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ANALYSIS OF CHANGEMENT DE PIED, ECHAPPÉ AND SISSONNE FERMÉ JUMPS IN FEMALE BALLET DANCERS

ANALIZA SKOKOV CHANGEMENT DE PIED, ECHAPPÉ IN SISSONNE FERMÉ PRI BALETNIH PLESALKAH

ABSTRACT

In classical ballet, jumping should stand more on technique and elegance rather than maximal height. This study aimed to investigate dancers' ability to perform stable jumps with classical ballet technique. Twenty-two female dancers [divided in two groups: Expert: n=12; Novice, n=10] were recruited to perform three vertical jump protocols: 1) Changement de Pied (CHA), composed by 5 consecutive jumps; 2) Echappé (ECH), composed by two consecutive 'Echappé' jumps; and 3) Sissonne Fermé (SF) jumps. Through an Optojump Next system were measured: a) Height (H) of jumps; b) Jumping Point Gap (JPG) and c) Used Area (UA).

The CHA analysis showed differences between consecutive jumps for JPG ($p=0.003$). An approach to significance ($p=0.52$) and a difference ($p=0.42$) between groups were found for H and JPG respectively, while no differences were found for UA. The ECH analysis revealed main differences between jumps for H ($p<0.001$), JPG ($p=0.003$) and UA ($p<0.001$), post-hoc analysis showed differences ($p<0.05$) between each jump from the fifth position to the second one and vice versa for H and UA whilst differences between groups emerged only for UA ($p=0.001$). The SF analysis showed no differences for all parameters.

The results showed as in CHA dancers carried out a control on the jump height to maintain their "aplomb" and limit the medio-lateral displacement, which was also influenced by the dancers' experience (NOV group showed higher H and JPG values). The dancers' skill was also demonstrated by their ability to perform similar jumps in each of the two echappé cycles.

Key words: classical ballet, dance, ability, jumps

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IZVLEČEK

V klasičnem baletu naj bi izvedba skokov temeljila bolj na tehniki in eleganci kot na maksimalni višini skoka. Cilj raziskave je bil preučiti sposobnost plesalk za izvedbo stabilnih skokov s klasično baletno tehniko. V raziskavi je sodelovalo 22 baletk [razdeljene so bile v dve skupini: izkušene: n = 12 in začetnice: n = 10], ki so izvedle tri protokole vertikalnih skokov: 1) *changement de pied* (CHA), sestavljen iz 5 zaporednih skokov; 2) *echappé* (ECH), sestavljen iz 2 zaporednih skokov *echappé,* ter 3) skoki *sissonne fermé* (SF). S pomočjo sistema Optojump Next smo izmerili: a) višino skokov (*Height* – H), b) razdaljo med dvema točkama skoka *Jumping Point Gap* (JPG) in c) uporabljeno območje *Used Area* (UA).

Analiza CHA je odkrila razlike med zaporednimi skoki pri JPG ($p = 0{,}003$). Približevanje statistični značilnosti ($p = 0{,}52$) in razlika ($p = 0{,}42$) med skupinama sta bila opažena tako pri H kot pri JPG, pri UA pa ni bilo nobenih razlik. Analiza ECH je pokazala glavne razlike med skoki za H ($p < 0{,}001$), JPG ($p = 0{,}003$) in UA ($p < 0{,}001$), post-hoc analiza pa je pokazala razlike ($p < 0{,}05$) med vsakim skokom od petega položaja do drugega in obratno pri H in UA. Razlike med skupinama so se pokazale samo pri UA ($p = 0{,}001$). Analiza SF pri vseh parametrih ni odkrila nobenih razlik.

Rezultati so pokazali, da so baletke pri CHA nadzorovale višino skoka, da bi ohranile svoj 'aplomb' in omejile mediolateralni premik, na kar je vplivala tudi njihova izkušenost (skupina začetnic – NOV je imela višje vrednosti H in JPG). Znanje plesalk se je pokazalo tudi v njihovi sposobnosti izvedbe podobnih skokov v vsakem od dveh ciklov *echappé*.

Ključne besede: klasični balet, ples, sposobnost, skoki

INTRODUCTION

Classical ballet is a unique form of activity, which has also defined as a "silent art" characterized by artistic and aesthetic features that move in time and space based on music and unite the soul, expressiveness, body language and specific techniques (Koutedakis and Jamurtas, 2004; Reheem, 2015). In order to combine athletic capacity with high-level of creativity, ballet teachers should develop both physical fitness and individual artistic sensibility of their dancers. For this reason, the selection of professional ballet dancers is a very demanding process. Indeed, it should focus not only on the identification of dancers with a high level of athletic performance, but rather those who are very effective to show their emotions through specific ballet movements (Hamilton et al., 1992).

In terms of fitness performance, regardless to the repertoire, the ballet is considered a high skill intermittent activity requiring both the contribution of aerobic and anaerobic energy systems (Schantz and Åstrand, 1984; Wyon et al., 2003). In fact, a ballet class stimulates both these energy systems through: a) barre and center floor exercises performed at moderate intensity, and b) center floor exercise including jumps, traveling and mid-air turns, performed at higher intensity (Twitchett et al., 2009). However, in literature it has been argued how some ballet teachers could be reticent to increase the physical training loads (i.e. adding further resistance training) to the class' structure above mentioned, being afraid that the outcome of this choice could interfere (i.e., developing muscles hypertrophy) with the aesthetic components of the discipline (Koutedakis et al., 2007). On the other hand, some teachers agree that a supplemental training can improve the level of dancers' physical fitness, reducing their fatigue's perception during the performance and lowering the risk of injuries (Twitchett et al., 2011). These latter findings were also supported by a study of Koutedakis and Sharp (2004) which demonstrated how a supplementary strength training for hamstring and quadriceps muscles can protect professional dancers from fatigue after dance exercise and how only ballet studio does not provide enough scope for developing optimal muscular strength.

Among the fitness components, jumping is an integral part of classical ballet performance that is strictly related with the two energy systems (Wyon et al., 2006). In this regard in literature it has been revealed how the jumping activity of classical ballet dancers is characterized by: a) single explosive jumps with higher elevation and shorter duration which require a large reserve of muscular power; and b) sequences of jumps with lower elevation and longer duration (i.e., even >30 seconds) which require muscular endurance (Twitchett et al., 2009). An initial study of Stalder et al. (1990) showed as a supplemental weight training program was beneficial to enhance appropriate neuromuscular movement patterns increasing also, speed, stamina, coordination and precision of performance, without affecting the aesthetic components. Moreover, previous studies pointed out to a strict relationship between low level of strength (as well as muscles circumferences) and the jump height (Golomer et al., 2004), showing also a significant influence on performance exerted by the thigh and calf circumferences (Wyon et al., 2006). In this sense, Brown et al. (2007) argued that either plyometric and traditional weight training were effective to improve strength and power related variables in highly trained female (collegiate) dancers. At the same time, the authors highlighted how both the "ballon" (defined as the dancer's ability to hang suspended in the air during the jump) and the "overall jumping ability" (defined as the dancer's ability to create an aesthetically pleasing jump) are unaffected by supplemental conditioning such as weight and plyometric training (Brown et al., 2007).

However, to the authors knowledge, there are few studies investigating the dancers' aesthetic component in jumping. In particular, it has been claimed that the classical ballet jumping performance requires to combine the conditional aspects with the control of both technique and elegance of the execution, rather than being mainly focused only on maximal efforts. Considering how the jumps of the dancers are evaluated also from an aesthetic and qualitative point of view, it would be interesting to understand how they keep their jumping performance stable to follow the technical rules of the discipline and to create aesthetically pleasing jumps. Therefore, the aim of this study was double: a) to investigate the ability of female dancers to maintain stable jumping performances during three specific classical ballet jumps (as Changement de Pied, Echappé and Sissonne Fermé); b) to assess differences (if any) in jumping ability in relation to the different technical level of participants.

MATERIAL AND METHODS

Participants

A total of 22 female classical ballet dancers belonging to the same school were assigned to one of the two experimental groups: a) Expert, (EXP; n=12, age 17.7±3.4yrs), with at least 8 consecutive years of classical ballet experience; and b) Novice, (NOV; n=10, age 12±2yrs) whit an experience comprised between 2 and 4 years of study.

The mean characteristics of the dancers involved in this study are reported in Table 1.

All participants were recruited on voluntary participation and after the signature of their own or parental (when needed) informed consent. The study has been approved by the institutional review board (code CARD2018/22) of the University of Rome "Foro Italico" (Rome, Italy).

Procedures

Regarding the jumping procedures, both the experimental groups (EXP and NOV) performed three vertical jump protocols thought to reproduce real classical ballet jumps: 1) Changement de Pied (CHA) protocol, composed by 5 consecutive jumps. The starting position of the first jump is carried out from a demi plie in fifth position with the right foot in front, the dancer performs a jump while changing the foot position in the air and landing with the opposite foot in front in demi plie in the fifth position; 2) Echappé (ECH) protocol, composed by two consecutive 'Echappé' for a total of four jumps (each jump included a first jump from plié in fifth position to plié in second position and a second jump vice versa); 3) Sissonne Fermé (SF) protocol, where dancers jump starting from a fifth position, then changing legs in the air before landing laterally on one foot (with the second immediately following).

The three experimental protocols were repeated for two days (day 1 and day 2), with two trials executed for each one and the best performance considered for the statistics. In both day1 and day 2 after a standardized warm-up, consisting of a first part of "center barre" with specific exercises of dance barre without the barre ('plié', 'tendu', 'tendu jeté', 'rond de jambe', 'battement fondu', 'grand battement') and a second part with diagonals of small and medium jumps, the dancers were submitted the following order of tests: 1) Changement de Pied; 2) Echappé; 3) Sissonne Fermé.

Data were measured by means of the Optojump Next system (Microgate, Italy) and the following parameters (Opto Jump Next user manual, Version 1.12, http://www.microgate.it/Training/Support) were used to assess the dancers' performances: a) Height (H) defined as the height of jumps calculated with the following formula $h = Tf2 \cdot g8$; b) Jumping Point Gap (JPG) defined as the distance between the current Jumping Point and the previous, i.e. how much the centroid is displaced with respect to the previous jump. A value = 0 indicates the perfect repeatability of a jump (useful mainly for one-leg jumps), negative values indicate a displacement towards the drum (to the left for example), positive values indicate displacements in the opposite direction (to the right in this figure); in jumps with feet parallel to the bars indicate forward/back displacements; and c) Used Area (UA) defined as the difference in cm between the first and the last activated LED. It indicates how much the legs are apart.

Table 1: Descriptive characteristics (mean + SD) of the subjects (n = 22)

Subjects *(n)*	Weight *(kg)*	Height *(cm)*	Length right foot (cm)	Length left foot *(cm)*
Expert	51.2±6.4	162.8±6.4	22.7±0.8	22.7±0.8
Novice	44.7±10.7	153.6±9.8	22±1.3	22±1.3

Statistical Analyses

The analysis was carried out to investigate: a) differences between consecutive jumps performed in each trial for CHA and ECH; b) differences between Day 1 and 2 for CHA, ECH and SF; c) differences between levels of dancers (EXP and NOV).

Before using the parametric tests, the assumption of normality was verified using the Shapiro-Wilk test. Then, differences between consecutive jumps and experimental days with pooled data were analyzed by means of an ANOVA for repeated measures, while differences between experimental groups were assessed by means of an Independent Sample T-test. The level of significance was fixed as ($p \leq 0.05$). Statistical analyses were performed using SPSS

package (24.0 version; SPSS, Inc., Chicago, IL, USA).

RESULTS

The analysis of CHA showed no differences between consecutive jumps for H and UA, whilst differences were seen for JPG (p=0.003) [1st: 2.4±2.2; 2nd: 4.2±3.6; 3rd: 4.4±3.7; 4th: 5.1±4.9; 4.8±3.8 cm). No differences between day 1 and 2 were found for all parameters. Moreover, an approach to significance (p=0.52) and a difference (p=0.42) between groups (figure 1) were found for H (EXP: 12.3±2.3 and NOV: 14.6±3.3 cm) and JPG (EXP: 3.6±3 and NOV: 4.9±4.5 cm), respectively, while no differences were found for UA.

The analysis of ECH revealed main differences between jumps for H (p<0.001), JPG (p=0.003) and UA (p<0.001), post-hoc analysis showed differences (p<0.05) between each jump from the fifth position (with a larger occupied area) to the second one (with a smaller area) and vice versa for H and UA. No differences were found for all parameters between Day 1 and 2, while differences between groups (figure 2) emerged only for UA (p=0.001).

The analysis of SF, which was limited to assess differences between day 1 and 2 and level of dancers, showed no significant differences for all parameters.

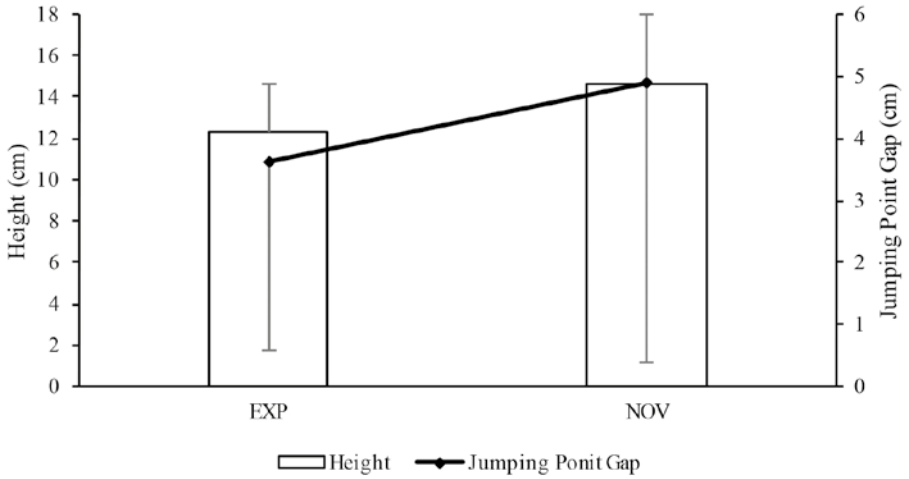

Figure 1: Differences between groups (EXP and NOV) for height and jumping point gap in CHA

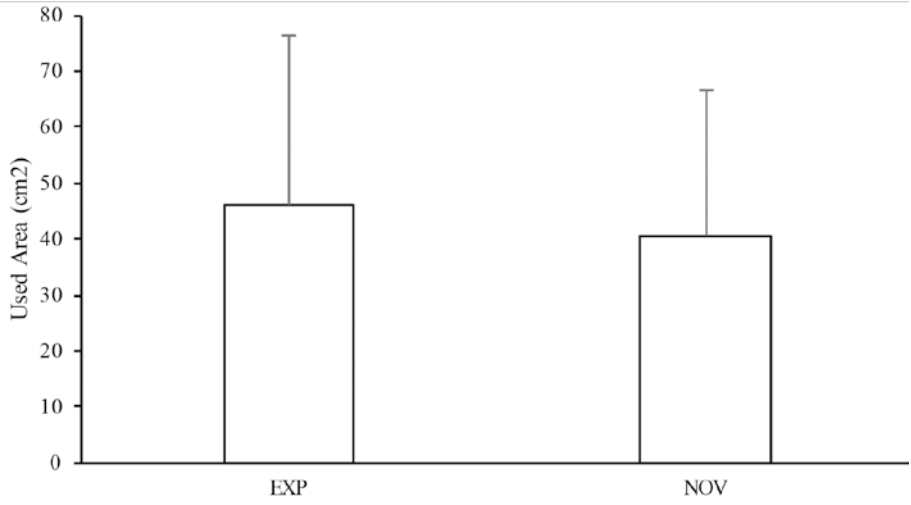

Figure 2: Differences between groups (EXP and NOV) for used area in ECH

DISCUSSION

This study had a double purpose: a) to investigate the ability of female dancers to maintain stable jumping performances during three specific classical ballet jumps (as Changement de Pied, Echappé and Sissonne Fermé; b) to assess differences (if any) in jumping ability in relation to the different technical level of participants.

In respect to the analysis of 'Changement de Pied', the assessment of stability of performance during five consecutive jumps, carried out with pooled data, showed the absence of significant

differences for height and used area, whilst a difference was seen for jumping point gap. Moreover, the analysis of performance in relation to the dancers' technical level showed an approach to significance and a difference between groups for height and jumping point gap, respectively. For the analysis of 'Echappé', the assessment of stability of performance (five consecutive jumps), carried out with pooled data, revealed main differences for height, jumping point gap and used area, while differences between groups emerged for used area.

In classical ballet the 'Changement de Pied' and 'Echappé', which are a sequence of small jumps, are used during a "petit allegro". The analysis of the five consecutive jumps that composed a CHA trial in our study revealed how all dancers performed them with a control of the jump height (H) and the area occupied by the feet between jumping and landing (UA). In fact, for this kind of jump is more important to maintain the aplomb (elegance) rather than producing the maximal effort (vertical height), and for this reason both our groups (EXP and NOV) were able to perform controlled jumps (Yuzurihara, 2013). However, the medio-lateral displacement (JPG) was significant for levels of expertise, with lower mean values registered for the EXP group. An explanation of this fact could be given by the higher ability of experienced dancers to perform an "aesthetically pleasing jump" where the ability to coordinate the release of strength is more important that the absolute employment of strength itself (Brown et al., 2007). Indeed, with experienced students, how in case of our EXP group, they perform an action mainly rising on the toes, then the sequence of jumps is done very rapidly limiting both pause and *"plié"* between jumps (Großhauser et al., 2012). In fact, it could be speculated that the higher the jumping height, the higher the JPG value. Moreover, the medio-lateral displacements are also influenced by the dancers' experience (Richardson et al., 2010). In fact, the NOV group showed both higher H and JPG values compared to the EXP one.

Differently from the CHA the analysis of the four consecutive jumps that compose our ECH test revealed significant differences for all parameters. However, is worthy to note that each trial of ECH was composed by two consecutive ECH and that each ECH jump included a first jump from plié in fifth position to plié in second position and a second jump vice versa. For this reason, the difference between jumps within an ECH has to be expected since the first jump comes from fifth position (closed feet) and the second one comes from a second position (open feet). The comparison of NOV and EXP groups shows a similar ability to perform ECH for H and JPG parameters, while a difference was found for UA. The fact that H and JPG were similar could be always explained by the dancers' tendency to control the elegance of the execution rather than producing the maximal effort. Instead, considering that in addition to the motion of the lower extremity (i.e. rotation, flexion, and extension abduction of hip; ankle flexion, etc.) (Kadel et al., 2005) also the lower limbs and feet lengths influence the stance and posture, it could be speculated that the difference for UA found in this study could be determined by anthropometric differences of the two groups (height 162.5±6.8 cm and 154.5±7.4 cm; feet lengths 22.4±0.8 cm and 22±1.1 cm for EXP and NOV, respectively).

The Sissonne Fermé jump is a very common and popular ballet step, seen in performances and throughout classes of most skill levels and it is part of the *"grand allegro"* (Sharykov, 2017). In our study, the analysis of SF showed no differences between experimental days and level of expertise for all parameters. In this form of ballet jump the lateral displacement is more influenced by the technique rather than the absolute level of strength. For this reason, despite not significantly, the JPG reached by the EXP group showed higher values, which could be speculated by their higher level of technique.

In a typical ballet class to facilitate the learning of technique of a Sissonne Fermé, this jump is usually taught in sequence with a "Changement de Pied". The rationale of this didactic choice is to make the student understand how use for the SF the same coordinated push of feet utilized for CHA. Moreover, this is also the reason why we included the SF in our study. Indeed, the results of this study show how the EXP group produces a better control of jumps' technique with lower and higher mean values for CHA and SF, respectively, compared to NOV group.

CONCLUSIONS

Our findings indicate that the jumping performance of female ballet dancers is characterized by an overall good control of technique and elegance of the execution, which is demonstrated by the fact that in consecutive jumps they tend to reduce the medio-lateral displacement. In particular the reduction of the centroid displaced, with respect to the previous jump, is more marked with expert dancers. Consequently, ballet teachers should help dancers to focus more on the core stability (i.e. training mainly the pelvic floor, transverse abdominis, multifidi spinae) in order to make understand the dancers that a jump performed during a ballet should "start" with the "activation" of these muscles (chains) before than stressing the counter movement to jump. Therefore, it means that dancers should be focused first on the postural control, rather than attempting to produced maximal efforts.

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