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Analysis of the Influence of Sensorimotor Coordination Development on Floor Acrobatic Training in Women's Artistic Gymnastics

Vladimir POTOP[1]*, Ion CARP[2]

Abstract

This paper aims to highlight the influence of sensorimotor coordination development on biomechanical characteristics in double back somersault executed on the floor by junior gymnasts aged 12 to 15 years. The following methods were used to achieve the goal and objectives of the research: analysis of specialized literature; method of pedagogical observation; method of pedagogical experiment; method of tests; video computerized method of biomechanical analysis; statistical-mathematical method and method of graphical representation. A number of 3 tests of evaluation of sensorimotor coordination were used during this study: test 1 –"Briuk" test, static balance; test 2 – static-kinematic stability and test 3 – stuck landing. The biomechanical analysis was made by means of Physics ToolKit program, monitoring the key elements of sports technique used in double back somersault on floor. The study findings show the level of sensorimotor coordination development in terms of spatial-temporal orientation, vestibular coordination and balance, kinematic and dynamic analysis of sports technique key elements regarding body segments trajectories, angular speeds and force momentum during double back somersault on floor. Also, the evaluation of sensorimotor coordination consistent with the biomechanical analysis of sports technique of floor acrobatic elements in the case of junior gymnasts aged 12 to 15 highlights their influence on the technical training and performances achieved in competitions.

Keywords: Gymnastics, biomechanics, sensorimotor coordination, performance.

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1. Introduction

The coordinative skills of athletes are quite different and specific to each sports branch. However they can be distinguished in conformity with the particularities of manifestation, criteria of evaluation and conditioning factors. In training and competition real practice, all coordinative abilities are not manifested separately but in a complex interaction [13].

Thus, the coordinative abilities designate a complex of predominantly psycho-motor skills including the ability to teach fast new movements, to adapt quickly and efficiently to various conditions, specific to different types of activities, by the reconfiguration of the motor background [7]. According to Blume (1981), quoted by Manno, the coordinative abilities are organized under the form of a system, taking into consideration the inter-conditioning of components and their purposes [8]. The manifestation forms of the coordinative abilities can be defined as follows [9]: general coordinative abilities, specific coordinative abilities and coordinative abilities under the conditions of other motor skills.

According to Berstein (1991), the optimal operation of the sensitive vestibular system has a great importance for achieving high results in different branches of sport, primarily in those sports in which the athlete must have a very good sensory-motor coordination. The increasing sports mastery and competitive programs difficulty require a specialized analysis to reveal the influence of different factors upon the vestibular analyzer and also the influence of the mechanical forces resulted from the inertial forces in linear and angular accelerations [2].

In terms of physiology, the coordination capacity can be defined as a complex psycho-motor quality based on the correlation between the central nervous system and the skeletal muscles during the performance of a movement [5].

The regulation of body posture – aspiration of the body to functional order, to the updating and coordination of human body units in balance – is an effective solution to define the motor tasks [3].

Because coordination is a natural inherited capacity, the specific methods to develop it are quite few in comparison with other bio-motor capacities. During the coordination development stages, the coach must try to use exercises of progressive increasing complexity. The difficulty and complexity of a skill can be increased by using situations, different sports equipment and facilities [4].

According to the compositional requirements and the specific of the apparatus (floor), women's artistic gymnastics uses different walkovers and somersaults belonging to different groups, forwards, backwards, sideways;

the double somersault is a mandatory compositional requirement. Knowing the correlative connections between the sensorimotor coordination indicators, biomechanical ones and the performance of junior female gymnasts aged 12 to 15 years and also the significance of these connections can contribute to the more efficient development of the modern didactical programs of learning.

2. Problem Statement

With regard to the manifestation forms of the coordination capacity (skill) in artistic gymnastics, it includes a series of "senses" or psychomotor skills, namely [11]: sense of balance; sense of orientation in space; sense of coordination of the movements made by the moving segments; sense of coordination of large muscle groups; sense of decomposition and analysis of movements; sense of rhythm; sense of assessment of distance, direction, velocity, amplitude and degree of strain. The coordinative capacity is largely dependent on the efficiency of the analyzers that influence directly the process of movement guidance and control. These analyzers cooperate and complement each other as follows [5, 12]: static-dynamic (vestibular) analyzer; kinesthetic analyzer; touch analyzer; sound analyzer; optical analyzer.

Thanks to its rich and diverse content, the floor is the longest event (in terms of length of time) of high dynamism and spectacularity. The floor exercises include a great variety of predominantly acrobatic movements - dynamic and static –that require mobility, balance and strength (boys) and choreographic elements (girls)[10, 17].

Biomechanics research in artistic gymnastics can be made both by methods of biomechanics and methods taken from other fields of knowledge (pedagogical, mechanical, physiological, psychological, medical etc.) with the main target to point out the main features of the movement [1, 6, 10].

3. Research Questions/Aims of the research

This paper aims to highlight the influence of sensorimotor coordination development on biomechanical characteristics in double back somersault executed on the floor by junior gymnasts aged 12 to 15 years.

Hypothesis of the paper. We believe that the assessment of sensorimotor coordination is consistent with the biomechanical analysis of sports technique of the double back somersaults on floor executed by junior

gymnasts of 12 – 15 years old and we shall show its influence on the acrobatic training and the performances achieved in competition.

4. Research Methods

The following methods have been used to achieve the tasks of the research: theoretical analysis and generalization of specialty literature data, pedagogical observation, pedagogical experiment, method of tests (testing of sensorimotor coordination) [2], video computerized method of biomechanical analysis, by "Kinovea" and "Physics ToolKit" programs; method of movement postural orientation [3]; statistical-mathematical and graphical methods by means of KyPlot programs.

3 tests of assessment of the sensorimotor coordination were used in this study:

1. Test 1 – Briuk" test, static balance, test for maintaining body balance on tiptoe with eyes closed and arms along the body (keeping at least 15-20 sec.).

2. Test 2 – static-kinematic stability – 5 forward rolls in 5 sec. with 10 in-place jumps with eyes closed, in the centre of the graduated circle (maximum deviation 35 cm).

3. Test 3 – stuck landing, in-depth salto from the higher bar (uneven bars), assessed by penalties for the execution mistakes 0.1 -1.0 points, 3 attempts were granted.

This scientific approach involved the organization of an experimental study, as part of a postdoctoral research, conducted from 2012 to 2014, with a group of 7 gymnasts of 12 to 15 years old, members of the Olympic Team of Izvorani.

5. Findings

Table 1 shows the results of the sensorimotor development of junior female gymnastsof 12-15 years old in terms of static balance, static-kinematic stability and stuck landing.

In table 2 are presented the results of the angular characteristics of sports technique key elements specific to double back somersaults executed on the floor by junior female gymnasts aged 12 to 15 years concerning the preparatory movement – launching posture, the basic movement – multiplication of body posture in the maximum height of GCG flight and the final movement phase – concluding posture – the landing.

Table 1. Results of sensorimotor coordination development of junior gymnasts aged 12 to 15, (n=7)

Statistics indicators	Test 1 (s)		Test 2 (cm)		Test 3 (points)	
	Initial	Final	Initial	Final	Initial	Final
$\overline{X}$	15.94	19.77	24.14	21.43	9.33	9.49
SD	2.22	0.72	3.76	1.98	0.08	0.07
t	-4.004		2.244		-7.778	
p	<0.01		>0.05		<0.001	

Table 2. Results of the angular characteristics of sports technique key elements in double back somersaults executed on the floor by junior female gymnasts aged 12 to 15 years

Acrobatic elements	Statistics indicators	LP (degrees)		MP (degrees)		CP (degrees)	
		Initial	Final	Initial	Final	Initial	Final
TDS 2012, n=4 2014, n=6	$\overline{X}$	90.75	85.00	68.00	57.33	71.75	94.33
	SD	2.5	3.58	5.88	6.95	12.34	25.17
PDS 2012, n=3 2014, n=6	$\overline{X}$	90.33	84.5	76.67	50.83	72.00	100.17
	SD	1.53	2.26	2.52	4.99	9.54	28.22
2012, n=7 2014, n=12	t	3.439		3.301		2.157	
	p	<0.001		<0.001		<0.05	

Note: TDS – tucked back somersault, PDS –piked back somersault, LP – launching posture; MP – multiplication of body posture; CP – concluding posture (final) – landing.

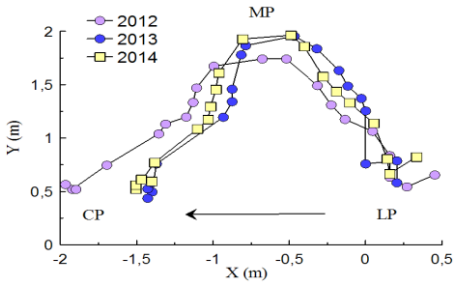
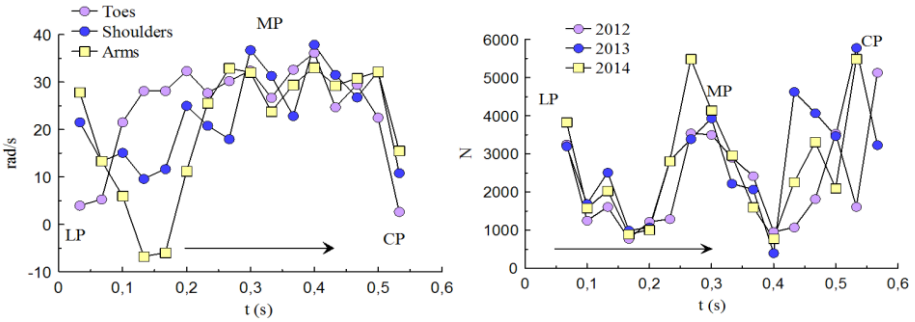


Fig. 1. Graphof GCG trajectory during execution of double back somersault piked, gymnast P.A. (13-15 years old)

Figure 1 shows the graph of GCG trajectory in the double back somersault piked executed by the gymnast P.A. (13-15 years old) during the Romanian National Championships of Women's Artistic Gymnastics 2012-2014, in terms of dynamics of the key elements of sports technique. In table 3 are presented the results of linear correlation of the sensorimotor coordination, biomechanical indicators and performances achieved in the floor events.



a)Angular velocity b) Resultant of GCG force

Fig. 2. Kinematic and dynamic characteristics of double back somersault piked, gymnast P.A. (13-15 years old)

Table 3. Results of linear correlation of the sensorimotor coordination, biomechanical indicators and performances (n=12)

No.		Indicators*		SMC			BI				AR
				1	2	3	4	5	6	7	8	9
1		Test 1, (sec)			-	.083	.109	.029	-	-	.115	-
2		Test 2, (cm)		-.682		-	-	-	-	.489	-	-
3	SMC	Test 3, (points)			-.598		.175	.289	-	-	.235	.620
4		IR(kg·m²)			-.499	-		.516	.413	.004	.026	.026
5			toes		-.511	-	-		.340	.006	.161	-
6	Biomechanics indicators	RM, (m)	should	-.336	-.020	-.015	-	-		.496	.205	.198
7			arms	-.803	-	-.263	-	-	-.126		-	.061
8		KE, (degrees)	CP	-	-.137	-	-	-	-	-		.281
9	Perf.	AR	FS	-.227	-.132	-	-.155	-	-	-	-	

Note: SMC –sensory motor coordination, BI – biomechanical indicators, Perf.- performances, AR – all around, IR – inertia of rotation, RM – radius movement, should.- shoulders, KE – key elements, CP – concluding position, *df*= N-2, p<0.05, r=0.576; p<0.01, r=708.

6. Discussions

The assessment of the sensorimotor coordination development of junior female gymnasts aged 12 to 15 yearswas made using three tests for static balance, static-kinematic stability and stuck landing [14], [15]. The results of the comparative analysis reveal the following matters (table 1, $\bar{x}$; ±SD):in test 1 an average of15.94; ±2.22 cm in initial testing and an increase of the balance keeping duration by 3.83 sec in final testing with significant differences between averages at $p<0.01$; in test 2 an average of 24.14; ±3.76 cm in initial testing and improvement of static-kinematic stability by 2.71 cm (diminution of deviation) in final testing with insignificant differences at $p>0.05$; in test 3 an average of 9.33; 0.08 points in initial testing and an increase by 0.16 points of landing stability in final testing and significant differences at $p<0.001$.

The results of the comparative analysis of the angular characteristics of the key elements of sports technique specific to double back somersault executed on the floor by junior gymnasts aged 12 to 15 years highlight(table 2, $\bar{x}$; ±SD): the launching posture (LP), atTDS, n=6 (angle between toes-shoulders) an average of 90.75; 2.5 degrees in initial testingand an improvement of the posture by 5.75 degreesin final testing and at PDS, n=6 an average of posture angle of 90.33; 1.53 degrees in initial testing and an improvement of the posture by 5.83 degreesin final testing. The comparison of the averages betweentests reveal significant differences at $p<0.001$; multiplication of body posture (MP) at maximum flight of the GCG, at TDS(angle between thigh and torso) the average is68.00; 5.88 degrees in initial testingand an improvement of the posture (decrease of tucked angle) by 10.67 degreesin final testing while at PDS the average of posture angle is of 766.67; 2.52 degreesin initial testing and an improvement of posture angle by 25.84 (piked position) in final testing. The differences of somersault averages between testing significant at $p<0.001$; in concluding posture (CP) – landing ($\bar{x}$; ±SD) at TDS (thigh-torso angle) the average is of 71.75; 13.34 degreesin initial testingand an improvement of posture angle by 22.58 degreesin final testing while at PDS the average of posture angle is 72.00; 9.54 degreesin initial testingand an improvement by 28.17 degreesin final testing. The differences of the averages between tests are significantat $p<0.05$.

These significant differences highlight the improvement of sports technique key elementsof the double back somersaultas a result of the implementation of the macro-methods of learning throughout junior female gymnasts' training [16].

The results of the comparative analysis of the individual biomechanical indicators of double back somersault executed by the gymnast P.A. (13-15 years old) showthe following (fig. 1): increase of the height of GCG flight from 1.741 m related to the floor by 0.221 m in final testing (1.962 m);at the same time the length of the somersault decreased leading to a higher and narrower trajectory (closer to technical requirements).

Concerning the kinematic characteristics of the double somersault piked executed by the gymnast P.A. (13-15 years) in terms of angular velocity of body segments around GCG we notice (fig. 2a): in launching posture (LP) there is a higher valueof arms angular velocity, namely 13.356 rad/s that ensures the optimum angle for flying off; during multiplication of body posture (MP) at the maximum height of GCG flight there is a higher value of the angular velocityof 32.926 rad/s at arms level, 30.197 rad/s at shoulders and 17.993 rad/s at toes; in concluding posture(CP) – landing, we observe a higher valueat arms level of 15.532 rad/s, 10.835 rad/s at shoulders and 2.638 rad/s at toes. All these values of angular velocity within the phasic description of sports technique key elements of double back somersault piked ensure the correct execution of these ones in compliance with the technical requirements of the international Code of Points.

Regarding the values of the comparative force resultant of GCG displacement during the double back somersault piked executed by the gymnast P.A. (13-15 years) we notice (table 2b): at LP there is a value of 3250 N in initial testing (2012) and an increase by 580 N in final testing; at MP – 3540 N in initial testing and an increase by 1950 N in final testing while at CP – 5130 N in initial testing and an increase by 360 N in final testing.

The results of thelinear correlative analysis between sensorimotor coordination indicators, biomechanical ones and the performance of junior female gymnasts aged 12 to 15 years reveal strong connections at $p<0.01$ between test 1 and performance, namely the balance keeping and the final score in the floor event; at $p<0.05$ between test 1 and 2; test 2 and 3;test 3 and performance. The other indicators highlight moderate and poor connections between these ones.

7. Conclusions

The results of the study emphasize the improvement of the sensorimotor coordination by increasing the duration of static balance

maintaining, diminution of deviation of the static-kinematic stability and improvement of the stuck landing.

The video-computerized biomechanical analysis according to the method of movement postural orientation highlights the improvement of the sports technique key elements of the double back somersault on floor executed by junior gymnasts of 12-15 years old based on the indicators of the kinematic and dynamic characteristics and the performances obtained in competition.

The results of the linear correlative analysis point out strong connections between the indicators of the sensorimotor coordination and the performances achieved in the floor events and moderate connections between some biomechanical indicators.

Also, the evaluation of sensorimotor coordination consistent with the biomechanical analysis of sports technique the back double somersaults of floor in the case of junior gymnasts aged 12 to 15 highlights their influence on the technical training and performances achieved in competitions.

8. Acknowledgments

This case study is an advanced stage of the pedagogical experiment of the post-doctoral thesis; it is included in the research plan in the field of National University of Physical Education and Sport of Ukraine, with the subject matters: 2.11 (Dynamic static stability as a basis for technical training of those involved in sports gymnastics views), 2.32 (Technical training of qualified athlete based on competitive exercises technique rationalization) and in the plan of research for 2016-2017 of the Faculty of Physical Education and Sport, Ecological University of Bucharest. We express our gratitude to the Romanian Gymnastics Federation and especially to Missis Anca Grigoraş Mihailescu – federal coach and to the coaches of the Olympic Team of Izvorani who helped us to conduct this research. I hereby declare under my own responsibility that the subjects participating in the research have been informed of the voluntary nature of participation in the research, of the understanding of the information received and of the understanding that withdrawal can be done at any time, without any negative consequences on the participant.

The research respected the ethical standards of the research, the participants / the next of kin of the participants gave their consent to take part in the research.

References

[1] Arkaev LJ, Suchilin NG. Kakgotovit' chempionov - Theory and technology of training.Top-class gymnasts [How to create champions]. Moscow: Fizkul'turai sport; 2004.328 p.

[2] Boloban VN. Sensorimotornaja koordinacija kak osnova tehnicheskoj podgotovki [Sensorimotor coordination as basis for technical training]. Sciencein the Olympic sport. Kiev. 2006. 2: 96-102.

[3] Boloban VN. Reguljacija pozy tela sportsmena [Regulation of athlete's body posture]. Monograph. Olympic. 2013. 232 p.

[4] Bompa TO. Periodizare: Teoriaşimetodologiaantrenamentuluisportiv [Periodization: Theory and methodology of training].Bucharest: "Ex Ponto" Publishing House; 2002. 435 p.

[5] Bota C, Prodescu B. Fiziologia educaţiei fizice şi sportului – ergofiziologie [Physiology of physical education and sport – ergo-physiology]. RâmnicuVâlcea: „Antim Ivireanu" Publishing House; 1997.237p.

[6] Bruggmann GP. Biomechanics of gymnastics techniques. Sport Science Review. 1994; 3: 79-120.

[7] Dragnea A, Bota A. Teoria activităţilor motrice [Theory of motor activity]. Bucharest: Didactic and Pedagogic Publishing House; 1999. 284 p.

[8] Dragnea A, Mate-Teodorescu S. Teoria sportului [Theory of Sport]. Bucharest: FEST Publishing House; 2002. 610 p.

[9] Dragnea A, Bota A, Teodorescu S, Stănescu M, Șerbănescu S, Tudor V. Educaţie fizică – teoria şi didactică [Physical education – theory and didactics]. Bucharest: FEST Publishing House; 2006. 300 p.

[10] Gaverdovskij JK. Teorija I metodika sportivnoj gimnastiki [Theory and Methods of Artistic Gymnastics].Moscow: Sov. Sport; 2014. 368 p.

[11] Grigore V. Gimnastica artistică – bazele teoretice ale antrenamentului sportiv [Artistic gymnastics – Theoretical bases of sports training]. Bucharest: "Semne" Publishing House; 2001. 194 p.

[12] Niculescu G. Gimnastica artistic. Repere teoretice [Artistic gymnastics. Theoretical highlights]. Bucharest: "Arvin press" Publishing House; 2003. 139 p.

[13] Platonov VN. Sistema podgotovki sporsmenov v olimpijskom sporte. Obshhaja teorija iejo prakticheskie prilozhenija [System of training athletes in Olympic sports. General theory andits practical applications]. Kiev: Olympic Literature Publishing House; 2004. 808 p.

[14] Potop V. Influence of sensory-motor coordination on the technical training in Women's Artistic Gymnastics. Bulletin of the Transylvania University of Brasov. 2013; 6(55): 37-46.
[15] Potop V, Grigore V, Moraru C. Analysis of the sensorimotor coordination development influence on sports performances in Women's Artistic Gymnastics. Discobolul – Physical education, Sport and Kinetotherapy. 2013 Dec; 4(34): 71-80.
[16] Potop V, Manole C, Nistor D, Andreyeva NO. Didactic Technologies of Learning the Double Back Somersault on Floor Based on the Biomechanical Analysis of Sports Technique in Women's Artistic Gymnastics. Journal of physical education and sport. 2015; 15(1): 120-127.
[17] Vieru N. Manual de gimnastică sportivă [Handbook of sports gymnastics]. Bucharest: "Driada" Publishing House; 1997. 263 p.