings	6.29	2.87	1.94	1.40	
Correlation matrix					
Factor 1	–	.40	.23	−.16	
Factor 2	.40	–	.06	.00	
Factor 3	.23	.06	–	−.04	
Factor 4	−.16	.00	−.04	–	

The factor loading matrix is displayed into blocks each factor in order of higher loading, and the loading absolute value of more than 0.4 is highlighted in bold font

covariance structure analysis was conducted to examine the relationships between the factors determining perceptions of emotion expressions using the Amos 16.0 software package. The results are shown in Fig. 1, in which significant path coefficients at the $p < .01$ level are represented with solid lines. The path coefficients are standardized estimates; the goodness-of-fit indices of the model indicated a good fit to the data (root mean square error of approximation [RMSEA] = .08, Bentler's comparative fit index [CFI] = .90, goodness of fit index [GFI] = .92).

The first finding was that Frequency and Velocity of Downward Movements, Frequency and Velocity of Upward Extension, and Turning or Jumping affected Dynamics. In addition, Body Closing negatively affected Dynamics. These results indicated that greater perception of Frequency and Velocity of Downward Movement, Frequency and Velocity

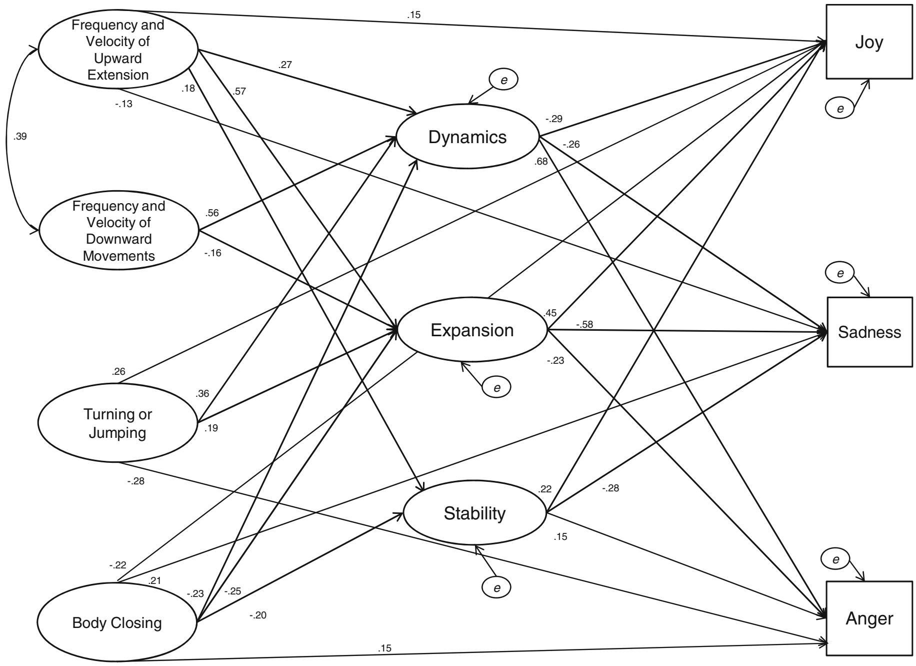

Fig. 1 The results of the Movements Impressions Emotions Model, and that evaluated movements and impressions related to the perception of emotions in dances. Frequency and Velocity of Upward Extension, Frequency and Velocity of Downward Movements, Turning or Jumping, and Body Closing are the factors of evaluated movements. Dynamics, Expansion, and Stability are the factors of impressions. Joy, sadness, and anger are the perceived emotions. Regarding path coefficients between variables, path coefficients that were significant ($p < .01$) are represented with solid lines. The "e" shows error variable. The path coefficients are standardized estimates

of Upward Extension, and Turning or Jumping led to a stronger conveyance of Dynamics. Expansion was positively affected by Frequency and Velocity of Upward Extension and negatively affected by Frequency and Velocity of Downward Movements and Body Closing. This indicated that the more Frequency and Velocity of Upward Extension was perceived, the more Expansion was conveyed. Finally, Stability was negatively affected by Body Closing and Frequency and Velocity of Upward Extension, indicating that decreased flexion was associated with an increased image of Stability.

Next, Expansion, Stability, Turning or Jumping, and negative Body Closing were shown to affect the perception of joy: the higher the evaluations of these factors, the more likely the dance was to be considered an expression of joy. Sadness was negatively affected by Dynamics, Expansion, Stability, and Frequency and Velocity of Upward Extension: the less dynamic and expansive a dance was, and the fewer stable movements it incorporated, the more likely it was to convey sadness. Additionally, Body Closing had a positive effect on the perception of sadness: the less upward extension and velocity were recognized, the more likely the movements were to be perceived as an expression of sadness. In addition, Turning or Jumping had a negative direct effect and Body Closing had a positive effect on the perception of anger in the dance expressions. Thus, the results demonstrated that if the dance was more dynamic and featured more closing of the limbs—yet fewer turns or jumps—then it was more likely to produce the perception of anger.

Discriminant Function Analysis of Emotional Expression in Dance

Covariance structure analysis showed that evaluated movement factors affected impression factors. To assess and determine whether the impression factors could help participants to distinguish between the three studied emotions, discriminant function analysis was used to test whether the impression factors could predict the type of emotion perceived. The results show that two discriminant functions were significant (Table 4).

The first discriminant function was the most important, with an eigenvalue of 1.19. In the first function, the standardized canonical discriminant function coefficients for Dynamics, Expansion, and Stability were 0.52, 0.72, and 0.30, respectively. Expansion had the greatest effect on the first discriminant function; the next most powerful effect was caused by Dynamics, then Stability. In the first function, the values at the centroid for each emotion were 0.62, −1.53, and 0.91 for joy, sadness, and anger, respectively. Hence, the tendency was that higher values of Expansion, Dynamics, and Stability were associated with higher levels of perception of joy and anger and lower levels of perception of sadness. The eigenvalue for the second discriminant function was 0.83. In the second function, the standardized canonical discriminant function coefficients for Dynamics, Expansion, and Stability were 0.85, −0.65, and 0.05, respectively. Dynamics positively contributed to the second discriminant function, while Expansion had a negative contribution. Also in the second function, the values at the centroid for each emotion were −1.17, 0.14, and 1.04 for joy, sadness, and anger, respectively. To summarize, greater Dynamics and lesser Expansion raised the likelihood of perceiving anger or sadness and lowered that of perceiving joy.

Figure 2 shows the distributions of the discriminant scores. The two functions, Z_1 and Z_2, are as follows:

$$z_1 = 0.69 \times (\text{Dynamics}) + 1.06 \times (\text{Expansion}) + 0.39 \times (\text{Stability}) - 7.03$$

$$z_2 = 1.12 \times (\text{Dynamics}) - 0.97 \times (\text{Expansion}) + 0.07 \times (\text{Stability}) - 0.56$$

The percentage of correct classifications by these two functions across emotions was high, at 82.8 %. These results showed that the impression factors used for evaluation in our study allowed the observers to discriminate between emotional expressions conveyed by dance.

Discussion

This experiment investigated whether observers could identify the specific emotions of joy, sadness, and anger from bodily expression in dance, clarified which factors influenced their perception of these emotions, and then developed the Movements Impressions Emotions Model using covariance structure analysis.

Table 4 Summary of discriminant analysis in emotional dance expressions

Function	Eigenvalue	% variance explained	Canonical correlation	p
1	1.19	58.9	.74	<.01
2	.83	41.1	.67	<.01

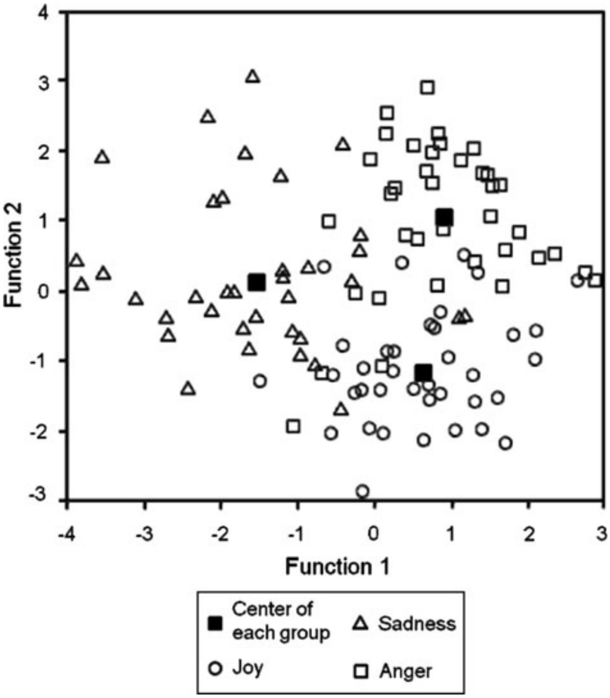

Fig. 2 The results of discriminant function analysis of emotional expression in dance

The results showed that participants could identify the specific emotions that were intentionally expressed in dance movements. These results are consistent with the findings of other studies of body movement. Boone and Cunningham (1998) and Montepare et al. (1999) reported that observers could identify joy, sadness, and anger from observation of body movements or gestures. Wallbott (1998) also indicated that emotions could be perceived in performances by actors, and Sawada et al. (2003a) showed that subjects could identify joy, sadness, and anger from arm movements in dance. Thus, our results are in agreement with those previous studies and further show that observers could accurately identify emotions from whole-body movements in dance.

Additionally, our study measured the emotional impressions and movement characteristics perceived by observers from dance. The factors determining impression formation regarding emotional dance expressions were revealed by factor analysis. The results indicate that impressions were constructed on the basis of the factors of Dynamics, Expansion, and Stability and that movements were evaluated in terms of the factors of Frequency and Velocity of Upward Extension, Frequency and Velocity of Downward Movements, Turning or Jumping, and Body Closing. Covariance structure analysis revealed that the factors of movement evaluations affected the factors of impressions, which in turn affected perception of emotions. This is the Movements Impressions Emotions Model. Previous studies have shown the relationships between feelings and movements (Matsumoto 1987), emotions and movements (Sawada et al. 2003a, b; Sakata and Hachimura 2007), and movements and impressions (Kamisato and Hoshino 1999, 2000; Kamisato et al. 2004; Zukawa 1995). However, no previous model has summarized and described the common factors in the relationships between movements, impressions, and emotions to elucidate their respective contributions to perception.

The perception of joy was fostered by Expansion, Stability, Turning or Jumping, and Body Closing. Movements in which the limbs use large amounts of space, turning, and jumping tend to have the greatest effects on the perception of joy. Wallbott (1998) reported that expressions of joy were associated with high-activity characteristics. Additionally, Matsumoto (1987) showed that expressions of happy feelings are characterized by high levels of energy, a large number of changes, skipping, jumping, and turning. Thus, our results are similar to those of studies indicating that expressions of joy were associated with the use of space and high levels of activity. We showed that observers recognized joy through seeing spaces and feeling stability rather than evaluating upward extension, turning, and jumping.

We found that perceived sadness in dance expressions was associated with low values of Dynamics, Expansion, Stability, and Frequency and Velocity of Upward Extension and high values of Body Closing. The loss of Dynamics, Stability, and constructional movements and the presence of Body Closing all tended to result in observers identifying the movements as conveying sadness. These results were analogous to those of a previous study in which Wallbott (1998) reported that movements of sadness were associated with loss of energy; further, Sawada et al. (2003a) revealed that arm movements of sadness exhibited weak characteristics. The findings of Matsumoto (1987) indicated that expressions of lonely feelings involve low speed, low energy, and high amounts of bending and stretching. Additionally, Brownlow et al. (1997) showed that observers recognized that dances portraying sadness lacked energy. These previous studies indicated that a lack of energy and dynamism are related to sadness, but we can also show that impressions of Body Closing and not using spaces also contribute to the recognition of sadness.

Perceived anger was linked with Dynamics, Body Closing, and Stability, but not Turning or Jumping or Expansion. De Meijer (1989) reported that the expression of anger was characterized by forceful movements, and Sawada et al. (2003a) showed that the expression of anger was associated with speed and force through arm movements. Wallbott (1998) reported that body movements expressing anger were associated with high activity. In addition, Sakata and Hachimura (2007) indicated that the relationship between the physical features of dance movements and their dynamic motives is driven by the velocity and acceleration of the limbs. Sawada et al. (2003b) demonstrated that leg movements expressing anger were characterized by acceleration. These previous studies convey information about strength and speed. Frequency and Velocity of Upward Extension and Frequency and Velocity of Downward Movements do not directly affect the recognition of anger, but they do affect the impression of Dynamics, which in turn reflects on the recognition of anger. In addition, not using spaces, and movements not including jumping and turning contribute to the recognition of anger. When dancers try to move without using the space around them, velocity and acceleration are needed. Thus, our findings with regard to anger are consistent with those of previous studies.

Subsequently, discriminant analysis was conducted to examine whether it was possible to perceive emotions according to impression factors. The results for the first function demonstrated the tendency for increased perceptions of joy and anger and decreased perceptions of sadness to be associated with higher Expansion, Dynamics, and Stability. In the second function, increased perceptions of anger and sadness and decreased perceptions of joy were characterized by higher Dynamics and lower Expansion. Our findings show that these impression factors can contribute to the discrimination of positive from negative emotions and that the impression of movement is important for the perception of emotions.

In this study, a model was constructed to describe the relationships among movement, impression, and emotion in terms of the observed characteristics of bodily expressions.

Similarly, emotional expressions in dance seem to involve common movements representing specific emotions. The model encourages further research to address emotional expression in dance and explore the factors that contribute to the perception of emotions. This study addresses bodily expression as a tool of nonverbal communication: in interacting with others during the course of communication as in dancing, we almost always exhibit many kinds of expressions while simultaneously delivering signals with our bodies; we also perceive these signals as observers. Recently, in addition to focusing exclusively on bodily characteristics, facial expressions, or voice characteristics, research has also focused on combined perception, such as combinations of face, voice, and bodily expression. Future research on the perception of combined or conflicting bodily expressions and emotions in facial expressions should also be investigated in the arena of dance.

References

Boone, R. T., & Cunningham, J. G. (1998). Children's decoding emotion in expressive body movement. *Developmental Psychology, 34*, 1007–1016.

Brownlow, S., Dixion, A. R., Egbert, C. A., & Radcliffe, R. D. (1997). Perception of movement and dancer characteristics from point-light displays of dance. *The Psychological Record, 47*, 411–421.

Camurri, A., Lagerlöf, I., & Volpe, G. (2003). Recognizing emotion from dance movement: Comparison of spectator recognition and automated techniques. *International Journal of Human Computer Studies, 59*, 213–225.

Clarke, T. J., Bradshaw, M. F., Field, D. T., Hampson, S. E., & Rose, D. (2005). The perception of emotion from body movement in point-light displays of interpersonal dialogue. *Perception, 34*, 1171–1180.

Coulson, M. (2004). Attributing emotion to static body postures: Recognition accuracy, confusions, and viewpoint dependence. *Journal of Nonverbal Behavior, 28*, 117–139.

de Gelder, B. (2006). Towards the neurobiology of emotional body language. *Nature Reviews Neuroscience, 7*, 242–249.

de Gelder, B., Bocker, K. B., Tuomainen, J., Hensen, M., & Vroomen, J. (1999). The combined perception of emotion from voice and face: Early interaction revealed by human electric brain responses. *Neuroscience Letters, 260*, 133–136.

de Meijer, M. (1989). The contribution of general features of body movement to the attribution of emotions. *Journal of Nonverbal Behavior, 13*, 247–268.

Dittrich, W. H., Troscianko, T., Lea, S. E. G., & Morcan, D. (1996). Perception of emotion from dynamic point-light displays represented in dance. *Perception, 25*, 727–738.

Ekman, P., & Friesen, W. V. (1971). Constants across culture in the face and emotion. *Journal of Personality and Social Psychology, 17*, 124–129.

Izaki, Y., & Matsuura, Y. (2000a). Buyou ni okeru Ugoki no Shitsu wo Hyoukasuru tame no Syukanteki Syakudo no Kouchiku –Douteki Rikisei no Kanten kara- [A subjective scale for evaluating the quality of body action in dance: From the point of view of kinetic force]. *Japan Journal of Physical Education, 45*, 54–64.

Izaki, Y., & Matsuura, Y. (2000b). Buyou ni okeru Ugoki no Shitsu kara mita Ugoki no Kouzou ni tsuite – Douteki Rikisei no Kanten kara- [The factorial structure of the quality of body action in dance: From the point of view of kinetic force]. *Japan Journal of Physical Education, 45*, 385–398.

Kamisato, S., & Hoshino, K. (1999). Okinawa Buyou ni okeru Undou Tokusei to Kansei Jouhou tono Kankei [Motion features and subjective impressions in Okinawan dance]. *Technical Report of IEICE, 99*, 49–54.

Kamisato, S., & Hoshino, K. (2000). Buyou ni okeru Syushi Kidou no Undou Tokusei to Syukanteki Insyou tono Kankei [Motion characteristics of finger and wrist trajectories and subjective impressions in freestyle dance]. *ITE Technical Report, 24*, 47–51.

Kamisato, S., Odo, S., Ishikawa, Y., & Hoshino, K. (2004). Extraction of motion characteristics corresponding to sensitivity information using dance movement. *Journal of Advanced Computational Intelligence and Intelligent Informatics, 8*, 167–178.

Laban, R. (1963). *Modern educational dance*. London: Macdonald & Evans, Ltd.

Matsumoto, C. (1987). Dance research: Problem situation and learning of problem solving II: Qualities of movements and feeling values. *Bulletin of Japan Association of Physical Education for Women'87*, 1, 53–89.

Montepare, J. M., Goldstien, S. B., & Clausen, A. (1987). The identification of emotions from gait information. *Journal of Nonverbal Behavior, 11*, 33–42.

Montepare, J. M., Koff, E., Zaitchik, D., & Albert, M. (1999). The use of body movements and gestures as cues to emotions in younger and older adults. *Journal of Nonverbal Behavior, 23*, 133–152.

Montepare, J. M., & Zebrowitz-McArthur, L. (1988). Impressions of people created by aged-related qualities of their gaits. *Journal of Personality and Social Psychology, 55*, 547–556.

Osgood, C., Suci, G., & Tannenbaum, P. (1957). *The measurement of meaning*. Chicago: University of Illinois Press.

Pollick, F. E., Paterson, H. M., Bruderlin, A., & Sanford, A. J. (2001). Perceiving affect from arm movement. *Cognition, 82*, 51–61.

Rozin, P., Taylor, C., Ross, L., Bennett, G., & Hejmadi, A. (2005). General and specific abilities to recognise negative emotions, especially disgust, as portrayed in the face and the body. *Cognition and Emotion, 19*, 397–412.

Sakata, M., & Hachimura, K. (2007). KANSEI Information processing of human body movement. *Lecture Notes in Computer Science, 4557*, 930–939.

Sasaki, Y. (2005). Kanjo ni motozuku Hokou Dousa no Shikibetsu ni tsuite -Engisya wo mochiita Kenkyu- [The identification of walking styles based on emotions: Research using the actors]. *Japanese Journal of Research on Emotions, 12*, 56–61.

Sawada, M., Suda, K., & Ishii, M. (2003a). Expression of emotions in dance: Relation between arm movement characteristics and emotion. *Perceptual and Motor Skills, 97*, 697–708.

Sawada, M., Suda, K., & Ishii, M. (2003b). *Relationship between leg movement quality and emotional expression in dance*. Poster session presented at the annual meeting of the International Association for Dance Medicine & Science, London, England.

van den Stock, J., Righart, R., & de Gelder, B. (2007). Body expressions influence recognition of emotions in the face and voice. *Emotion, 7*, 487–494.

Wallbott, H. G. (1998). Bodily expression of emotion. *European Journal of Social Psychology, 28*, 879–896.

Wallbott, H. G., & Scherer, K. R. (1986). Cues and channels in emotion recognition. *Journal of Personality and Social Psychology, 51*, 690–699.

Zukawa, A. (1995). *Buyou no Imeji Tankyu [The research of image in dance]*. Tokyo: Fumaido Shuppan.