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Dance Teachers' Aesthetic Perception of Kinematic Parameters

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Some experiments have shown that certain kinematic parameters can influence the subjective aesthetic perception of a nonexpert dance audience. In addition, it has been found that dance experience shapes dance perception, but it has not yet been described how this experience affects the aesthetic perception of dance movements. This paper aims to identify some of the kinematic parameters of expert dancers' movements that influence the subjective aesthetic perception of observing dance teachers. Four experienced contemporary dancers performed 3 repetitions of 4 dance-related movements (a turn, a jump, a balance, and a forward drop step and recovery). Motion was captured by a VICON-MX system. The resulting 48 animations were viewed by 11 dance teachers. The observers judged beauty using a semantic differential. The data were then subjected to a multiple factor analysis. The results suggested that there were strong associations between higher beauty scores and specific kinematic parameters, such as turning velocity, balance duration, jump height and range of motion. These results were very similar to those obtained in previous studies with nonexpert observers.

Keywords: motion-capture, dance movements, contemporary dance, motor experience, aesthetic experience

There is considerable interest in the empirical assessment of the aesthetic appreciation of art (Leder, Belke, Oeberst, & Augustin, 2004; Mastandrea, Bartoli, & Carrus, 2011; Zaidel, Nadal, Flexas, & Munar, 2013). In recent years, the aesthetic perception of dance has also been the subject of numerous studies. Research on this topic has a great deal to contribute to the field of empirical aesthetics as a whole, as it contrasts with the common analysis of the aesthetic perception of fixed images or static artworks (Christensen & Calvo-Merino, 2013). Like the spatial features of a photograph or the temporal aspects of a musical composition, the spatial and temporal features of a dancer's movement can induce a psychological state in the observer that is usually termed *aesthetic experience* (Bhatara, Tirovolas, Duan, Levy, & Levitin, 2011; Calvo-Merino, Jola, Glaser, & Haggard, 2008).

The specific nature of the aesthetic experience will depend on the sensory perception of the person who observes a work of art, reads a piece of literature, or sees a play. Specifically in dance, a number of studies have revealed that people with dance training manifest both different neural and perceptual responses to the observation of dance than those of novices. This suggests that kinesthetic experience is relevant to the aesthetic perception of dance (Calvo-Merino, Glaser, Grèzes, Passingham, & Haggard, 2005, Calvo-Merino, Grèzes, Glaser, Passingham, & Haggard 2006; Cross, Kirsch, Ticini, & Schütz-Bosbach, 2011; Jola, Abedian-Amiri, Kuppuswamy, Pollick, & Grosbras, 2012; Kirsch, Drommelschmidt, & Cross, 2013; Montero, 2012). In other art forms, some authors propose the existence of a "general factor" of aesthetic judgment (Eysenck, 1940), which is influenced by different elements of the artwork, and by the artistic experience of the observer (Eysenck, 1972; Marty, Munar, & Nadal, 2005; Winston & Cupchik, 1992). In dance, the artistic experience is related to movements and motor patterns (Castañer, Torrents, Anguera, Dinusová, & Jonsson, 2009). This produces motor effects that can be analyzed. Cross, Hamilton, and Grafton (2006) found that physical

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training alters motor representation, suggesting that there is a link between action production and perception. It also has been demonstrated that visual experience (Calvo-Merino, Urgesi, Orgs, Aglioti, & Haggard, 2010; Jola et al., 2012) as well as physical experience (Calvo-Merino et al., 2005, Calvo-Merino et al., 2006; Orgs, Hagura, & Haggard, 2013) can shape the perceptual processes involved in watching dance. Cross et al. (2011) suggested that there is a close connection between embodied simulation of a movement and its perceived aesthetic qualities. They studied how the observer's physical ability to perform the movement influenced the perception of beauty of a dance movement, and found that movements rated as beautiful were accompanied by stronger activation in the brain's posterior regions of the action observation network. Kirsch et al. (2013) also found that specific physical training produced higher enjoyment and interest while observing the movements trained.

Different experiments have established a way to analyze dance by reducing it to its core motor elements. Narrative, costume, expressive or musical elements are removed to study the kinematics of dance and its relation with aesthetic appraisal (Calvo-Merino et al., 2008; Castañer, Torrents, Morey, & Jofre, 2012; Torrents, Castañer, Jofre, Morey, & Reverter, 2013). The human eye is extremely sensitive to biological movement; for example, observers can identify the gender, identity, or even the emotion of performers solely on the basis of point map displays (Clarke, Bradshaw, Field, Hampson, & Rose, 2005; Cutting & Kozlowski, 1977; Dittrich, Troscianko, Lea, & Morgan, 1996; Pollick, Kay, Heim, & Stringer, 2005). Some researchers have used motion-capture analysis to identify specific movement components within dance that may influence its perceived quality. This type of analysis also reduces the amount of potentially interfering stimuli, such as the face of the dancers (Christensen, & Calvo-Merino, 2013). For instance, Neave et al. (2011) identified three movement measures as key predictors when nonexperts in dance observed nonexpert dancers: the variability and amplitude of movements of the neck and trunk and the speed of movements of the right knee. In other research, observing isolated specific contemporary dance movements performed by expert dancers, Torrents et al. (2013) found that nonexpert dance observers are influenced by the most basic characteristics of dance movements, such as turning speed, the time for which balance is maintained and the amplitude of movement (range of motion of the limbs or area projected by joining the most distal points of the whole body during a dance movement). Concretely, dancers performed a turn, a jump, a balance, and forward drop step and recovery. Although it has been demonstrated that experience in dance can give a different appreciation of what is or is not beautiful (Calvo-Merino & Jones, 2012; Cross, 2012; Kirsch et al., 2013), to our knowledge no previous studies have identified the specific movement parameters that influence dance experts' aesthetic appreciation. Based on the literature, we hypothesized that experts would be influenced by other movement parameters than novices. As we have mentioned before, literature reveals that experts manifest both different neural and perceptual responses to observing dance, and the embodied simulation of a movement can change the perceived aesthetic qualities (Calvo-Merino et al., 2005, Calvo-Merino et al., 2006; Cross et al., 2011; Jola et al., 2012; Kirsch et al., 2013; Montero, 2012). In light of the aforementioned, the purpose of the current study was to identify the kinematic parameters of expert dancers' movements that influence dance experts' subjective aesthetic perception.

Method

Participants

Eleven female dance teachers (aged 35.9 ± 10.65 years; 14.1 ± 11.5 years of teaching practice) volunteered to participate as expert dance observers of avatar images performing dance movements. The teachers were specialized in different dance disciplines (four in contemporary dance, six in classical ballet, one in creative dance and one in hip hop), but all of them had experience in different dance disciplines. All of them were informed about the study's scope and methods, and they gave their written informed consent to participate in the study.

Construction of the Avatars

Four contemporary dancers with more than 5 years of professional practice (two males aged 31 ± 9.9 years, height 171.5 ± 4.95 cm, weight 68.9 ± 3.5 kg; two females aged 28 ± 12.7 years, height 164.5 ± 6.36 cm, weight 55.45 ± 5.3 kg) volunteered to participate in the study by performing four dance movements. The dancers were informed about the study's scope and methods and gave their written informed consent to participate and to be filmed for research purposes. Previously, the same images had been used to analyze the aesthetic perception of these dance movements by nonexpert dance observers (Castañer et al., 2012; Torrents et al., 2013).

The four dancers performed three repetitions with different effort (light, moderate, and strong) of four contemporary dance movements in a space measuring 3 × 4 × 2.5 m. This capture volume was previously calibrated for the three-dimensional (3D) motion capture system, working with 10 cameras (125 Hz) for 3D reconstruction plus one conventional video camera (PAL [Phase Alternated Line] standard) for reference.

The dancers were given time to warm up prior to image capture. Thirty-eight retroreflective markers (14 mm diameter) were then attached to the dancers' bodies at defined locations according to the VICON Full Body PlugInGait marker set (VICON MX, Oxford, United Kingdom). Participants wore tight clothing to facilitate the gathering of accurate information from the markers. Once the markers had been attached to the clothes, the clothes were fixed to the skin using double-sided tape underneath the marker location. The movements to be performed were explained to the dancers, who were allowed to practice them until they felt confident. The movements involved were a turn, a jump, a balance, and a forward drop step and recovery (see Figure 1). Each movement was repeated in three different movement qualities, according to Laban's criterion of muscular tension of effort used in contemporary dance (the dancers were familiar with this language): light, moderate, and strong (Laban, 1971). A total of 48 trials were filmed with 10 cameras from the 3D motion analysis system (VICON MX). This system provided the position in space and time of each defined body segment: head, arms, forearms, hands, thorax, pelvis, legs, lower legs, and feet. In this way, joint motion was calculated. On the basis of all this information the authors, who are dance experts, used custom-written MATLAB (The Mathworks, Inc., Natick,

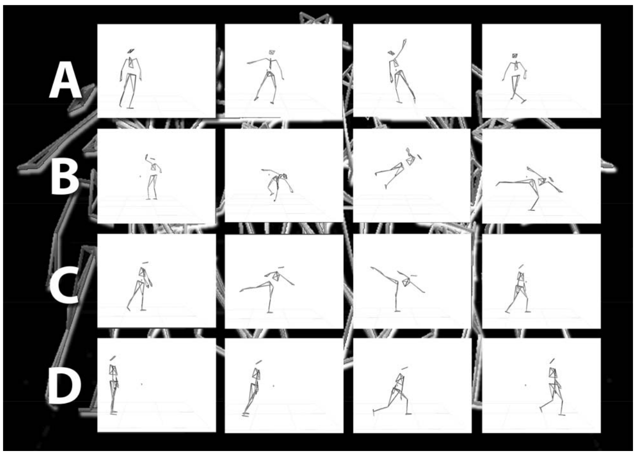

Figure 1. Avatars performing the four movements. (A) *Tour en dehors* or turn performed with the right leg extended to the side of the body and elevating the left arm. (B) Skater's jump or *brisé volé en arrière en tournant*: a jump combined with a turn that tries to reach the parallel full body extension facing the floor. (C) *Arabesque penchée* or stability movement elevating the right leg, bending the body forward and describing a straight line with the arms and with the right leg and left arm. (D) Forward drop step and recovery: a displacement made by leaning forward and catch stepping forward.

MA) routines to calculate 39 parameters (see Table 1) that they thought might influence aesthetic perception. Several of the parameters could be calculated for more than one movement, while others were specific to a given movement. As it is detailed in Table 1, parameters are generally referred to the turn velocity and acceleration of different body parts; the duration of the single limb stance in the balance; the height of the jump; the distance traveled during the forward drop step and recovery; the position and angles of the different body parts in all movements; the stability in the turn, the balance, and the displacement of the center of mass (CM), measured by the fluctuations of the CM at different frequency ranges and in all three axes; the amplitude of the movement in the jump, measured by the area projected by the body in the air or the vertical trajectory of the CM in the jump; and forward drop step and recovery.

Given the complexity of some of the studied tasks (especially turns), it was decided to create the avatars by drawing lines joining the tracked markers attached to the body, depicting the different segments: head, thorax, upper arm, lower arm, hand, pelvis, thigh, leg, and foot. This would help to ease perception by providing more visual cues. The reporting tool Polygon (VICON MX) was used to create video clips showing the animated stick avatars. All movements were performed in the same orientation, assuming there was a front were the audience would be sitting and have the best view of each given movement. Accordingly, all animations were shown from a centered audience perspective. The video clips had durations between 2 and 15 s each, depending on the movement and the dancer.

Procedure

The teachers observed all 48 animations in one session. They were asked to rate each dance movement using a 7-point semantic differential, anchored by *ugly* and *beautiful* (Osgood, Suci, & Tannenbaum, 1957), following the findings of other similar studies (Castañer et al., 2012; Marty et al., 2003; Torrents et al., 2013). The reliability of beauty ratings was previously tested in a similar study (Morey-Klapsing et al., 2010; Torrents et al., 2010).

The animations were presented in groups of movements, but in a random order in terms of the dancer or the quality of the movement. Each animation was shown three times so that the observers had enough time to appreciate it. Subsequently, a black screen was presented for 5 s. Observers had to write down the score given to each animation by marking the number in a scale.

Data Analysis

The biomechanical parameters were crossed with the observers' subjective judgments. Data were analyzed using FactoMineR software,[1] which is designed for multivariate exploratory data analysis, and in this case a multiple factor analysis (MFA) was conducted (Escofier & Pagès, 1994; Husson, Josse, Lê, & Mazet, 2007; Lê, Josse, & Husson, 2008).

The core of MFA is an extension of the principal components analysis applied to the whole set of variables. Each group of variables is weighted, which makes it possible to analyze different points of view by taking them equally into account. The aim of principal components analysis and thus of the MFA is to reduce the dimensionality of the data set with the condition to lose as little information as possible. The reason why it is important to reduce the variables of a data set is that many multivariate data analysis procedures (e.g., cluster analysis, multiple regression etc.) cannot handle a too large amount of variables (too many explanatory variables in comparison to the number of trials). This analysis helped us to describe (a) individuals' study (i.e., we observed the variability between the trials and see if we could find different profiles of trials) and (b) variables' study (i.e., we wanted to find linear relationships between biomechanical variables and aesthetic appreciation).

Resulting graphical outputs, individual factor map and correlation circle, for the first two principal components (PC1 and PC2) are used. As Abdi and Williams (2010) explain,

> the first principal component is required to have the largest possible variance (i.e., inertia and therefore this component will "explain" or "extract" the largest part of the inertia of the data table). The second component is computed under the constraint of being orthogonal to the first component and to have the largest possible inertia. The values of these new variables for the observations are called factor scores, and these factors scores can be interpreted geometrically as the projections of the observations onto the principal components. (p. 434)

Individual factor maps describe the results of the individuals' study showing the scores according to the first two principal components. Together, they explain about 50% of the information contained in the data set. The graph is divided into four areas, and similar trials (according to biomechanical data) are placed close to each other. With this analysis, we can see if the same dancer

[1] The FactoMineR software was developed and is maintained by F. Husson, J. Josse, and S. Lê from Agrocampus Rennes and by J. Mazet (http://factominer.free.fr/index.html).

Table 1
Motion Parameters Calculated From the Three-Dimensional Data

Parameter	Movement	Abbreviation
1. Difference (%) between turning velocities (around the vertical axis of the room) of head and pelvis	Turn	$\Delta\omega z_{P\text{–}H}$
2. Difference (%) between vertical turning velocities (around the vertical axis of the room) of head and thorax	Turn	$\Delta\omega z_{T\text{–}H}$
3. Maximum turning velocity of the pelvis (around the vertical axis of the room)	Turn	$MAX\omega z_P$
4. Mean and *SD* of the head angle (expressed relative to pelvis orientation: around anteroposterior axis, around transversal axis, around the vertical axis of the room)	Turn	αx_H αy_H αz_H $SD\alpha x_H$ $SD\alpha y_H$ $SD\alpha z_H$
5. Mean, *SD*, and maximum of the thorax angle (around the vertical axis of the room)	Turn	αz_T $SD\alpha z_T$ $MAXz_T$
6. Mean, *SD*, and maximum of the pelvis angle (around the vertical axis of the room)	Turn	αz_P $SD\alpha z_P$ $MAXz_P$
7. Coefficient of variation (CV) of the pelvis angular acceleration (around the vertical axis of the room: 6 Hz low-pass filter)	Turn	CVP6
8. CV of the pelvis angular acceleration (around the vertical axis of the room: 12 Hz low-pass filter)	Turn	CVP12
9. CV of the pelvis angular acceleration (around the vertical axis of the room: 20 Hz low-pass filter)	Turn	CVP20
10. Integral of the fast Fourier transform (FFT) of the position of the center of mass (CM; viewing perspective: near–far, right–left, down–up) in the interval from the first value above 0 to 2.5 Hz; slow vibration	Turn, Arabesque (Arab.), Forward fall (FF)	$SlowVibx_{CM}$ $SlowViby_{CM}$ $SlowVibz_{CM}$
11. Integral of the FFT of the position of the CM (viewing perspective: near–far, right–left, down–up) in the interval 2.5–5 Hz; middle vibration	Turn, Arab., FF	$MidVibx_{CM}$ $MidViby_{CM}$ $MidVibz_{CM}$
12. Integral of the FFT of the position of the CM (viewing perspective: near–far, right–left, down–up) for frequencies >5 Hz; fast vibration	Turn, Arab., FF	$FastVibx_{CM}$ $FastViby_{CM}$ $FastVibz_{CM}$
13. Integral of the FFT of the position of the center of the pelvis (viewing perspective: near–far, right–left, down–up) in the interval from the first value above 0 to 2.5 Hz	Turn, Arab., FF	$SlowVibx_P$ $SlowViby_P$ $SlowVibz_P$
14. Integral of the FFT of the position of the center of the pelvis (viewing perspective: near-far, right-left, down-up) in the interval 2.5–5 Hz	Turn, Arab., FF	$MidVibx_P$ $MidViby_P$ $MidVibz_P$
15. Integral of the FFT of the position of the center of the pelvis (viewing perspective: near–far, right–left, down–up) for frequencies >5 Hz	Turn, Arab., FF	$FastVibx_P$ $FastViby_P$ $FastVibz_P$
16. Duration of the single-limb stance	Arab.	DURATION
17. Right leg angle relative to the vertical in the plane of view	Arab.	α_{rLEG}
18. Left leg angle relative to the vertical in the plane of view	Arab.	α_{lLEG}
19. Right arm angle relative to the vertical in the plane of view	Arab.	α_{rARM}
20. Left arm angle relative to the vertical in the plane of view	Arab.	α_{lARM}
21. Angle between right leg and right arm in the plane of view	Arab.	$\alpha_{rLEG\text{–}rARM}$
22. Angle between left leg and left arm in the plane of view	Arab.	$\alpha_{lLEG\text{–}lARM}$
23. Angle of the right arm to the plane of view	Arab.	α_{rARM}
24. Angle of the left arm to the plane of view	Arab.	α_{lARM}
25. Angle of the right leg to the plane of view	Arab.	α_{rLEG}
26. Angle of the left leg to the plane of view	Arab.	α_{lLEG}
27. Area of the polygon joining ankles and wrists, projected on the frontal plane of the pelvis at the instant of takeoff (normalized to the square of body height)	Skater's jump (SJ)	A_{TO}
28. Area of the polygon joining ankles and wrists, projected on the frontal plane of the pelvis at the instant of maximum height of the CM (normalized to the square of body height)	SJ	A_{hMAX}
29. Area of the polygon joining ankles and wrists, projected on the frontal plane of the pelvis at the instant of touch down (normalized to the square of body height)	SJ	A_{TD}
30. Vertical amplitude of the CM motion	SJ, FF	$AMPz_{CM}$
31. Maximum achieved height of the CM	SJ	$hMAX_{CM}$
32. Maximum vertical inclination of the line joining 7th cervical vertebra (C7) with the right heel at the instant of maximum height of the CM	SJ	INCLMAX

(*table continues*)

Table 1 (*continued*)

Parameter	Movement	Abbreviation
33. Root mean square (RMS) of the angle between thorax and pelvis during flight (Euler rotations, pelvis around thorax in the sequence mediolateral, anteroposterior, vertical)	SJ	αx_{P-T} αy_{P-T} αz_{P-T}
34. RMS of the angle between pelvis and right leg during flight (Euler rotations, leg around pelvis in the sequence mediolateral, anteroposterior, vertical)	SJ	αx_{rLEG-P} αy_{rLEG-P} αz_{rLEG-P}
35. RMS of the angle between pelvis and left leg during flight (Euler rotations, leg around pelvis in the sequence mediolateral, anteroposterior, vertical)	SJ	αx_{lLEG-P} αy_{lLEG-P} αz_{lLEG-P}
36. Maximal trunk forward leaning prior to forwarding the foot	FF	α_{TRUNK}
37. Angle defined by the line joining the midpoint between both ankles with the sacrum and the sacrum with C7 at maximal forward leaning	FF	$\alpha_{C7-ANKLE}$
38. Forward step length	FF	l_{STEP}
39. Symmetry of the anteroposterior velocity/time curve of the CM (vertical symmetry axis at the absolute minimum)	FF	$SYM_{\omega AP}$

performs the movement in a similar way in the three repetitions or if the effort applied to the movement resulted in a very different way of performing the movement. In this case, trials should be grouped according to the effort applied and not to the dancers who perform the movement. To understand what it means for each trial in terms of aesthetic appreciation or biomechanical values, it is necessary to have a look at the second plot, the correlation circle, and see if the place where the trial is projected corresponds to the place where an aesthetic value, or a biomechanical variable, is projected.

Correlation circles describe the correlation between the different biomechanical variables and aesthetic appreciation and shows the projection of the initial variables in the factors space. Each arrow represents each variable, and the angle between two arrows represents the correlation of the respective variables. When two variables are far from the center and close to each other, they are significantly positively correlated. If they are orthogonal, they are not correlated, and if they are on the opposite side of the center, then they are significantly negatively correlated.

Results

Tour en Dehors (Turn)

The first panel of Figure 2 shows the individual factor map for the avatar analysis of the turn (accounting for 48.59% of the total variability). The trials were divided into three groups. The three trials of Dancer 4 represented a compact group, while the trials of Dancers 1 and 2 formed another group; Dancer 3 presented another group, although with more heterogeneous results. Figure 2 also includes the correlation circle of the most determinant kinematic parameters and the possible values of the beauty appraisal (1–7). For PC1 and PC2, the original variables strongly associated with the highest score (7) were the maximum turning velocity ($MAX\omega z_P$); the slow and middle fast vibration of the CM in the vertical plane ($SlowVibz_{CM}$, $MidVibz_{CM}$); the slow vibration of the CM in the horizontal plane ($SlowViby_{CM}$); and the slow vibration of the pelvis in the vertical plane ($SlowVibz_P$). The highest score was associated with the second trial of Dancer 4 (trial performed with moderate effort). The lowest scores (1, 2) were associated with the differences between vertical turning velocities of head and thorax ($\Delta\omega z_{T-H}$) and of head and pelvis ($\Delta\omega z_{P-H}$), the *SD* of the head angle around the vertical axis ($SD\alpha z_H$), the variables $SlowVibx_{CM}$ and $SlowVibx_P$, and the first trial of Dancer 3.

Skater's Jump

The trials were also divided into three groups. The three trials of Dancers 1 and 3 represented two different groups, while the trials of Dancers 2 and 4 formed another compact group, regardless of the quality of the movement. In the jump task, there was a clear association between the highest scores (6, 7) and the amplitude (vertical amplitude of the CM motion: $AMPz_{CM}$), height (maximum achieved height of the CM: $hMAX_{CM}$), maximum inclination (meaning "horizontality") of the body at the instant of maximum height of the CM (INCLMAX) and the angle between pelvis and right leg during flight in the horizontal plane (αy_{rLEG-P}; 51.28% of the total variability). All three trials of Dancer 1 were associated with the highest scores, while the lowest scores were associated with the first and second trial of Dancer 3 (performed with light and moderate effort; see Figure 2).

Arabesque

Trials of the stability movement (arabesque) were also clearly grouped depending on the performer. The highest scores (5, 6, 7) were associated (45.29% of the total variability) with the duration of the single limb stance (DURATION), the right leg angle relative to the plane of view (α_{rLEG}), the middle fast and the fast vibration of the center of the pelvis in the frontal plane ($MidVibx_P$; $FastVibx_P$), the fast vibration of the CM in the vertical plane ($FastVibz_{CM}$) and the middle fast vibration of the CM in the frontal plane ($MidVibx_{CM}$). The highest scores corresponded to the second and third trial of Dancer 4 (performed with moderate and strong effort). The lowest score was associated with the left leg angle relative to the vertical in the plane of view (α_{lLEG}) and with the second and third trials of Dancer 1 (see Figure 2).

Forward Drop Step and Recovery

In the individual factor map of this movement, the trials were not grouped by performer or the quality of the movement (see

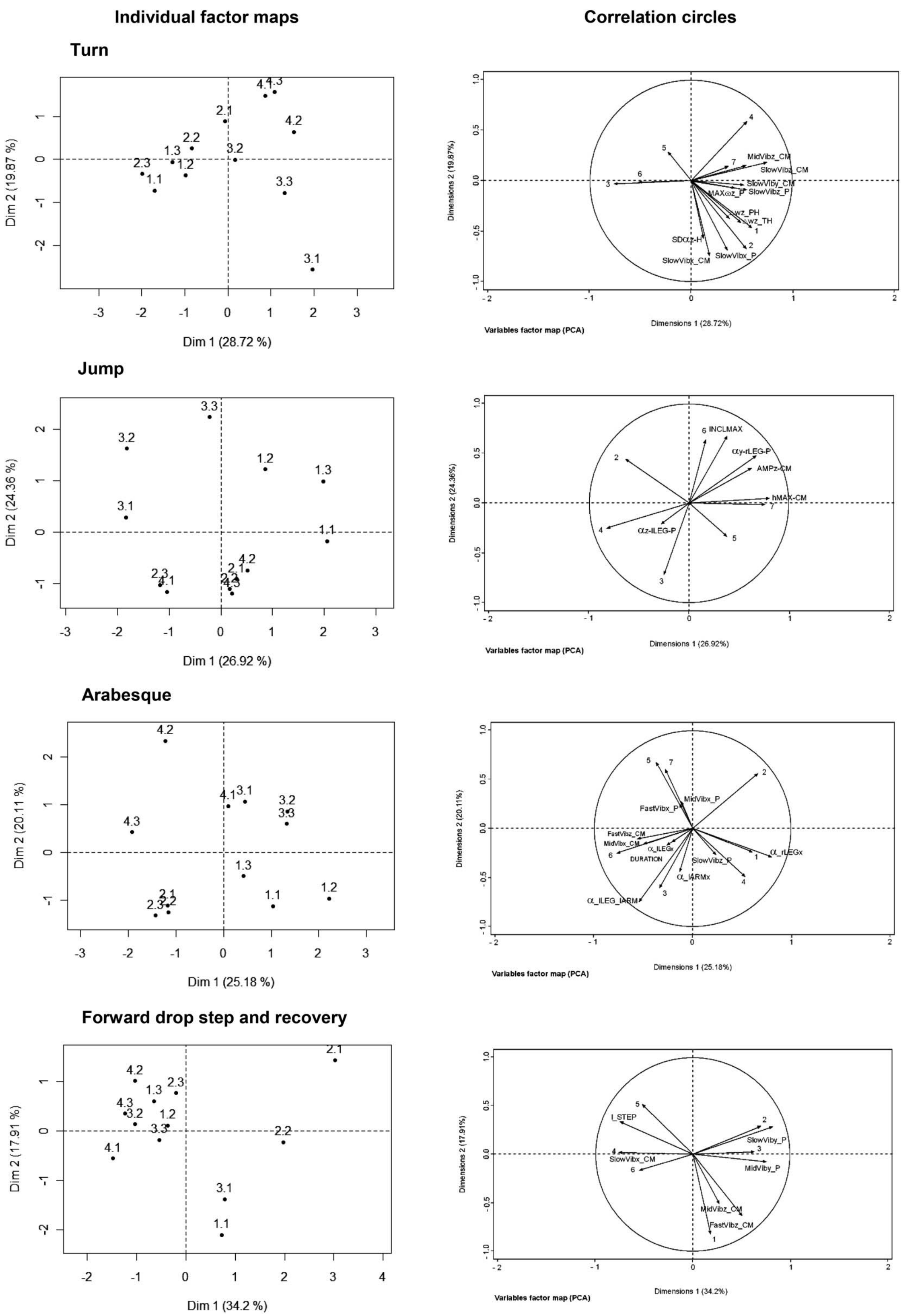

Figure 2. Individual factor map for the analysis of the four movements (left), along with the correlation circle of all the kinematic parameters and the possible beauty appraisal values (right). In the individual factor map, the trials are represented by two numbers (i.e., 1.1). The first number corresponds to the dancer and the second to the effort applied (1: light; 2: moderate; 3: strong). The variables are projected onto the factor map and are represented as vectors. The closer to 1 the vector magnitude is, the better is the projection.

Figure 2). The variables factor map of the displacement showed a clear association of the variable length of the step (l_{STEP}) with the highest scores of this movement (4, 5, 6), and a low association between these scores and vibration of the CM in the interval from 0 to 2.5 Hz and in the *x*-axis ($SlowVibx_{CM}$; 52.11% of the total variability). The observers did not mark the score 7 for this movement, with the exception of one observer for one of the trials. All the trials of Dancer 4, as well as the second and third trials of Dancers 1 and 3, were associated with the highest scores. The lowest scores (1, 2) were associated with the vibrations of the center of the pelvis in the *y*-axis (left to right for the observers) in the intervals from 0 to 2.5 Hz and from 2.5 to 5 Hz ($SlowViby_{P}$, $MidViby_{P}$). The first trials of Dancers 1 and 3 and the second of Dancer 2 were associated with the lowest scores.

Discussion

Previous research has documented that visual and physical experience, as well as the ability to perform a movement, can shape the perceptual processes involved in watching dance (Calvo-Merino, Jones, Gillmeister, Tziraki, & Forster, 2012; Jang & Pollick, 2011). On the other hand, some researchers have found kinematic parameters related with aesthetic perception in dance. However, the studies that compare nonexperts with experts have focused on neural responses to watching dance and the studies focused on kinematic parameters were carried out with nonexpert observers. In this study, we analyzed which kinematic dance parameters were related with the aesthetic perception of beauty by dance teachers. We hypothesized that experts would be influenced by different movement parameters than nonexperts, but results show that the perception of beauty of isolated movements is very similar between novices and dance teachers.

As Torrents et al. (2013) suggested in analyses of nonexpert observers' appraisal of beauty in contemporary dance movements, expert observers' perception of beauty is clearly influenced by the style of each dancer, rather than by the quality of movement that he or she sought to achieve. This is supported by the results of the individual factor maps, which clearly grouped the trials of each participant regardless of the quality of each trial, with the exception of the forward drop step and recovery. It is precisely in the evaluation of this movement that observers preferred trials performed with moderate and strong effort, probably because this kind of effort resulted in a movement with a greater range of motion.

Strong associations were found between higher appraisal scores and certain kinematic parameters. The parameters that were associated with the highest scores and lowest scores in the turn and in the jump were nearly the same as those obtained when nonexpert observers evaluated the performance of these movements (Torrents et al., 2013). The turning velocity seemed to be the most relevant parameter in turns. Fluctuations or a swaying movement seemed to be associated with better scores when they occurred in the plane of view (down–up and right–left), with worse scores being awarded when they occurred in depth (near–far) and when they were below 2.5 Hz. This was probably because they were regarded as a lack of stability in the execution. Differences in the velocities of different body parts (head, thorax, and pelvis) were also badly scored, probably because these differences broke with the harmony of the movement.

The beauty of the jump seems to be associated with a big range of motion or amplitude, inclination (horizontality) of the body in the air and the height of the jump. These parameters are in agreement with the results obtained with nonexpert observers (Torrents et al., 2013), with the exception of the height of the jump. We hypothesized that the reason for this result was that nonexpert observers placed greater emphasis on the amplitude of movement (considering that there is a lowering of the CM prior to jumping) than on the final height achieved by the CM. However, in this case, expert observers valued the final height as an important parameter to performing a nice jump.

As with the nonexperts, the teachers associated beauty in executing an arabesque with the time that the dancer took to performing it, probably because maintaining the position is a sign of mastery of balance. Beauty was also associated with the amplitude of movement, in this case evaluated according to the angle of the elevated leg (right) in the plane of view.

The teachers' aesthetic perception of the forward drop step and recovery differed more widely from the results obtained with nonexpert observers. Teachers appreciated the length of the step, while nonexperts placed more value on the maximum achieved inclination at the beginning of the movement and the vertical motion amplitude of the CM. Nevertheless, all of these parameters suggest the appreciation of the amplitude of the movement.

Overall, the results suggest that dance teachers, as well as nonexpert observers, are influenced by the most basic characteristics of dance movements, such as turning speed, the time for which balance is maintained, and the amplitude of movement. The similarity between the results of this study and the prior study with nonexpert observers surprised us, as we expected that a dance background would have a greater influence on the aesthetic evaluation of dance movements. Although the perceptual processes involved in watching dance were probably different for nonexperts as compared with dance teachers (Calvo-Merino et al., 2005, Calvo-Merino et al., 2006, Calvo-Merino et al., 2010; Jola et al., 2012; Orgs et al., 2013), the similar results obtained in this study suggest that the aesthetic perception when observing isolated specific contemporary dance movements is very similar for populations with different dance backgrounds. In addition, the general agreement with the previous study of nonexperts reinforces the results of both studies, as the replication with a different population provided very similar results.

One of the limitations of this study is that observers just evaluated dance movements, rather than pieces of choreographies. The effect of isolated actions is different from the impact of these actions embedded within a choreography. The aesthetic evaluation of a choreography probably depends on the dance background. Expert observers are likely to be influenced by aspects other than purely aesthetic ones or personal feelings, aspects that are determined by the perceiver's concepts and expertise, style, codes, history, and traditions of the art form (Augustin & Leder, 2006; Leder et al., 2004; Morris, 2008). Therefore, future work should focus on the parameters that determine the aesthetic perception of choreographies. Jola et al. (2012) used live dance performances in their study. We could not use this interesting approach, as we focused on kinematic parameters and the experiments had to be carried out in a lab.

Finally, we have not taken into account the emotional component of dance. As Christensen and Calvo-Merino (2013) suggest, dance usually has a communicative intention, and there is generally a strong emotional component. The observers' emotion perceptions and recognition are crucial to the aesthetic experience of dance. Therefore, the influence of emotions in the aesthetic perception of dance could be an important question for future studies.

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