TIME MOTION AND PERFORMANCE ANALYSIS IN TANGO DANCE

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ANALIZA GIBANJA IN PLESNEGA NASTOPA V TANGU

ABSTRACT

The aim of this study was to investigate the movement and choreography characteristics between four different quality groups in tango. Thirty-five dance couples competing in an international competition in the adult category were selected for analysis. The total time and average speed in each direction of movement and the number of changes of direction were compared between four different quality groups. The average speed of the movement and choreography path was 1.14 ± 5.1 m/s and 77.56 ± 11.1 m, respectively. Dancers mostly danced in line of dance (LOD) (M = 10.74 ± 5.2 s), diagonal to the center (DC) (M = 9.96 ± 4.5 s), and diagonal to the wall (DW) (M = 8 ± 3.1s). Although no significant differences were found, the time spent dancing in LOD decreased with the more successful quality group. Significant differences between the quality groups were found in the speed of movement in LOD direction ($\chi2$ = 9.4, df = 3, p = 0.024), which decreased with the more successful quality group. Dancers made an average of 26.31 ± 3.4 changes in direction. Statistical differences were found between the quality groups ($\chi2$ = 7.7, df = 3, p = 0.04). This is the first detailed study in tango analyzing the characteristics of movement and choreography. The quality groups differ in the speed of movement in some directions of movement and in the number of changes of direction. The results presented can help choreographers and coaches to adequately design the physical preparation of the dancers, the structure of the choreography and the technical and tactical requirements**.**

Keywords: DanceSport, tango, performance analysis, aesthetic sports

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IZVLEČEK

Cilj te študije je bil preučiti gibalne in koreografske značilnosti med štirimi različnimi kakovostnimi skupinami v tangu. V analizo je bilo vključenih petintrideset plesnih parov, ki so tekmovali na mednarodnem tekmovanju v članski kategoriji. Skupni čas, povprečna hitrost v različnih plesnih smereh in število sprememb smeri gibanja, smo primerjali med štirimi različnimi kakovostnimi skupinami. Povprečna hitrost gibanja in opravljena pot sta bili 1,14 ± 5,1 m/s in 77,56 ± 11,1 m. Plesalci so večinoma plesali v plesni smeri (PS) (M = 10,74 ± 5,2 s), diagonalno proti centru plesišča (DC) (M = 9,96 ± 4,5 s) in diagonalno iz centra plesišča (DV) (M = 8 ± 3,1s). Čeprav ni bilo statistično značilnih razlik, se je čas gibanja v PS zmanjševal z uspešnejšo kakovostno skupino. Statistično značilne razlike med skupinami so bile v hitrosti gibanja v PS ($\chi2$ = 9,4, df = 3, p = 0,024), ki so se zmanjšale z uspešnejšo skupino. Plesalci so v povprečju naredili 26,31 ± 3,4 sprememb smeri gibanja, med skupinami pa so bile statistično značilne razlike ($\chi2$ = 7,7, df = 3, p = 0,04). To je prva podrobna študija, ki je preučevala značilnosti gibanja in koreografije v tangu. Kakovostne skupine so se razlikovale po številu sprememb smeri gibanja in po hitrosti gibanja v nekaterih plesnih smereh. Predstavljeni rezultati so lahko v pomoč koreografom in trenerjem pri oblikovanju ustreznega trenažnega procesa za izboljšanje telesne pripravljenosti plesalcev, pridobitvi dodatnega tehničnega in taktičnega znanja ter pri sestavi koreografije.

Ključne besede: Športni ples, tango, analiza nastopa, estetski športi

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INTRODUCTION

DanceSport consists of Latin-American and ballroom dances, both of which include five dances that contribute equally to the final results. In the ballroom dances of Waltz, Tango, Viennese Waltz, Slow Foxtrot and Quickstep, dancers assume a close holding position and move anticlockwise across the dance floor. Each dance has unique steps and figures. Tango differs from other ballroom dances in that it does not contain fluid movements with raising and lowering of the center of gravity and swing. The dancing posture in tango is compact and the knees are bent, with no flowing or smooth movements (Rayner, 2012). Characteristic of the tango are sharp body movements and standing positions, fast body rotations and changes of direction, danced at a tempo of 31 - 33 beats per minute. Dancers in tango follow an anticlockwise trajectory, dancing zigzag from the edge to the center of the dance floor, and use rapid accelerations and stops (Howard 1976; Laird and Laird 2009).

Performance analysis in dance is mostly based on the exploration of elements of movement and choreography. Zaletel, Vučković, James, Rebula, et al. (2010) found that the average movement speed in tango is 1.02 m/s, which is the slowest compared to other ballroom dances. They also reported differences in movement between adult and youth dancers. The average movement speed and distance covered in adult dancers are 1.12 m/s and 109.33 m, respectively, while youth dancers dance at an average speed of 0.82 m/s and travel a distance of 76.33 m. Angioi, et al. (2007) analyzed dancer performance to determine the physical and physiological demands of modern dance and to develop a method for analyzing dance performance. Fifty observed modern dancers danced an average of 14.75 ± 14.43 minutes and made 0.5 ± 0.48 directional changes per minute. Twitchett, et al. (2009) studied the physical demands of a classical ballet performance and examined the differences between artists, soloists, and principal dancers. They analyzed work intensity, body movement, partnering, and number of transitory movements. The results showed that the most physical demands are required of principal dancers. Wyon, et al. (2011) found significant differences in exercise intensity, directional changes, and specific choreography elements between classical and modern dancers. Ballet dancers and modern dancers performed 6.14 ± 5.68 min and 5.41 ± 6.47 min, respectively, at high intensity, including fast runs, high jumps, and lifts. Ballet dancers made significantly more changes of direction (M = 3.34 ± 1.86) than modern dancers (M = 0.58 ± 0.58).

In recent research, various methods have been used for motion capture and data preprocessing that allow more precise measurements (Protopapadakis et al., 2018). Laban Movement Analysis is the most commonly used analysis system that aims to identify style qualities in dance movements. The algorithm used captures the four components (Body, Effort, Shape, Space) and can be used to compare and evaluate movements (Aristidou, Stavrakis, et al., 2015). Body sensors to measure body postures and analyze movements in dance are also a commonly used method (Kitsikidis et al., 2014; Bakalos et al., 2018). Extraction of skeletal data contains a considerable amount of information for the analysis of different choreographies (Rallis et al., 2017). The analysis of choreographic sequences is an extremely complicated task due to many factors such as the dancer's emotions, motion capturing systems, and calibration issues (Aristidou et al., 2018; Aristidou, Charalambous, et al., 2015). Nowadays, machine learning offers many opportunities for analysis, classification, semantic annotation, and emotional understanding of human choreographic movements (Rallis et al., 2020).

Few studies investigated performance analysis in DanceSport. Zaletel, Vučković, Rebula et al. (2010) researched movement characteristics in some ballroom and Latin American dances. They found that the trajectory and speed of movement between male and female dancers in ballroom dance are almost the same, so it is not necessary to track them separately. In Latin American dance, however, the trajectory and speed of movement differ between male and female dancers. Zaletel, Vučković, James et al. (2010) found that adult dancers move faster than youth dancers in all ballroom dances. Prosen, et al. (2013) investigated choreography characteristics in Viennese waltz between two quality groups and found that top ranked dancers performed all turns at similar movement speed and significantly faster in reverse turns on curved trajectory compared to the lower ranked dancers.

However, there is no detailed research on dance performance, movement characteristics, and directional changes in tango. Since tango has a specific zigzag movement on the dance floor and its choreography consists of more changes of direction compared to other ballroom dances, it is necessary to study its movement characteristics and choreography in detail. Comparing dancers of different quality gives dancers and coaches information about good choreography structure and movement characteristics in tango that can help them improve their performance. Therefore, the aim of this study was to find out in which movement directions the dancers danced most frequently, and to analyze the time spent and speed of movement in each direction. In order to analyze the dancers' movement skills on the dance floor and the differences in the choreography structure in tango, the number of changes of movement directions was also analyzed and compared between four different quality groups.

METHODS

Participants

Thirty-five dance couples competing in the adult category (over 19) of the high-level IDSF International Open dance competition were selected for analysis. The dance couples were divided into four quality groups (QG): Finalists (QG1 = 6), Semifinalists (QG2 = 6), Quarterfinalists (QG3 = 11), and Round of 16 Finalists (QG4 = 12).

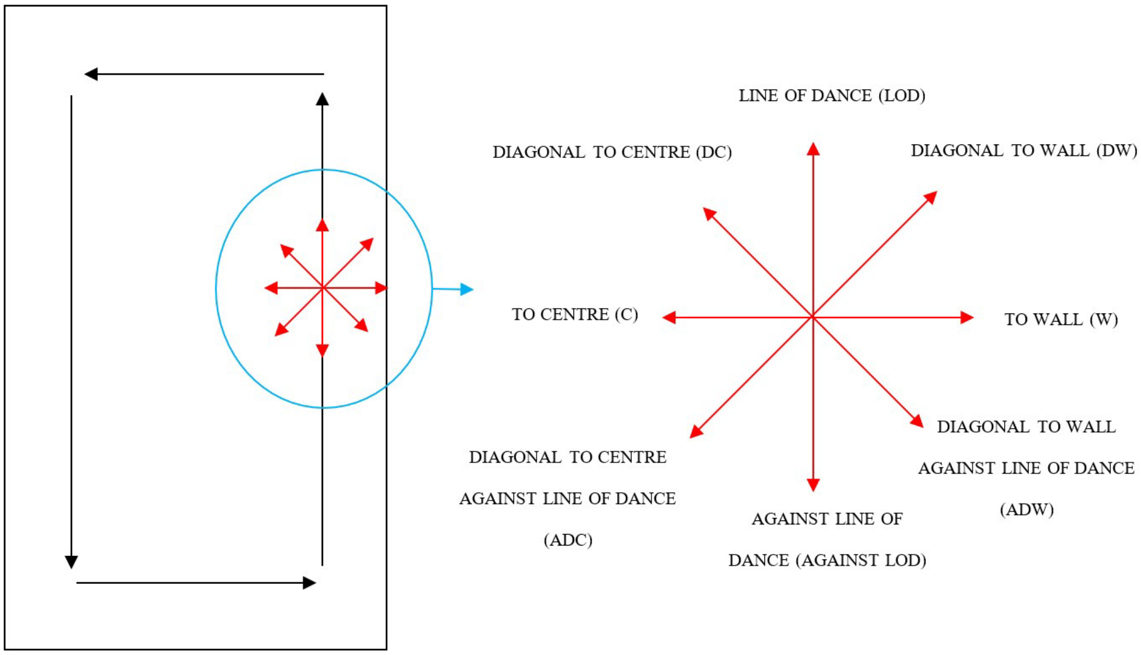
Ethical approval was granted by the Faculty of Sport of the University of Ljubljana and informed consent was obtained from all participants.

Procedures

All dances were recorded using a fixed analog PAL video camera (JBL UTC – A6000H, Korea), fastened to the ceiling in the center of the dance floor, its wide-angled lens (2.3 mm – 6.0 mm, Kenko, Japan) adjusted to cover the entire dance floor, which was 26 m x 15 m. The video signal was recorded directly to DVD+R disc, using a Phillips DVD recorder, yielding a digital MPEG2 encoded file which was transferred to a personal computer. Before further processing the video was de-interlaced and resampled to a resolution of 352x288 pixels and frame rate of 25 frames per second. Spatial calibration was performed to provide plane-to-plane mapping of image pixel locations into the world coordinate system of the dance floor. This video was processed automatically using state-of-the-art computer vision tracking algorithms (Kristan et al., 2009) under the supervision of the operator, who was responsible for detecting and correcting any mistakes made by the automated tracker. Every couple was tracked from the beginning until the end of their tango dance. Output from the tracking software was further processed, as detailed by Perš, et al. (2002), to yield speed and path length information. A second camera was located by the side of the dance floor to facilitate annotation of the details of the dancers' posture relationships. These digital images were transferred into the same computer and temporally synchronized with the video from the top-view camera. The operator manually annotated these images. All processed data were stored using Microsoft Access software and filtered using SQL queries.

During the performance, the dancers can stand on the same square (SS) and show elegant postures or typical tango head turns. They can dance in the same place and turn around (dance still (DS)) or they can dance anticlockwise in the chosen direction across the dance floor. There are eight directions of movement in DanceSport (Figure 1). The change of direction was noted when the dance couple took the first step in the new direction.

Figure 1. Directions of movement in DanceSport.



The differences between the quality groups are shown in three directions (LOD, DC, DW), mostly used in dance, and in the variables DS and SS.

Statistical Analysis

Data analyses were performed using the SPSS statistical package (v 21.0), and data were divided into four quality groups. Dependent variables were the total time (s) and average speed (m/s) of each direction of movement, the time (s) and average speed (m/s) in a single phase of the direction of movement, and the number of changes in direction. Descriptive analyses and MANOVA were carried out. The Kruskal-Wallis test was used to determine differences between quality groups for variables that were not normally distributed. Statistical significance was accepted at $p < 0.05$.

RESULTS

The average time, speed of movement, and path of choreography were 68.25 ± 5.1 s, 1.14 ± 5.1 m/s, and 77.56 ± 11.1 m, respectively. The time of dancing and the path differed among dancers, because some dancers started dancing as soon as the music started, while others started slightly later (Table 1). Although no significant differences were found between the quality groups (QG), QG1 danced the slowest.

Table 1. Average speed of movement, path and choreography time of each quality group (QG).

Quality group	Average speed of movement (m/s)	Path (m)	Choreography time (s)
QG1	1.05 ± 0.1	68.58 ± 7.6	65.61 ± 5.2
QG 2	1.17 ± 0.2	80.08 ± 12.7	68.7 ± 3.75
QG 3	1.16 ± 0.2	78.76 ± 13.5	67.95 ± 4.8
QG 4	1.15 ± 0.1	79.69 ± 7.8	69.71 ± 6
All	**1.14 ± 0.1**	**77.56 ± 11.1**	**68.28 ± 5.1**

*Numbers are mean ± SD

Most of the time, the dancers stood in the same place and performed head movements and line positions (M = 21.38 ± 6.3 s). Between several positions, they danced on the same square (M = 10.4 ± 5.4s). When moving counterclockwise, all dancers mostly used three directions, the line of dance (LOD) (M = 10.74 ± 5.2 s), the diagonal to the center (DC) (M = 9.96 ± 4.5 s), and the diagonal to the wall (DW) (M = 8.0 ± 3.1s). Only 20 dancers were used for the other directions. Although no significant differences were found, the time danced in LOD decreased with the more successful quality group. QG1 and QG2 also danced longer DC than in LOD and DW. In contrast, QG3 and QG4 danced longer in LOD than in DC and DW (Table 2).

Table 2. Time of dancing in each movement direction for quality groups.

Movement direction/ Quality group	LOD	DC	DW	DS	SS	OTHER
QG1	11	14.97	11.77	16.27	33.59	12.4
QG2	14.53	19.1	12.78	15.34	29.99	8.26
QG3	16.68	14.61	10.75	18.10	26.56	13.3
QG4	17.71	12.19	12	12.12	35.16	10.82
All	**15.73**	**14.6**	**11.71**	**15.23**	**31.32**	**11.41**

*Numbers as percent/portion (%)

The longest time in a single phase of the direction of motion had the DC (M = 3.71 ± 1.1 s). They were shorter for DW (M = 2.86 ± 1 s), LOD (M = 2.74 ± 1 s), DS (M = 2.64 ± 1 s), and SS (M = 2.31±0.8 s). No significant differences were found between the quality groups.

Dancers moved faster toward DC (M = 1.81 ± 0.3 m/s) compared with DW (M = 1.67 ± 0.2 m/s), LOD (M = 1.58 ± 0.3 m/s), and DS (M = 0.73 ± 0.2 m/s). Significant differences between the quality groups were found at LOD ($\chi 2 = 9.4$, df = 3, p = 0.024). The speed of movement in LOD decreased with the more successful quality group. QG1 and QG2 moved faster in DC and DW than in LOD. These results show the fastest zigzag movement on the dance floor, which is typical for tango dance. QG3 moved the slowest in DW compared to other quality groups, and QG4 had the smallest differences in movement speed between LOD, DC, and DW compared to other quality groups (Table 3)

Table 3. Speed of movement in each direction for quality groups.

Movement direction (m/s)/ Quality group	LOD	DC	DW	DS
QG1	1.37 ± 0.4	1.75 ± 0.3	1.72 ± 0.2	0.64 ± 0.1
QG2	1.42 ± 01	1.88 ± 0.3	1.82 ± 0.2	0.72 ± 0.2
QG3	1.61 ± 0.3	1.84 ± 0.3	1.54 ± 0.3	0.74 ± 0.2
QG4	1.74 ± 0.2	1.77 ± 0.3	1.7 ± 0.2	0.77 ± 0.1
All	**1.58 ± 0.3**	**1.81 ± 0.3**	**1.67 ± 0.2**	**0.73 ± 0.2**

*Numbers are mean ± SD (m/s)

Dancers made an average of 26.31 ± 3.4 directional changes. Statistical differences were found between the quality groups ($\chi2 = 7.7$, df = 3, $p = 0.04$). QG1 made the fewest directional changes (M = 23.33 ± 1.5) compared to other quality groups (QG2; M = 27 ± 3.6, QG3; M = 27 ± 3.6, QG4; M = 26 ± 3.8).

DISCUSSION

The purpose of this study was to examine movement and choreography characteristics in tango and to find out if there are differences in dance performance between quality groups. Few studies investigated movement characteristics in DanceSport (Zaletel, Vučković, James, et al. 2010, Prosen et al. 2013). Zaletel, Vučković, James, et al. (2010) found that adult dancers in tango move faster and use more zigzag trajectories than youth dancers. However, the present study is the first study to investigate the characteristics of choreography in tango and compare different quality groups. Most of the time, dancers stood in the same place (31%) and performed fast head movements and line positions typical of tango. Between these standing positions, they often danced on the same square (15%), waiting for free space to change their movement direction. Dancers mostly used three directions of movement, LOD (16%), DC (15%), and DW (12%). Although the differences between the quality groups were not significant, the time danced in LOD decreased with the more successful quality group. Q3 and Q4 also danced more time in LOD than in DC and DW directions, which was not the case for Q1 and Q2. Rebula (2011) found similar results that higher quality dancers used fewer circular trajectory compared to lower quality dancers. In addition, Zaletel, Vučković, James, et al. (2010) found that adult dancers were more likely to use a zigzag trajectory than a circular trajectory. On contrary youth dancers mostly use a circular trajectory. Movement to DC and DW (zigzag) direction require a high degree of skill to move between other couples on the dance floor and the ability to adapt the choreography to different situations. Lower quality dancers should reduce the amount of time they dance in the circular trajectory and incorporate more zigzag movements.

Differences between the quality groups were also noted in the speed of movement in the different directions of movement. Q1 and Q2 moved with similar speed in DC and DW and significantly slower in LOD compared to QG3 and QG4. This shows the emphasis on zigzag movement, which apparently lower quality dancers (Q3 and Q4) are not capable of. Similarly, Prosen, et al. (2013) reported that higher dancers in Viennese waltz had a more similar speed for natural and reverse turns than lower dancers, allowing for fluid and smooth movements typical of waltz. Circular movements in tango allow for greater speed compared to zigzag movements, as dancers moving DC or DW cross the trajectory of other dancers. Higher quality dancers are able to maintain a similar speed of movement in both DC and DW, while lower quality dancers use a higher speed of movement in LOD. Better quality choreographies obviously contain faster zigzag movements and slower movements in the line of the dance. Differences in the speed of the zigzag movement and the movement in the line of the dance provide more dynamics in the choreography, which makes the choreography more attractive and making the dancers more visible among the other dancers on the dance floor.

Significant differences were found in the number of changes in movement direction. QG1 has fewer direction changes compared to the other quality groups. Tango is a dynamic and varied dance, but to present these characteristics of tango, it is not necessary to use a greater number of changes of direction. This can be presented by using steps and figures with different tempos, different line positions, accelerations, and reductions in speed. Fewer changes of direction of movement can also show good floor craft. Better quality dancers are able to continue dancing in the same direction and adjust their choreography even when other dancers cross their movement path, and they are also able to anticipate the movement path of other dancers.

Lower quality dancers often use fixed routines in which they place their choreography in exactly the same place each round (Hurley, 2012). Lower quality dancers could improve their movement skills and floor craft by knowing the basic and standard figures to incorporate when they need to adjust their choreography because other couples cross their trajectory. A good dancing hold, posture, and partnering skills that allow the female dancer to respond to a possible sudden change in choreography or direction of movement without detracting from a beautiful performance and musicality. Dancers need to improve their ability to anticipate the direction of movement of other couples on the dance floor and find an alternative space in which to proceed to the next figure. To improve this, coaches should ensure that more dance couples participate in training sessions so that dancers have the opportunity to practice floor craft.

The results of this study suggest that coaches and dancers should pay more attention to the following parts. First, the choreography should include faster elements when moving in the zigzag direction. Slower elements should be presented in the line of the dance. Second, fewer changes of movement directions should be used and movement diagonally to the center should continue longer without stopping. These suggestions can be achieved through the proper selection of elements of the choreography that the dancer can perform, taking into account his physical preparation and technical and tactical skills. The movement skills could be improved by sufficient training conditions, for example, by simulating the competition with more quality couples on the dance floor.

This study has some limitations. The sample of participants is small because we wanted to divide the dancers into different quality groups based on their results at the same competition. Since dancers have different choreography elements, we only measured those that all dancers incorporated into their performance. If more characteristics of movement and choreography were measured, we would get a more comprehensive picture and a better quality perspective of good floor craft and structure of choreography. Therefore, further studies should focus on more details of movement characteristics, such as accelerations and decreases in movement speed as a result of other dancers on the floor, and examine more of those choreography elements that most dancers incorporate into their choreography. New methods already used for movement analysis in other dances should also be used in DanceSport.

CONCLUSION

This is the first study in tango to analyze the characteristics of movement and choreography, and it makes an important contribution to DanceSport. The differences found between quality groups can help dancers and coaches to better understand the structure of good choreography and the movement requirements. Proper physical preparation of the dancer, the structure of the choreography, and technical and tactical knowledge can make an important contribution to the dancer's success.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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