

<https://doi.org/10.52449/1857-4114.2021.38-2.06>

CZU: 796.012:796.83

IMPACT OF SENSORY-MOTOR ACTIONS ON THE DEVELOPMENT OF BOXER MOVEMENT COORDINATION

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Abstract. *The present study reveals a specific methodological approach regarding the training of junior boxers with the application at the training process base of sensory-motor actions in order to determine the optimal ways of educating the coordination of movements. In this context, a test module is developed and approved, the character of which elucidates and essentializes the specific actions on which a training process can be based, aimed at increasing the coordination qualities, which will later be able to converse the training activity on the vector of increase performance. Along with other specific tests provided for determining the training levels of boxers, the respective test module can promptly establish the concordance between the forms of practice so that all prescribed actions are found to be important for the effective training of technical-tactical skills specific to the contemporary boxer.*

Keywords: *boxing, movements coordination, sensory-motor actions, specific testing, visual-motor reaction, vestibular stability, development tendency, technical perfection.*

Introduction. Given the spectacular evolution in contemporary boxing, the importance of many qualities of the athlete always increases, such as the ability to quickly orient in space, fine differentiation of own muscular sensations, regulation of muscle tension, rapid reaction to various external signals, vestibular stability etc. [4, 7, 10].

The high bio-psycho-motor training of the young boxer also requires: education of a higher degree of precision, excellent sense of rhythm of movements, ability to relax muscles freely, ability to react quickly and timely in the changing conditions in the boxing ring [1, 5, 8]. Thus, the formation of the set of integral capacities is, at present, one of the main objectives and finalities of the boxer training process, especially in the age category of trainees (14-15 years-old), the age at which education of these qualities is considered appropriate.

This idea has been highlighted and substantiated by many specialists [3, 5, 9, 11],

who do not question the need to develop the ability to regulate and optimal direct (namely quickly, accurately, rationally) of movements, known as "coordination skills".

However, the problem of developing the coordination of movements in boxers is a key issue that requires essential approaches for the exceptional training of future boxing champions.

Thus, various exercises that characterize the fulfillment of the elements with a high degree of difficulty in short time intervals in the specific execution of boxing movements, with a high concentration of muscular efforts and which can intervene with a substantial increase the effective growth of technical correctness requires a direct treatment by specific testing in order to determine the contribution of correctness or incorrectness that the respective exercises can offer [2, 3, 6]. This dictates the need to refine the content of specific tests on the practice of various exercises in the training of performance boxers.

In the context of the above, the subject has become the main subject of this research.

The purpose of this study is to determine the impact of sensorimotor actions on the development of movements' coordination in boxers by applying to the boxing training process base of the specific tests that, in turn, can promote the diversity of actions towards effective and rational training of athletes.

Objectives: the study on the interactive development of movement coordination through specific actions and exercises; appreciation of the influence of test exercises on the development of the boxer's special motor skills; the inclusion in the training process of actions that represent the quality of coordination of movements; determining the significance of the test module in order to establish the accuracy of the application and use of the various forms of practice.

Methods, program. In order to establish the way of testing some constituent features of the coordinative capacity influencing the technique of specific procedure execution (as a final result of investigations), it was developed the **test (unit) module** for the subjects included in the experiment, which, to a greater extent or less, to identify the degree of possession of such capacity by performing the actions described below.

I. Tests determining the degree of complex visual-motor reaction to the moving object:

- from 10 repetitions (at each indicator) the correct execution technique is assessed at the moment of complete bending of the arm in the elbow joint to the contact with the hanging pillow that is thrown to the subject (in the case of direct punches, but in the case of side punches at the moment when the elbow joint is open no more than 45°. The exact performances from the front direction, from the side, from the bottom, taking into account the following punches were taken into account: **a** – left punch to the head; **b** – right punch to the head; **c**- left hook to the

head; **d**- right hook to the head hook, **e** – right uppercut to the head; **f**- left uppercut to the head; **g**- right uppercut to the body, **h**- left uppercut to the body.

II. Tests that determine the degree of vestibular stability:

- from sitting on the hemisphere (bosu), performing serial punches on the points marked on the stable manikin (on the wall): **a**- 10 head punches consecutively with both hands (5 left - 5 right), **b** -10 at the point signifying the chin and **c** -10 punches to the body.

III. Tapping - test:

- appreciation of the different punch frequency (the condition not to be repeated) against time (5 sec.) with calculation of the number of repetitions / punches.

In connection with what is described, it is considered particularly necessary to constantly vary with the exercises, both which are prone to educate the coordination of movements, as well as to develop maneuvering actions, manifestation of reasoning and expressive elements in indeterminate situations.

These tests propose for research the possibilities to increase the training of boxing athletes, interacting with specific exercises, characteristic of the coordinative capacity development of the movements aligned, namely the specific action of the athlete in the ring.

Taking into account that the content of the training process for cadet boxers (14-15 years- old) is obviously based on the particularities of age and the evolution of the exercises they must learn, each form of actions execution was incomparable, where appropriate and diversified methodological and educational approaches were followed.

The following were taken into account: determining the speed (rapidity) of paying attention to the form of movement; efficiency and correctness of practice by increasing the maximum frequency of movements performed; alternating exercises in a

combinatorial way, where it is necessary to take into account the maximum tempo of movement which is higher in the distal joints compared to the movements in the proximal joints (it is known that at the age of 13-14 years-old the tempo of movement increases by 0,3-0.4 movements per second); full realization of the personal possibilities of each athlete; the duration of the exercises in series while maintaining the maximum speed

of execution of the punches; limiting the degree of difficulty with which the exercise is performed; avoiding breaks during the execution of the attack exercise; subsequent inclusion of development exercises of a muscular force that develops due to the strong frequency of the control impulses sent to the muscles from the nerve centers.

Results.

Table 1. Comparative analysis of the level of movement coordination in the cadet boxers of the experimental and control groups at the initial stage

Test module	Coding of actions	Experimental group (n = 15) X ± S x	Control group (n = 13) X ± S x	Statistical indicators	
				t	P
I. Complex visual-motor reaction to the moving object (scale from 1-10)	I-a	4.54 ± 0.84	5.02 ± 0.72	0.74	> 0.05
	I-b	5.68 ± 0.27	5.44 ± 0.28	0.32	> 0.05
	I-c	5.12 ± 0.46	5.14 ± 0.56	0.06	> 0.05
	I-d	6.32 ± 0.27	5.57 ± 0.38	0.43	> 0.05
	I-e	5.80 ± 0.40	5.06 ± 0.64	1.02	> 0.05
	I-f	4.48 ± 0.14	4.73 ± 0.47	0.46	> 0.05
	I-g	6.04 ± 0.58	5.66 ± 0.75	0.75	> 0.05
	I-h	5.36 ± 0.71	5.19 ± 0.63	0.28	> 0.05
II. Vestibular stability (scale from 1-10)	II-a	6.14 ± 0.63	6.02 ± 0.48	0.14	> 0.05
	II-b	5.39 ± 0.44	5.53 ± 0.52	0.35	> 0.05
	II-c	6.85 ± 0.39	6.74 ± 0.28	0.08	> 0.05
III. Tapping test (no. repetitions -t = 5 sec.)	III-a	6.44 ± 1.22	6.05 ± 1.08	0.44	> 0.05

The scoring scale provided assessments of the results from 1-10, criteria according to which it was noted: precision of the punch, the accuracy of the punch, the correctness of the punch (of the execution), the speed (the speed of the execution). According to the scoring criteria, the actions performed for grade 10 are considered valid: the highest speed of execution and maneuver, the sequence in the phases of preparation and execution of the decisive action (punch), selection of the most appropriate place and time of execution, operability of distance exchange, etc., including the correct number of executions. For grade 9, 8, 7 etc. such

numerical results were recorded, only in decreasing quality and efficiency in performance. The results of these tests are also between 4 and 6 points, with statistically insignificant differences (t = 0.28 - 1.02, with P>0.05).

In addition, it can be mentioned that the researched subjects have a certain level of training, this due to the fact that they already have a baggage of practical-motor skills acquired, but if we align this training to the coordination chain, it proves to be insufficient, because, at this level of sports category the degree of possession of both

coordinative skills and other qualities must be more advanced.

Based on the results obtained at the stage of completion of the investigation in the sensorimotor test module, it can be mentioned that the athletes of the experimental group demonstrated increased levels of skills researched during the pedagogical experiment (Table 2). Thus, the young boxers were able to raise the level of their skills both in the complex visual-motor reaction to the moving

object, where they demonstrated a more advanced system of sensorimotor calculations, operative determination of distance assessments, execution time of the decisive movements, as well as of the system of reproduction of different parameters of the movements by the operative calculation of the force that they had to exert for the efficient fulfillment of the prescribed actions, including the integrity of the exercise accuracy.

Table 2. Difference of the movement coordination level in the experimental group subjects according to the sensorimotor test module (initial and final stage of the research)

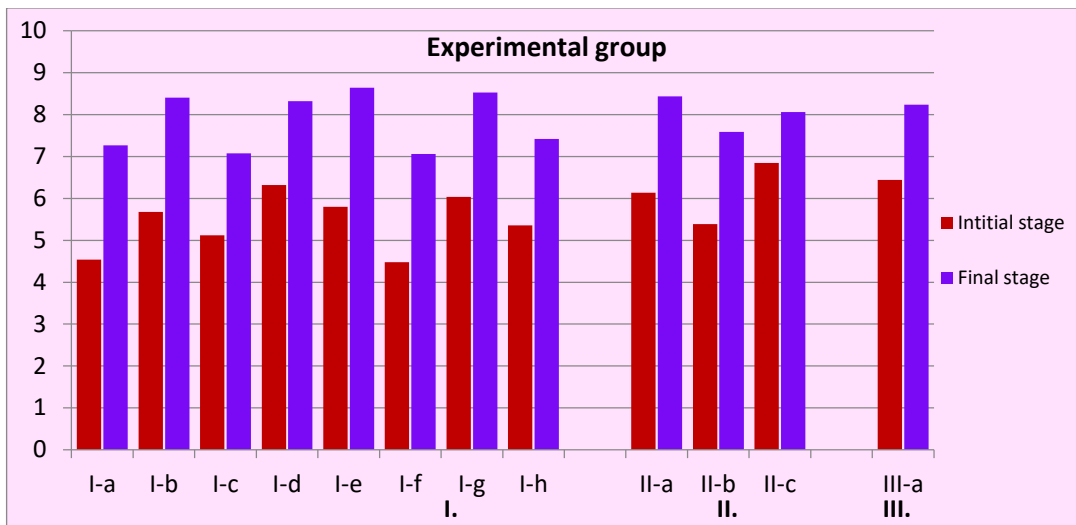
<i>Test module</i>	<i>Coding of actions</i>	<i>Experimental group</i>		<i>Statistical indicators</i>	
		<i>Initial stage (n = 15) X ± S_x</i>	<i>Final stage (n = 15) X ± S_x</i>	<i>t</i>	<i>P</i>
I. Complex visual-motor reaction to the moving object (scale from 1-10)	I-a	4.54 ± 0.84	7.27 ± 0.45	3.78	<0.001
	I-b	5.68 ± 0.27	8.41 ± 0.32	3.24	<0.001
	I-c	5.12 ± 0.46	7.08 ± 0.44	2.71	<0.01
	I-d	6.32 ± 0.27	8.32 ± 0.23	2.93	<0.01
	I-e	5.80 ± 0.40	8.64 ± 0.47	3.56	<0.001
	I-f	4.48 ± 0.14	7.06 ± 0.28	3.12	<0.01
	I-g	6.04 ± 0.58	8.53 ± 0.33	2.75	<0.01
	I-h	5.36 ± 0.71	7.42 ± 0.63	2.38	<0.01
II. Vestibular stability (scale from 1-10)	II-a	6.14 ± 0.63	8.44 ± 0.49	3.94	<0.001
	II-b	5.39 ± 0.44	7.59 ± 0.42	2.18	<0.01
	II-c	6.85 ± 0.39	8.06 ± 0.28	2.77	<0.01
III. Tapping test (no. of repetitions: t=5 sec.)	III-a	6.44 ± 1.22	8.24 ± 1.02	2.83	<0.01

In the series of explanations presented, it should be mentioned that the athletes from the experimental group reached the point when they were able to minimize the movements in addition, outlining here the technique of superior execution where, the influence of the coordinative exercises applied in the training process with boxer athletes, cadet category is much lighter.

There is an increase in the average execution of more than 2.44 points in all test events, and the variable "t" is between 2.38

and 3.78, which demonstrates a significance of P<0.01 - <0.001.

Coming with an assessment of the results of vestibular stability, there is also an increase of levels in test events, where the variable „ t ”is between 2.18 and 3.94, which demonstrates a significance of P<0.01 - <0.001. This proves the low dispersion of the results (the more statistically close the upper and lower borders are, the higher the percentage of the respective indicator, which demonstrates a high degree of stability).



Note: I - complex visual-motor reaction to the moving object; II - vestibular stability; III- Tapping test

Fig. 1. Dynamics of movement coordination indicators according to the sensorimotor test module of boxers in an annual training cycle (experimental group)

Significant differences are found between the final results presented by the subjects taken for research between the experimental and control group on all indicators exposed to the test (1-a, 1-b, 1-c, 1-d, 1-e, 1-f, 1-g, 1-h), which shows *the complex visual-motor reaction to the moving object* with the significance threshold of $P < 0.05 - < 0.01$.

Such differences are also found in the assessment of the degree of *vestibular stability* and in the *Tapping test*.

Obviously, all these results are due to the intensive education of coordinative-motor skills, which changed the level of training of cadet boxers to another perspective.

Table 3. Results of the movements coordination development level in cadet boxers according to the sensorimotor test module (final stage)

Test module	Coding of actions	Experimental group (n = 15) $\bar{X} \pm S_x$	Control group (n = 13) $\bar{X} \pm S_x$	Statistical indicators	
				t	P
I. The complex visual-motor reaction to the moving object (scale from 1-10)	I-a	7.27 ± 0.45	5.13 ± 0.66	2.95	<0.01
	I-b	8.41 ± 0.32	6.57 ± 0.48	2.66	<0.01
	I-c	7.08 ± 0.44	5.84 ± 0.62	2.59	<0.01
	I-d	8.32 ± 0.23	6.02 ± 0.31	2.49	<0.01
	I-e	8.64 ± 0.47	6.52 ± 0.72	2.08	<0.01
	I-f	7.06 ± 0.28	5.29 ± 0.39	2.47	<0.01
	I-g	8.53 ± 0.33	6.61 ± 0.55	2.39	<0.01
	I-h	7.42 ± 0.63	6.18 ± 0.48	1.88	<0.05
II. Vestibular stability (scale from 1-10)	II-a	8.44 ± 0.49	6.89 ± 0.37	2.03	<0.01
	II-b	7.59 ± 0.42	6.41 ± 0.44	1.12	> 0.05
	II-c	8.06 ± 0.28	7.00 ± 0.37	2.03	<0.05
III. Tapping test (no. of repetitions: t = 5 sec.)	III-a	8.24 ± 1.02	6.85 ± 1.24	2.44	<0.01

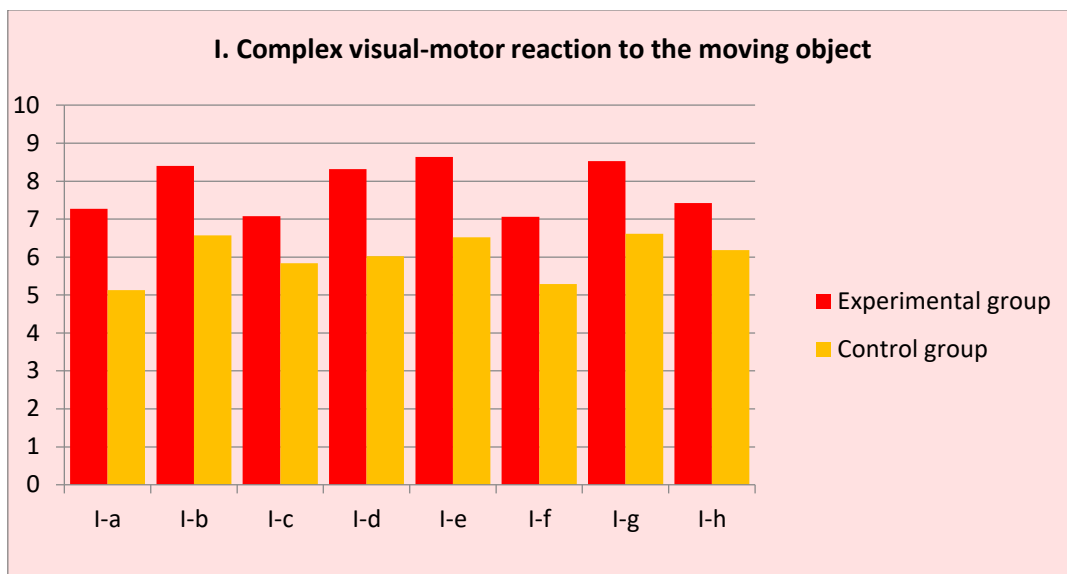


Fig. 2. The final statistical results for the indicator "Complex visual-motor reaction to the moving object" showing the movement coordination level according to the sensorimotor test module of boxers in an annual training cycle (experimental and control group)

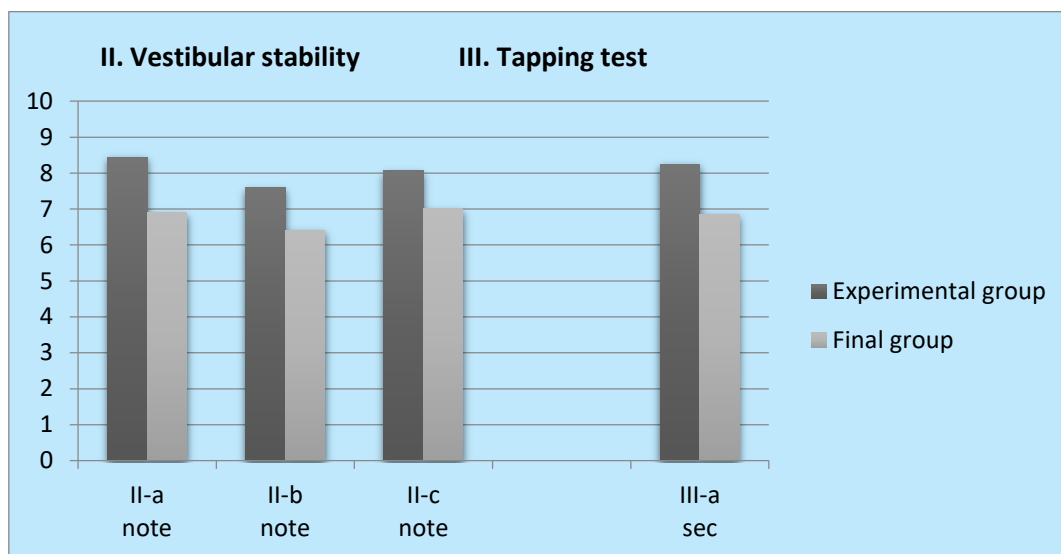


Fig. 3. The final statistical results on the indicators "Vestibular stability" and "Tapping test" showing the movement coordination level according to the sensorimotor test module of boxers in an annual training cycle (experimental and control group)

Obviously, all these characteristics are interconnected and are in a permanent connection with each other through which the steering mechanism is formed with difficult motor actions (here we consider the functional state of the analyzer system, the degree of adjustment of body position in

various actions or movements also the difficult ones, degree of motor memory formation and the possibility of reproduction the movements when asked, etc., which is demonstrated by the applied sensorimotor tests module results.

In **conclusion** it can be noted that the applicability of sensorimotor actions on movement coordination development in boxers is effective, but in order to increase the bio-psycho-motor potential of athletes, they can be widely used in the practice of the multiannual training process.

These statements may provoke other research from the perspective of sports

training in boxing by using other modules / forms of specific testing, which deepen the study of certain issues such as: the training / testing program of the respiratory system, blood vessel muscles (function of contracting) to withstand sudden changes in blood pressure; the functions of visual analyzers and others.

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