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Study Regarding Coordination at Landings Performed in Women's Artistic Gymnastics

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Abstract

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The purpose of this study was to investigate the existing correlations between intersegmental coordination and the scores obtained by the athletes for the technical element – landing in artistic gymnastics. The subjects who took part in this study were 21 female athletes aged between 9-10 years, practicing artistic gymnastics. The RCMV test included in the PSISELTEVA battery, developed by RQ Plus, was used to assess intersegmental coordination expressed by certain psychomotor parameters (perceptual-motor learning ability, performance coefficient, personal optimum rhythm, resistance to disruptive factors and resistance to time pressure). Using the Spearman correlation, there were highlighted important relations between the results obtained in RCMV test by the female athletes practicing artistic gymnastics and the scores for the technical element – landing (in the case of vault and uneven bars). The analysis of the results indicates that there is a positively significant correlation between the following psychomotor parameters: perceptual-motor learning ability, performance coefficient, resistance to time pressure and the scores obtained by the female athletes for landing (in the case of vault). Also, there is a negatively significant correlation between the personal optimum rhythm coefficient and the results for landing (vault). Consequently, the results indicate that the development of intersegmental coordination can positively influence the technical element – landing of the female athletes practicing artistic gymnastics.

Keywords: Intersegmental coordination; landing; vault; uneven bars; artistic gymnastics.

1. Introduction

The importance of intersegmental coordination, as a component part of the psychomotor domain, has become over the last few years a greater point of interest and undoubtedly represents a challenging topic of investigation. Coordination is the ability to execute smooth, accurate, controlled movements (O'Sullivan, Schmitz, & Fulk, 2014: 206). Coordinated movement involves multiple joints and muscles that are activated at the appropriate time and with the correct amount of force, so that smooth, efficient

and accurate movement occurs. Thus, the essence of coordination is the sequencing, timing and grading of the activation of multiple muscle groups (Schumway-Cook & Woollacott, 2012: 121). Coordinated movements are characterized by proper speed, distance, direction, rhythm and muscle tension (Raj, 2006: 60), and they also involve a high proportion of perception, anticipation and concentration (Schreiner, 2000: 7).

Furthermore, specialized literature (Aniței, 2007: 123) reveals the importance of coordinated movements as an indicator that allows a correct evaluation of instrumental movements (those movements associated with manipulation of devices, tools, machines, movements that can be done at superior indices of precision, dexterity and timing). Coordinated movements represent a distinct category of instrumental movements, which give the subject the possibility to economize effort, motor action, in predictable (stereotypical) and unpredictable (of adjustment) situations. The level of movement coordination is influenced by the level of knowledge of motor skills, as well as by the disruptive factors or the desultory characteristics of the environment. The quality of coordination is influenced by the position of the subject – the precision of manipulation movements is maximum for the objects set in front and below the shoulder level. Coordination difficulties manifest through: temporal discrepancies between information processing and motor act execution, errors of non-synchronization of individual movements, order errors (inversions or substitutions of movements) or commutative errors (persevering with the previous movement, interferences between movements). Together with other motor capacities, coordination plays a vital role in successful athletic performance (Ackland, Elliott, & Bloomfield, 2009: 211). Artistic gymnastics can be globally defined as a discipline which involves that the athletes perform routines on different apparatus and requires advanced motor skills: endurance, strength, flexibility, coordination and body control (Werner, Williams, & Hall, 2011: 5). The gymnastics "game" is played by performing combinations of technical elements, joining isolated skills together (speed, strength, balance, coordination etc.) to create a unit that will lead to success (Mitchell, Davis, & Lopez, 2002: 15). Landing, in modern gymnastics, is one of the most important factors which determine the final rank of gymnasts at competitions (Marinsek & Cuk, 2008). A successful landing depends on the physical fitness (preparation) and motor control of the gymnast. Physical preparation refers to the gymnast's ability to cope with the load to which they are exposed during the landing. Motor control refers to the control the gymnast has over the skill they perform. Both of these factors enable successful and safe landings (Marinsek, 2010). The Vault apparatus is one of the most dynamic and spectacular events found in the Artistic Gymnastics competition program. This event requires the athletes to have special qualities: power, speed, coordination, spatial and temporal orientation (Manos, 2008: 110). Uneven bars is the apparatus requiring optimal physical, technical and psychological training of the gymnast, expressed by a good sense of the bar and spatial and temporal orientation, courage and self-confidence, so that the spectacular character and the dynamism of execution in competition confirms the training preparation results (Potop, 2006: 167).

The purpose of the study consists in investigating intersegmental coordination expressed by certain psychomotor parameters (perceptual-motor learning ability, performance coefficient, average complex reaction time, personal optimum rhythm, resistance to disruptive factors and resistance to time

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pressure) and the scores obtained by the athletes for the technical element – landing (in the case of vault and uneven bars) in artistic gymnastics.

2. Materials and methods

2.1. Participants

A number of 21 female athletes, aged 9-10 years, practicing artistic gymnastics and having a competitive experience comprised between 1 and 2 years participated in the study.

2.2. Devices and materials

The devices and materials used in the study were: the computer (only fulfilled the role of support in computerized testing) – the participants did not provide any response to the test using the keyboard or mouse (they viewed the standardized training on the computer monitor); the computerized RCMV test, within PSISELTEVA tests, developed by RQ Plus – this test involves the use of levers and pedals (the movements associated with device manipulation – levers, pedals are known as instrumental movements). Today, the use of computer technology ensures the accuracy of registrations.

2.3. Procedure

The computerized RCMV test was performed by the athletes on the same day and in the same moment of the day – in the afternoon. The participants were tested without previously practicing any exercise (being in a rest state).

The RCMV test consists in displaying a software made up of different images that present, at variable time intervals and in a randomized order, square-shaped relevant stimuli positioned centrally-left/-right, upward/downward, as well as a green-coloured circle positioned upward-right, which becomes red at variable time intervals. The subject must respond through a motor reaction of the upper limbs (button pressing) and lower limbs (pedal pushing), by a homogeneous/heterogeneous bi-segmental or multi-segmental combination, depending on the number and position of the displayed squares. The red circle in the upward-right corner claims the one-segmental movement of the hand. The test is individually applied and lasts about 10 minutes.

The coefficients (investigated in our study) provided by the battery software are: perceptual-motor learning ability (rapid adaptation of movements to new perceptual conditions), performance coefficient (a qualitative measure statistically calculated by relating the correctly issued responses to the test time), personal optimum rhythm (a qualitative measure statistically calculated by correlating the number of errors to the total number of stimuli), resistance to disruptive factors (when facing a problem - unpredictable appearance of signal-stimuli, distraction - the subject gives correct responses) and resistance to time pressure (ability to perform motor tasks under stress conditions expressed by increasing the dynamics of situations). The results obtained by the female athletes practicing artistic gymnastics in RCMV test were correlated to the scores obtained by the athletes for the technical element – landing (in the case of vault and uneven bars).

2.4. Description of the technical events

2.4.1. Vault

Handstand on the vault table facing the movement direction, snap down, landing at fixed point (Fig. 1) and maintaining the landing.

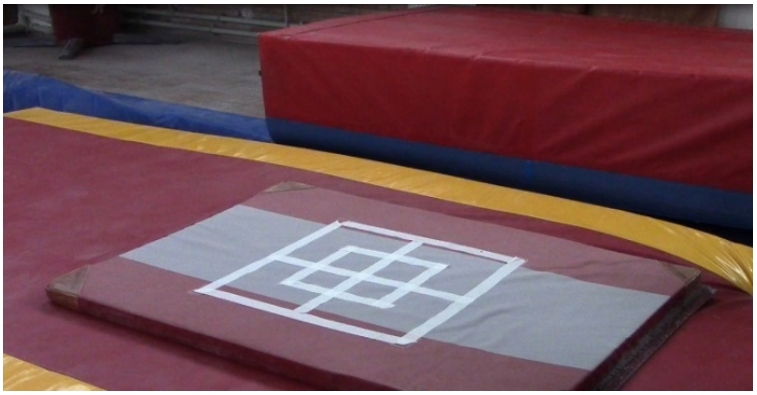

Fig. 1. Fixed point landing in the vault event

2.4.2. Uneven bars

Hanging on the upper bar, forward swing, backward swing, forward swing with 180° turn, bar releasing, landing at fixed point and maintaining the landing.

2.4.3. Point awarding

For the following technical events, in women's gymnastics apparatus - Vault, Uneven bars, the score for landings was obtained from the points awarded for the area where the athlete has landed (fixed point landing) and the points awarded for penalty tenths (Fig. 2). For the landing area, the points were given as follows:

- Landing in area 1 – 5 points;
- Landing in area 2 – 4 points;
- Landing in area 3 – 3 points;
- Landing in area 4 – 2 points;
- Landing in area 5 – 1 point;
- Landing in area 6 – 0 points.

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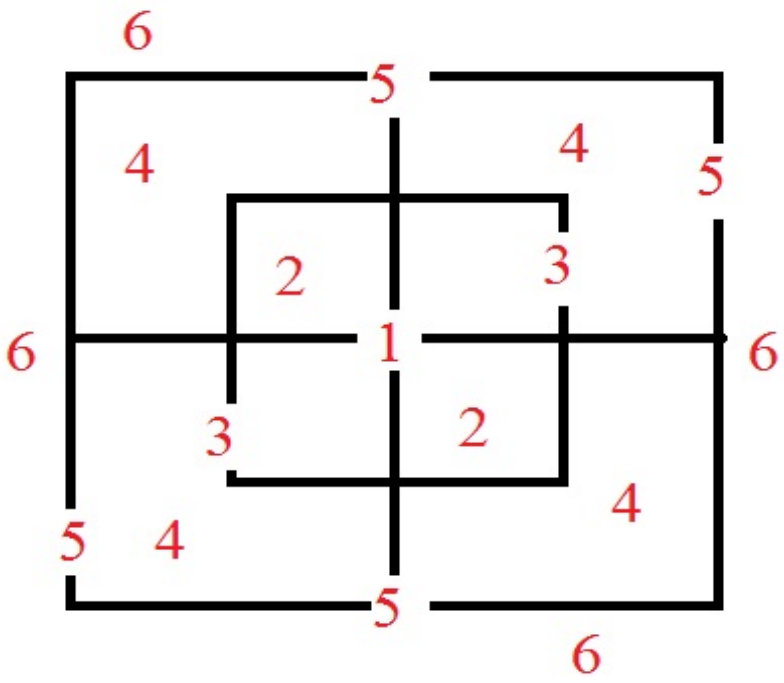

Fig. 2. Landing areas

For every one-tenth of the penalty, points were awarded on a scale from 10 to 0 corresponding to each penalty size, starting with 0.00 penalty points up to 1.00 penalty point (penalty - 0.00 - 10 points, 0.10 - 9 penalty points, and so on, 1.00 - 0 penalty points).

3. Results

Preliminary data analysis (box-plot charts) has emphasized that in the case of the results obtained in RCMV test (perceptual-motor learning ability, performance coefficient, personal optimum rhythm, resistance to disruptive factors and resistance to time pressure) and in the case of the scores obtained by the female athletes for landing (vault and uneven bars), there were no excessive values – marginal or extreme ones.

Using the Spearman correlation, we have verified if there were any relations between the results obtained for RCMV test by the female athletes practicing artistic gymnastics and the scores for the technical element – landing, in the case of vault (Table 1) and uneven bars. The following conditions for the application of Spearman correlation are fulfilled (Labăr, 2008: 87): both variables are ordinal or one of them is quantitative and the other ordinal; the sample does not have a large volume (21 subjects); the scores of a variable are monotonously related to the scores of the other variable, meaning that, once the values of a variable register growth, the values of the other variable will also grow (decrease) – but not necessarily in a linear manner.

Table 1. Results for RCMV test and the scores obtained by the female athletes practicing artistic gymnastics for the technical element – landing (in the case of vault)

Variables	Athletes	Mean	Standard Deviation	Standard Error	Landing (vault) Spearman's rho Correlation Coefficient
landing (vault)	21	11.62	2.18	.48	1.000
perceptual-motor learning ability	21	0.48	.257	.056	0.540*
performance coefficient	21	0.39	.116	.025	0.628**
personal optimum rhythm	21	0.31	.199	.092	-0.448*
resistance to disruptive factors	21	1.03	.552	.012	0.257
resistance to time pressure	21	0.56	.290	.063	0.489*

***. Correlation is significant at the .01 level (2-tailed).* **. Correlation is significant at the .05 level (2-tailed).*

The analysis of the results indicated in Table 1 emphasizes that:

- There is a positively significant correlation (0.540) between perceptual-motor learning ability (rapid adaptation of movements to new perceptual conditions) and the scores obtained by the female athletes for the technical element – landing, in the case of vault ($p< 0.05$);

As for correlation, a proper indicator for the effect size index is the determination coefficient (r^2) whose value is 0.29. We can say that 29% of the variation of the two variables is common, the rest being due to other influences. It means that the relation between the perceptual-motor learning ability and the technical element – landing, in the case of vault, is moderate.

- There is a positively significant correlation (0.628) between the performance coefficient (a qualitative measure statistically calculated by relating the correct and wrong responses to the test time) and the results of the female athletes for the technical element – landing, in the case of vault ($p< 0.05$);

The determination coefficient (r^2) has a 0.39 value, meaning that the relation between the performance coefficient and the results of the female athletes for the technical element – landing, in the case of vault, is moderate to strong.

- There is a positively significant correlation (0,489) between the resistance to time pressure coefficient (ability to perform motor tasks under stress conditions expressed by increasing the dynamics of situations) and the results of the female athletes for the technical element – landing, in the case of vault ($p< 0.05$);

The determination coefficient (r^2) has a 0.23 value, meaning that the relation between the resistance to time pressure coefficient and the scores obtained by the female athletes for the technical element – landing, in the case of vault, is moderate to low.

- There is a negatively significant correlation (-0.448) between the personal optimum rhythm coefficient (a qualitative measure statistically calculated by correlating the number of errors to the total number of stimuli) and the results of the female athletes for the technical element – landing, in the case of vault ($p< 0.05$);

The determination coefficient (r^2) has a 0.20 value, meaning that the relation between the personal optimum rhythm coefficient and the results of the female athletes for the technical element – landing, in the case of vault, is moderate to low.

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Table 2. Results for RCMV test and the scores obtained by the female athletes practicing artistic gymnastics for the technical element – landing (in the case of uneven bars)

Variables	Athletes	Mean	Standard Deviation	Standard Error	Landing (uneven bars) Spearman's rho Correlation Coefficient
landing (uneven bars)	21	10.76	2.05	.45	1.000
perceptual-motor learning ability	21	0.48	.257	.056	-0.024
performance coefficient	21	0.39	.116	.025	-0.026
personal optimum rhythm	21	0.31	.199	.092	0.067
resistance to disruptive factors	21	1.03	.552	.012	-0.089
resistance to time pressure	21	0.56	.290	.063	-0.084

The analysis of the results indicated in Table 2 emphasizes that:

For the perceptual-motor learning ability coefficient, performance coefficient, personal optimum rhythm, resistance to disruptive factors and resistance to time pressure coefficients, we have found that there is no correlation with the results obtained by the female athletes practicing artistic gymnastics for the technical element – landing, in the case of uneven bars ($p > 0.05$).

4. Discussions and conclusions

It is considered that the understanding of sports principles and bases, although improved, is still marginal, with gaps in knowledge about technique attributes throughout the sport (Prassas, Kwon, & Sands, 2006). For this reason, the present study aimed to identify some of the variables contributing to successful performance. Our research revealed the existence of several positively significant statistical correlations between the intersegmental coordination, expressed by certain psychomotor parameters: perceptual-motor learning ability, performance coefficient, resistance to time pressure coefficient, and the scores registered by the female athletes practicing artistic gymnastics for the technical element – landing (in the case of vault). Also, the obtained results demonstrate that there is a negatively significant correlation between the personal optimum rhythm coefficient and the scores obtained by the athletes for landing, in the case of vault. The results obtained by the athletes for landing, in the case of vault, are related to the ability of rapidly adapting the movements to new perceptual conditions, to the ability of performing motor tasks under stress conditions expressed by increasing the dynamics of situations and also to the smaller number of errors in tasks requiring intersegmental coordination. Our research underlines that the development of intersegmental coordination influences the results for landing, in the case of vault. This may positively influence the athletes' evolution during the competition, which requires coordinated and flawless movements and executions. Specialized literature mentions that, in gymnastics, it is very important to develop the intersegmental coordination, among other motor skills, because of the high variety and difficulty of movements performed by the athletes, which make this sport so popular and attractive (American Sports Education Program, USA Gymnastics, 2011). The research was limited by the physical and mental state of the subjects during

testing (fatigue, affective-motivational factors), which might cause variations in the motor responses. Another limitation was related to the sample of athletes. The situation might be different with a sample made up, for example, only of male athletes. Observation and conversation, as research methods, support the value of our research, which is based on the study of intersegmental coordination. The study results provide useful information for coaches to be used in their training strategy, for scientific sports training management. The research data may also be used by the sport psychologists, who will develop stimulation programs for some of the characteristics (for example: resistance to time pressure when performing intersegmental movements) associated to sports performance. The RCMV test can be used as a complementary means of psychological preparation, as it provides data about the intersegmental coordination, which may become objective points in the specific training of the athletes practicing artistic gymnastics.

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