

# Association Between Selected Physical Fitness Parameters and Aesthetic Competence in Contemporary Dancers

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## Abstract

The physical demands imposed on contemporary dancers by choreographers and performance schedules make their physical fitness just as important to them as skill development. Nevertheless, it remains to be confirmed which physical fitness components are associated with aesthetic competence. The aim of this study was to: 1. replicate and test a novel aesthetic competence tool for reliability, and 2. investigate the association between selected physical fitness components and aesthetic competence by using this new tool. Seventeen volunteers underwent a series of physical fitness tests (body composition, flexibility, muscular power and endurance, and aerobic capacity) and aesthetic competence assessments (seven individual criteria commonly used by selected dance companies). Inter-rater

reliability of the aesthetic competence tool was very high ( $r = 0.96$ ). There were significant correlations between the aesthetic competence score and jump ability and push-ups ( $r = 0.55$  and  $r = 0.55$ , respectively). Stepwise backward multiple regression analysis revealed that the best predictor of aesthetic competence was push-ups ( $R^2 = 0.30$ ,  $p = 0.03$ ). Univariate analyses also revealed that the interaction of push-ups and jump ability improved the prediction power of aesthetic competence ( $R^2 = 0.44$ ,  $p = 0.004$ ). It is concluded that upper body muscular endurance and jump ability best predict aesthetic competence of the present sample of contemporary dancers. Further research is required to investigate the contribution of other components of aesthetic competence, including upper body strength, lower body muscular

endurance, general coordination, and static and dynamic balance.

Technical mastery of skills is essential to achieving the necessary aesthetic competence during dance performance. Since the body is the instrument of the dancer's expression, it has been suggested that aspects of performance could benefit from enhanced physiological capabilities, such as muscular strength and power.<sup>1,2</sup> This is the case in other aesthetics-based activities, where the artistic qualities and performance efficiency improve with enhanced physiological capabilities.<sup>3,4</sup> In elite rhythmic gymnasts, for example, basic aspects of performance (such as jumps and leaps) are influenced by strength, power, endurance, and flexibility,<sup>4</sup> while general performance efficiency is associated with rhythmic coordination.<sup>5,6</sup> Studies have revealed that in gymnastics specific adaptations, such as dynamic and static balance, are attained with training.<sup>7</sup> This, in turn, can significantly affect the overall performance.

Numerous studies of contemporary (or modern) dancers have examined their levels of selected fitness components, such as aerobic capacity,<sup>8,9</sup> anaerobic power,<sup>10</sup> muscular strength and power,<sup>11,12</sup> and anthropometric characteristics.<sup>13,14</sup> However, there is no published information on the associations between these fitness parameters and aesthetic competence,

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**Table 1** Selected Marking/Assessment Criteria and Scoring Guidelines

Criterion	Description	Mark 1-10
1. Control of movements	Controlled landing from jump/turn, controlled lifting/lowering of limbs, controlled shifting of body weight. Core strength, alignment, posture.	1-3: Some evidence of co-ordination, movement control, and body awareness, but limited and inconsistent. 4-6: Some elements were stronger than others. 7-8: Secure general co-ordination and body alignment; generally well controlled movements. 9-10: Well co-ordinated movement and controlled work all of the time, with accurate alignment.
2. Spatial skills	Spatial awareness, accuracy and intent.	1-3: Little or no use of peripheral space; poor use of performance space. 4-6: Some good use of space, but inconsistent. Some elements stronger than others. 7-8: Good use of space about 80% of the time, with general accuracy and intent. 9-10: Secure and confident use of space, with accuracy and intent.
3. Accuracy of movements	Arm placement, feet positions, fully stretched leg extensions (if required).	1-3: Little or no precision throughout sequence. Unclear leg/arm lines. 4-6: Some precision, but inconsistent. Some elements stronger than others. 7-8: Correct positioning about 80% of the time. 9-10: Precise placing with well articulated gestures of limbs.
4. Technique	Elevation, turning and falling techniques, height of extensions, balance, posture, placement, articulation.	1-3: Little or no evidence of high technical skill in any element. 4-6: Some skill in some elements, general virtuosity achieved. 7-8: Good virtuosity shown about 80% of the time. 9-10: A stunning performance showing virtuosity and skill throughout.
5. Dynamics, timing and rhythmical accuracy	Dancing with correct timing and ability to perceive movement and rhythmic patterns. Showing awareness for changes in musical dynamics and phrasing.	1-3: Little or no ability to perform and respond in time to the music. Little or no dynamic qualities. 4-6: Performed in time for over half of the sequence, with some ability to respond to different rhythms and dynamics of movement. 7-8: Timing was accurate for most of the sequence, and response to varying rhythms was shown. General good use of dynamics. Good sense of musicality. 9-10: Timing was accurate throughout, with very good response to various rhythms, dynamics and phrases.
6. Performance qualities	Ability to execute the work for an audience. Presence, expressiveness, memory recall.	1-3: Few or no performance qualities were shown. Poor memory recall. 4-6: Some performance qualities were shown. Generally good memory recall. 7-8: Strong expressive qualities and memory recall about 80% of the time. 9-10: Excellent and well developed projection of a range of expressions, feelings and emotions. Mature approach, with understanding of motivation for the movement.
7. Overall performance	Does the performance overall impress markers?	1-3: Dancer made little impression on the audience. 4-6: Dancer not at full potential yet, OR strong work but lacking ability to impress overall. 7-8: Dancer has the ability to shine, but was hindered by minor aspects of performance. 9-10: Impressive!

which may be considered indicators of actual performance.<sup>15</sup>

In comparison to physical fitness and its well-defined components,<sup>16</sup> the description of aesthetic competence is far less clear. Moreover, there are no validated and reliable tools with which to assess either aesthetic competence or full dance performance. In only two recent studies have aspects of fitness and aesthetic competence

been considered simultaneously, and both of these investigations relied on fairly subjective evaluations of selected aesthetic elements.<sup>1,2</sup> Dance teachers, artistic directors, and dance institutions and companies rely on a variety of non-standard criteria and methods to quantify performance. Hence, given the lack of standardized valid and reliable procedures, the objective evaluation of aesthetic competence is

very difficult to achieve.

To our knowledge only one study has attempted to quantify and score aspects of dance performance such as overall proficiency, full body involvement, articulation, and skills.<sup>17</sup> No studies have yet determined which of the main fitness components (i.e., aerobic capacity, local muscular endurance, flexibility, and body composition) would best predict aesthetic

competence in contemporary dancers. Therefore, the aim of this study was to investigate this relationship by using the newly developed aesthetic competence tool.

## Methods

### Design

This study was designed in two parts: The first part (reliability study) replicates and re-examines a novel aesthetic competence tool as previously recommended by these authors<sup>18</sup>; in the second part (association study) this tool is used to explore correlations between fitness and aesthetic components in contemporary dance performance.

### Reliability Study

#### Tool Development

Auditioning criteria from pre-professional contemporary dance institutions and professional companies in the United States, United Kingdom, and Australia (three pre-professional contemporary dance institutions, four university dance courses, one professional company, and one examination body) were collected. The aesthetic competence tool was developed as a composite of the seven most frequently used criteria. In applying the tool each criterion was evaluated using a Likert scale model ranging from 1 to 10; thus, the maximum possible total score was 70. The following general word-anchors were provided for scoring purposes: 1-3 = little or no ability to perform elements as required; 4-6 = some elements performed appropriately; 7-9 = elements performed appropriately for about 80% of the time; 10 = elements performed appropriately during the whole performance. The assessment criteria and scoring guidelines appear in Table 1.

Two dance teachers with at least

seven years experience of assessing and auditioning dancers were recruited as judges. They had similar dance backgrounds (e.g., professional training as contemporary dancers and qualified teacher status), and were teaching staff at two different pre-professional contemporary dance institutions. One judge also had experience on an audition panel for dance companies. The judges were unknown to the dancers or to each other.

Six professional contemporary dancers (four females) were recruited as performers (age:  $31 \pm 5.1$  years; height:  $163.6 \pm 6.5$  cm; weight:  $57.2 \pm 8.1$  kg; total years of dance training:  $20.1 \pm 9.4$ ; years of professional activity:  $13.7 \pm 3.1$ ). All participants were dancing full-time when recruited, were free of injury, and were not involved in any supplementary fitness training or other sport activity. At the time of recruitment each dancer was fully informed about being video recorded during the aesthetic competence test.

The dancers were asked to perform a movement sequence lasting 60 seconds choreographed specifically for this study. All performers learned the dance sequence the same day, in the same studio, and at the same time. Each participant was given 20 minutes to learn the choreography and then five minutes to practice in front of the camera before being video recorded.

Each performance was video-recorded, subsequently copied three times, and randomly ordered in an edited video containing a total of 18 clips. The video was then handed, together with choreographic notes and assessment guidelines, to the two judges, who scored the dancers separately. Judges were given the following instructions: 1. to mark all

dancers from the video on the same day, 2. not to rewind the video clips at any time once the scoring procedure had begun, 3. to perform the assessment during the first hours of the morning on a pre-arranged specific day, and 4. to follow the scoring guidelines (Table 1).

The dancers were scored on each performance that was observed by the judges. The performances seen were identified by clip number in order for the authors to associate scores given with the corresponding performances.

### Statistical Analysis

The scores given for each criterion by the two judges were compared to assess inter-rater reliability. For intra-test-retest reliability, each judge's scores for the three separate trials were also compared. All analyses were conducted using two-way mixed intra-class correlation coefficients (ICC) in SPSS (version 12.0, SPSS Inc., Chicago, IL, USA). Confidence intervals (95%) were also calculated for all ICCs.<sup>19</sup>

### Association Study

#### Participants

Eleven female dance students in pre-professional training and six professional contemporary dancers (five females) were recruited. Table 2 depicts the anthropometric and demographic characteristics of the participants. Inclusion criteria at the time of recruitment were: 1. enrollment in a recognized pre-professional dance institution, or employment as a dancer in an established dance company; 2. no injury at the time of the fitness assessment; and 3. no involvement in any supplementary fitness training or sport activity during the three months preceding the fitness assessment. Participants were also

**Table 2** Anthropometric and Demographic Characteristics of Participants (Mean  $\pm$  SD)

Participant Level	Sample Size	Age (years)	Height (cm)	Weight (kg)	Dance Training (years)	Professional Experience (years)
Professional	N = 6	29.6 $\pm$ 4.4	163.0 $\pm$ 5.5	56.4 $\pm$ 6.7	20.5 $\pm$ 8.3	10.7 $\pm$ 6.7
Student	N = 11	24.7 $\pm$ 2.9	165.4 $\pm$ 4.6	59.1 $\pm$ 7.8	10.7 $\pm$ 2.1	—
Overall Sample	N = 17	26.1 $\pm$ 4.0	164.7 $\pm$ 4.8	58.3 $\pm$ 7.4	15.6 $\pm$ 6.9	—

**Table 3** Summary of Fitness Tests Employed

Fitness Component	Method	Equipment	Type of Test	Reference
% Body Fat	Skinfold	Skinfold caliper	Field based	Siri, 1961 <sup>23</sup>
Aerobic capacity	DAFT test	HR monitors	Field based	Wyon et al. 2003 <sup>29</sup>
Lower body muscular power	Jump Height	Jump mat	Field based	ACSM <sup>21</sup>
Upper body muscular endurance	Push-ups	Stop-watch	Field based	ACSM <sup>21</sup> ; Wood et al. 2004 <sup>27</sup>
Central body muscular endurance	Plank	Stop-watch	Field based	BASES <sup>20</sup>
Joint mobility and muscular flexibility	Active and passive hip ROM	Geometrical protractor	Field based	BASES <sup>20</sup> ; Redding et al. 2004 <sup>36</sup>

DAFT = dance aerobic fitness test; HR monitors = heart rate monitors; ROM = range of motion.

informed about the photography and video recording requirements for the study. Written informed consent was obtained from all participants after full verbal and written explanation of the data collection procedures. The Research Centre for Sport, Exercise and Performance Ethics Committee of the University of Wolverhampton approved the study protocol.

#### **Data Collection Procedures**

For each dancer all testing was completed during the same day, in the following order: dancer's fitness assessments followed by aesthetic evaluation. A three-hour interval was allowed between fitness assessment and the aesthetic competence test in order to avoid undue fatigue.

#### **Fitness Assessment**

The majority of protocols used for assessment of the selected fitness parameters were in accordance with the guidelines of the British Association for Sport and Exercise Sciences<sup>20</sup> and the American College of Sport Medicine.<sup>21</sup> The fitness assessment was carried out at the dancers' workplace. Therefore, field-based protocols and portable equipment were employed. Table 3 provides a summary of fitness tests employed.

#### **Anthropometry**

Standing height was measured to the nearest 0.5 cm using a Seca stadiometer 208 (Hamburg, Germany), with the participants in bare feet and their heads positioned in the Frankfurt horizontal plane. Total body mass was

measured to the nearest 0.5 kg with a Seca beam balance 710 (Hamburg, Germany). Using a Harpenden caliper (John Bull, St. Albans, UK), body fat percentage (%BF) was calculated from the mean of three readings per site according to the 4-sites formula of Durnin and Womersley,<sup>22</sup> where the sum of the triceps, subscapular, suprailiac, and calf skinfolds is needed to estimate body density. This was then used (employing the Siri equation)<sup>23</sup> to calculate %BF. The Siri equation has previously been used in dancers.<sup>24</sup>

#### **Flexibility**

The dancers were asked to perform, both actively and passively, a sideways leg extension (*développé à la seconde*), which involves the combined hip action of flexion, abduction, and external rotation. Assessment of active (functional) range of motion (ROM) of the hip was achieved using the dancer's muscle activation only, with the participant in standing position on the floor and one hand resting on a barre. Assessment of passive flexibility required the dancer to move the joint using his or her hand to its ROM limit. Landmarks were placed at the following anatomical points: the tip of the fibular head on the lateral side of the lower leg, and the middle of the inferior side of the lateral malleolus. Four images were taken with a digital camera for each dancer's performance of the *développé à la seconde* to calculate the active and passive ROM. Measurements were recorded for both legs. Although this protocol

is suggested for both ballet and contemporary dancers,<sup>20</sup> and has been recommended for the assessment of dance specific flexibility-related skills,<sup>25</sup> its validity and reliability are unknown.

#### **Muscular Power**

Standing vertical jump (or jump ability) was assessed using a jump meter (Jump MD, TKK 5106; Takei Yashiroda, Japan). Volunteers were barefoot and were asked to assume the dance first position (heels together and feet externally rotated). They were then instructed to perform a *demi-plié* and immediately jump as high as possible off both feet, using the technique for performing *sautés* (jumps, heels together, hips externally rotated, and feet pointed). The dancers were subsequently instructed to perform the same test but jumping off one leg and landing on the same leg, first on the right side and then on the left. These tests have been extensively used to assess jump ability, and have been found to correlate well with lower body muscle power.<sup>2,26</sup> During these tests the arms were not used. Each test was repeated three times, and the highest score (in centimeters) was recorded for further analysis.

#### **Muscular Endurance**

For assessment of muscular endurance two different field-tests were used. The first was a push-ups test,<sup>21</sup> which is a valid and reliable indicator of upper body muscular endurance.<sup>27</sup> This test was administered with the dancer starting in the modified knee push-up

**Table 4** Inter-rater Reliability

	Mean $\pm$ SD		Mean $\pm$ SD of mean differences	95% C.I.	P value	ICC
	Judge 1	Judge 2				
Criterion 1	6.4 $\pm$ 1.6	6.7 $\pm$ 1.6	0.3 $\pm$ 1.0	-0.8 – 0.2	p > 0.05	r = 0.89 (p < 0.01)
Criterion 2	7.0 $\pm$ 1.4	7.3 $\pm$ 1.2	0.3 $\pm$ 0.7	-0.6 – 0.0	p > 0.05	r = 0.93 (p < 0.01)
Criterion 3	6.7 $\pm$ 1.7	7.0 $\pm$ 1.1	0.3 $\pm$ 0.8	-0.7 – 0.0	p > 0.05	r = 0.92 (p < 0.01)
Criterion 4	6.9 $\pm$ 1.6	6.9 $\pm$ 1.2	0 $\pm$ 0.7	-0.3 – 0.4	p > 0.05	r = 0.93 (p < 0.01)
Criterion 5	7.0 $\pm$ 1.1	7.5 $\pm$ 1.1	0.4 $\pm$ 0.5	-0.7 – 0.2	p > 0.05	r = 0.96 (p < 0.01)
Criterion 6	7.3 $\pm$ 1.4	7.3 $\pm$ 1.2	0 $\pm$ 0.4	-0.3 – 0.1	p > 0.05	r = 0.97 (p < 0.01)
Criterion 7	6.7 $\pm$ 1.6	6.0 $\pm$ 1.9	0.7 $\pm$ 1.0	-0.1 – 1.2	p > 0.05	r = 0.90 (p < 0.01)

95% C.I. = 95% Confidence Interval; ICC = Intraclass Correlation Coefficients.

position (legs together, lower leg in contact with mat with ankles plantar flexed, back straight, hands shoulder width apart, and head up). The dancers were instructed to lower the body until the chin touched the mat and then return to the starting position. The maximum number of push-ups performed consecutively in one minute was counted as an indicative score of upper body muscular endurance. For the second test participants were asked to maintain the plank position (whole body parallel to the floor and supported by the forearms and the toes) for as long as possible. This position provides reliable information about endurance of the core muscles (abdominals and dorsal group muscles).<sup>28</sup> The total time, measured in minutes, that the dancers spent in the required position was recorded for further analysis.

### **Aerobic Capacity**

Aerobic capacity was tested using the validated Dance Aerobic Fitness Test (DAFT).<sup>29</sup> This procedure has been previously used with dancers to monitor cardiorespiratory capacity.<sup>30</sup> The test consists of five progressively demanding stages, lasting 4 minutes each, for a total of 20 minutes. Each stage is a contemporary dance sequence, which increases in intensity and speed at each stage. Before the test each dancer underwent a familiarization process, and was introduced to the tempo of each stage. They were also informed of the test termination criteria.<sup>30</sup> Prior to testing they were fitted with a Polar heart rate monitor (Kempele, Finland) that was used at

the end of the test to provide values for maximum achieved heart rate. This information was used as an indicator of aerobic fitness level.<sup>29,30</sup>

### **Contemporary Dance Aesthetic Competence Test**

The aesthetic competence test described above was implemented with the dancers in the current study. In this case the dance sequence that the participants learned and performed lasted 90 seconds, and there was just one judge, a contemporary dance teacher with 10 years experience assessing dancers at pre-professional and professional levels.

### **Statistical Analysis**

Routine pre-analyses were conducted using the Kolmogorov-Smirnov normality tests to assess the normal distribution of the studied variables. Descriptive statistics were used to report mean  $\pm$  SD scores for all variables.

Pearson Product Moment correlations were utilized to detect linear associations among the studied variables in SPSS (version 12.0, SPSS Inc., Chicago, IL, USA). Stepwise backward multiple regression analyses examined the strength of the association between aesthetic competence (total score) and the five specific physical parameters. Univariate analyses of variance (ANOVA) investigated the prediction power of several interactions of covariates (e.g., jump height and push-ups and/or plank and flexibility) on aesthetic competence total score (dependant variable). Finally, the prediction power of each physi-

cal parameter was examined against each individual criterion used in the present aesthetic competence tool. In order to investigate sensitivity of the aesthetic competence tool a sub-analysis of data was also conducted to compare (using ANOVA) professional and student dancers' scores. Statistical significance was set at p < 0.05.

## **Results**

### **Reliability Study**

With regard to inter-rater reliability, there were no significant differences (p > 0.05) in the scores given for each individual criterion between the two judges, and the ICC of the total score for judges 1 and 2 was r = 0.96, p < 0.01 (Fig. 1). Table 4 shows in detail the inter-rater reliability results. For intra-test-retest reliability, repeated measures ANOVA showed no significant differences (p > 0.05) between the three individual assessments carried out by either judge. Table 5 depicts results for intra-test-retests. All ICC values among the three individual assessments for judges 1 and 2 were greater than or equal to 0.85.

The 95% limits of agreement found no significant bias in any of the assessments for either the inter- or intra-test-retest reliability (p > 0.05).

### **Association Study**

#### **Association Between the Aesthetic Competence Total Scores and Fitness Components**

Table 6 shows the mean scores obtained by the dancers on the physical fitness and aesthetic competence tests. Pearson Product Moment correlations detected significant associations (Figs.

**Table 5** Intra-rater Test-retest Reliability

Judge 1	Mean ± SD 1st trial	Mean ± SD 2nd trial	Mean ± SD 3rd trial	P values	F values	S.E. 1st trial	S.E. 2nd trial	S.E. 3rd trial	95% C.I. 1st trial	95% C.I. 2nd trial	95% C.I. 3rd trial	ICC
Criterion 1	6.7 ± 1.6	6.2 ± 1.8	6.5 ± 1.7	p > 0.05	.128	.666	.749	.718	4.9-8.4	4.2-8.1	4.6-8.3	r = 0.86 (p = 0.04)
Criterion 2	7.3 ± 1.6	6.6 ± 1.3	7.0 ± 1.2	p > 0.05	.326	.666	.557	.516	5.6-9.0	5.2-8.1	5.7-8.3	r = 0.88 (p = 0.03)
Criterion 3	6.5 ± 1.3	6.3 ± 1.9	7.1 ± 1.8	p > 0.05	.383	.562	.802	.749	5.0-7.9	4.3-8.4	5.2-9.1	r = 0.91 (p = 0.01)
Criterion 4	7.2 ± 1.6	6.5 ± 1.6	7.2 ± 1.7	p > 0.05	.324	.654	.670	.703	5.5-8.8	4.8-8.2	5.3-8.9	r = 0.94 (p = 0.01)
Criterion 5	7.3 ± 1.5	6.8 ± 1.4	7.0 ± 1.5	p > 0.05	.171	.614	.600	.632	5.7-8.9	5.3-8.4	5.4-8.6	r = 0.95 (p = 0.01)
Criterion 6	7.5 ± 1.3	7.0 ± 1.4	7.3 ± 1.5	p > 0.05	.189	.562	.577	.614	6.0-8.9	5.5-8.5	5.7-8.9	r = 0.85 (p = 0.06)
Criterion 7	6.8 ± 1.7	6.3 ± 1.7	6.8 ± 1.7	p > 0.05	.167	.703	.714	.703	5.0-8.6	4.5-8.2	5.0-8.6	r = 0.92 (p = 0.01)
Judge 2	Mean ± SD 1st trial	Mean ± SD 2nd trial	Mean ± SD 3rd trial	P values	F values	S.E. 1st trial	S.E. 2nd trial	S.E. 3rd trial	95% C.I. 1st trial	95% C.I. 2nd trial	95% C.I. 3rd trial	ICC
Criterion 1	6.8 ± 1.7	6.5 ± 1.5	6.8 ± 1.8	p > 0.05	.077	.703	.619	.749	5.0-8.6	4.9-8.1	4.9-8.7	r = 0.96 (p = 0.01)
Criterion 2	7.2 ± 1.5	7.3 ± 1.2	7.3 ± 1.2	p > 0.05	.033	.600	.494	.494	5.6-8.7	6.1-8.6	6.1-8.6	r = 0.89 (p = 0.02)
Criterion 3	6.8 ± 1.2	7.0 ± 1.3	7.2 ± 1.2	p > 0.05	.115	.477	.516	.477	5.6-8.1	5.7-8.3	5.9-8.4	r = 0.90 (p = 0.01)
Criterion 4	7.0 ± 1.4	6.6 ± 1.2	7.0 ± 1.3	p > 0.05	.132	.577	.494	.516	5.5-8.5	5.4-7.9	5.7-8.3	r = 0.92 (p = 0.01)
Criterion 5	7.6 ± 1.2	7.2 ± 1.2	7.6 ± 1.2	p > 0.05	.349	.494	.477	.494	6.4-8.9	5.9-8.4	6.4-8.9	r = 0.94 (p = 0.01)
Criterion 6	7.6 ± 1.2	7.2 ± 1.7	7.2 ± 1.3	p > 0.05	.326	.494	.477	.542	6.4-8.9	5.9-8.4	5.8-8.6	r = 0.90 (p = 0.01)
Criterion 7	5.8 ± 2.1	5.8 ± 1.9	6.3 ± 1.9	p > 0.05	.127	.872	.792	.760	3.6-8.1	3.8-7.9	4.4-8.3	r = 0.96 (p = 0.01)

S.E. = Standard Error; 95% C.I. = Confidence Interval; ICC = Intraclass Correlation Coefficients

2, 3, and 4) between the mean score obtained from the aesthetic competence test and push-ups ( $r = 0.55$ ,  $p = 0.02$ ), jump on the right leg ( $r = 0.55$ ,  $p = 0.03$ ), and jump on the left leg ( $r = 0.55$ ,  $p = 0.02$ ).

Stepwise backward multiple regression revealed that the best predictor of aesthetic competence was push-ups ( $R^2 = 0.30$ ,  $F = 6.4$ ,  $p = 0.02$ , 95% confidence intervals = 0.11 to 1.34). However, it was found that the interaction of push-ups and standing vertical jump off both feet demonstrated an improved prediction power ( $R^2 = 0.44$ ,  $F = 11.6$ ,  $p = 0.004$ , 95% confidence intervals = 0.009 to 0.04).

**Association between the Seven Individual Criteria and Fitness Components**

Stepwise backward multiple regression analysis revealed that the best predictor among all the physical parameters tested was push-ups. A significant prediction of this variable was detected for the following criteria:  $R^2 = 0.25$ ,  $F = 4.9$ ,  $p = 0.041$  for criterion 1;  $R^2 = 0.32$ ,  $F = 7.0$ ,  $p = 0.018$  for criterion 2;  $R^2 = 0.24$ ,  $F = 4.9$ ,  $p = 0.043$  for criterion 3;  $R^2 = 0.286$ ,  $F = 6.0$ ,  $p = 0.027$  for criterion 5;  $R^2 = 0.31$ ,  $F = 6.7$ ,  $p = 0.002$  for criterion 6, and finally,  $R^2 = 0.36$ ,  $F = 8.3$ ,  $p = 0.011$  for criterion 7. However, using interactions in univariate analyses, the combination of push-ups and jump ability revealed a higher prediction power (criterion 1:  $R^2 = 0.39$ ,  $F = 9.8$ ,  $p = 0.007$ ; criterion 2:  $R^2 = 0.49$ ,  $F = 14.8$ ,  $p = 0.002$ ; criterion 3:  $R^2 = 0.32$ ,  $F = 14.5$ ,  $p = 0.016$ ; criterion 4:  $R^2 = 0.35$ ,  $F = 8.2$ ,  $p = 0.012$ ; criterion 5:  $R^2 = 0.42$ ,  $F = 10.8$ ,  $p = 0.005$ ; criterion 6:  $R^2 = 0.43$ ,  $F = 11.6$ ,  $p = 0.004$ ; and criterion 7:  $R^2 = 0.44$ ,  $F = 12.0$ ,  $p = 0.003$ ).

**Sub-analyses: Professional Versus Student Dancers**

ANOVA revealed that the mean aesthetic competence scores obtained from professional ( $N = 6$ ) and student ( $N = 11$ ) dancers were significantly different:  $49.0 \pm 9.7$  vs.  $36.5 \pm 9.6$ , respectively,  $p < 0.05$  ( $F = 6.403$ ;  $df = 1$ ).

**Table 6** Results of Fitness Assessment and Aesthetic Competence Test for all Dancers (N = 17)

	AC points	BF (%)	DAFT (bmin <sup>-1</sup> )	Muscle Endurance Push-ups (reps)	Muscle Endurance Plank (min <sup>-1</sup> )	Muscle Power SVJ (cm)	Flexibility Active (°)	Flexibility Passive (°)
Overall	40.94 ± 11.2	19.8 ± 2.8	194.5 ± 9.4	30.8 ± 8.4	2.1 ± 0.9	29.66 ± 5.3	73.6 ± 13.1	126.0 ± 12.7
Professionals	49.0 ± 9.7	18.8 ± 2.9	190.0 ± 10.9	33.8 ± 5.1	2.0 ± 0.9	32.1 ± 5.8	74.4 ± 13.9	126.5 ± 6.4
Students	36.5 ± 9.6	20.3 ± 2.7	197.0 ± 7.8	29.2 ± 9.5	2.1 ± 0.9	28.3 ± 4.7	73.1 ± 12.9	125.7 ± 15.1

AC = aesthetic competence; BF% = body fat percentage; DAFT = dance aerobic fitness test; reps = total number of repetitions; SVJ = standing vertical jump.

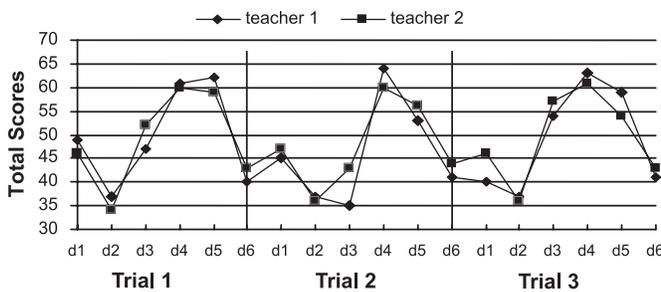
**Discussion**

The aim of this study was to test a novel aesthetic competence tool for reliability and investigate the association between seven selected physical fitness parameters, both individually and collectively, and aesthetic competence in contemporary dancers. We found that the newly developed aesthetic competence tool was reliable. We also found that upper body muscular endurance (measured by the use of push-ups) and lower body mus-

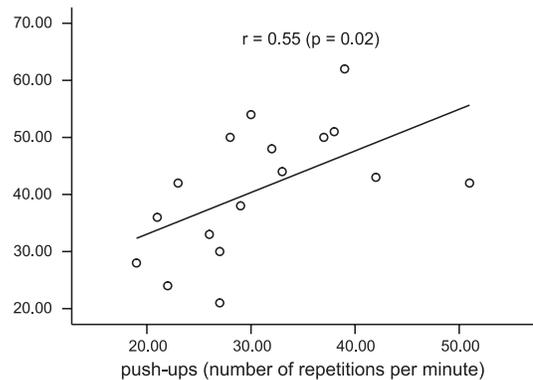
cle power (as demonstrated in jump ability) strongly predicted aesthetic competence.

Contemporary (or modern) dance incorporates many different techniques, movements and styles. Compared to ballet, contemporary dance is characterized by a greater variety of technical demands imposed by choreographers during performance.<sup>31</sup> These are a reflection of the many different contemporary techniques (Graham, Limon, Cunningham, and

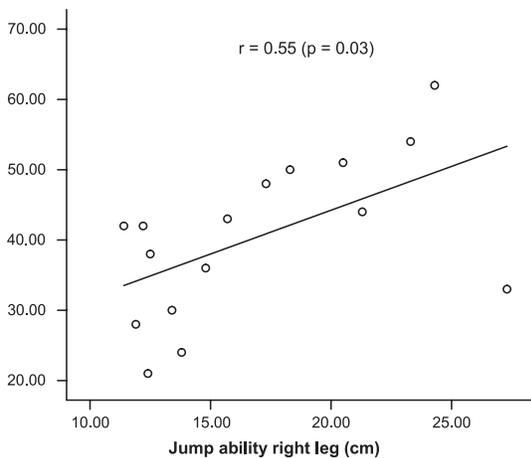
so forth).<sup>31</sup> Therefore, contemporary dancers are expected to be ready to perform a diverse repertoire, coping with the different demands of each performance. With the help of reliable means, dance scientists might be expected to understand which physical fitness components most affect the aesthetic competence of contemporary dancers. This information, in turn, could be useful in designing effective fitness training for improvement of aesthetic competence, and



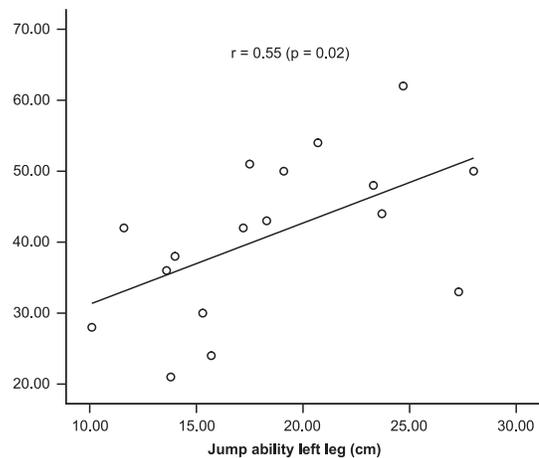
**Figure 1** Inter-raters reliability (d = dancer id).



**Figure 2** Correlation coefficient between aesthetic competence (total score) and upper body muscular endurance (push-ups test).



**Figure 3** Correlation coefficient between aesthetic competence (total score) and jump ability (right leg).



**Figure 4** Correlation coefficient between aesthetic competence (total score) and jump ability (left leg).

thus performance. For these reasons it is important to develop valid indicators of the aesthetic quality of dance performance.<sup>15</sup>

The aesthetic indicators used to develop the aesthetic competence tool and to assess the aesthetic competence of dancers in this study were based on the seven most frequently used criteria by pre-professional dance institutions and professional companies in auditioning dancers. In this study it was not possible to assess construct validity, as there is no well-established or accurate test in dance against which to compare our results. Therefore, once the aesthetic competence tool was developed, no further validation was attempted. Nevertheless, we have assessed inter- and intra-test-retest reliability.

Results from the univariate analyses revealed that upper body muscular endurance in combination with lower extremity muscular power was the best aesthetic competence predictor. This was consistent for both the aesthetic competence total score and the individual criteria that constituted the aesthetic competence tool. These results support previous data indicating that significant increases in muscular power improve the aesthetics of jumping.<sup>2</sup> Upper body muscular endurance is essential to partnering (systematically lifting and supporting other dancers), and transitional movements from floor to standing, and vice versa (e.g., from a handstand to lying prone on the floor).<sup>32</sup>

Aerobic capacity was not found to be a significant aesthetic competence predictor. This was anticipated since preliminary data suggest that dance is predominantly an intermittent type of exercise.<sup>33</sup> Also, despite flexibility being an essential attribute of dancers,<sup>34</sup> the results did not detect any significant associations between flexibility levels and aesthetic competence. All dancers participating in this study may well have already reached the level of flexibility required by the dance sequence used to assess aesthetic competence. Similarly, it has been stated that strict auditions ensure that young candidates have

the required flexibility at the point of entry into most dance schools.<sup>16</sup> Such strict regimens have succeeded in transforming dance into an activity practiced by very flexible individuals.

Significant differences were recorded in the aesthetic competence total scores between professional and pre-professional dancers. This result was anticipated given the greater performance experience of the professionals. Moreover, this finding may suggest that the newly developed aesthetic competence tool is sensitive enough to detect differences between the various levels of training in contemporary dancers.

The contemporary dancers in this study showed decreased levels of lower body muscular power (demonstrated in jump height) compared to a group of professional ballet dancers studied previously.<sup>35</sup> However, our sample included professional and pre-professional dancers, while data from the earlier study reflected only professional dancers. In addition, using the same techniques, a lower flexibility level was observed in the present sample compared to ballet dancers.<sup>36</sup> These differences may be due to less importance being placed on flexibility in contemporary dancers compared to ballet dancers. The present findings also revealed that our sample of contemporary dancers had reduced muscular power levels compared to non-dancers<sup>12</sup> and other aesthetic athletes, such as rhythmic gymnasts.<sup>37</sup> This may be due to the fact that dance training, in contrast to gymnastics, primarily focuses on skill acquisition, and hence does not elicit significant improvements in specific fitness parameters.<sup>33</sup> For this reason supplementary training has been recommended to improve aspects of contemporary dance performance.<sup>1,16</sup>

It is reasonable to assume that the present results may have been influenced by certain methodological limitations. One such limitation is the lack of a power calculation to determine the number of participants required for the purposes of this study to avoid Type I error. Another limitation is the lack of assessment of lower extremity

endurance and upper body maximal strength in the physical fitness tests.

Future studies may incorporate different criteria in accordance with different contemporary dance styles, taking into consideration how psychometric variables such as personality, energy effort, and risk-taking styles may have an impact on the aesthetic competence scores given by judges. In addition, using more judges and re-testing the tool with different choreographies employing partner work would give more power to the aesthetic competence tool. An enlarged male sample size would allow for a direct comparison between male and female dancers.

Within the limitations of the current study, it is concluded that upper body muscular endurance and jump ability best predict aesthetic competence in the present sample of contemporary dance students and professionals. Further research is required to investigate the contribution of other aspects to aesthetic competence, including upper body strength, lower body muscular endurance, general coordination, and static and dynamic balance.

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