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Original Article

Assessment of the stability of body functional systems in orienteers

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Abstract:
The article deals with developing a physiologically and psychologically justified program for improving functional stability in orienteers in the changing conditions of sports performance. The study was conducted from 2015 to 2018 on the premises of the scientific laboratory and in the field experiment. 25 orienteers (males and females) aged 17-20 years participated in the study. The experiment was conducted as a comprehensive control aimed at the assessment of the vestibular apparatus and physical and technical fitness of a functional and psychophysiological status in athletes. As a result of the experiment, all orienteers made a significant progress in the development of static and dynamic balance during the year of training. The results obtained in the experimental group in the platform balance test exceeded the initial data by 45.4% compared to 5.2% in the control group. The speed of sensorimotor reaction in athletes from the control group decreased by 4.3%, in the experimental group – by 16.7%. The results obtained for the critical frequency of flicker remained almost the same. Therefore, the improvement of the results obtained can be considered as a proof of the advantage of our method.
Keywords: functional system, critical frequency of flicker, reaction speed

Introduction.

Issue of stability of functional systems (FS) in athletes, the development of theoretical and methodical provisions of such a stability, as well as the study of a psychophysical and physiological basis for improving functional stability in highly-skilled athletes have become new directions in sports physiology.

Competitions in sports orienteering are characterized by a long-distance and challenging terrain. Successful competition performance requires both physical qualities (quickness, strength, endurance), which determine physical preparation in orienteers, and studying the issues of vestibular stability [7, 11, 13].

Even less research has been conducted in the field of statokinetic stability being the ability of the body to preserve stable performance, space orientation, and balance. This ability is provided by the optimal regulation of physiological and mental functions under the factors related to passive and active displacement [7, 10].

Sports orienteering imposes high requirements on all mental aspects such as attention, creativity, image memory, and emotions [8, 9]. Physical and technical fitness is not sufficient for successful performance in orienteering. Therefore, an athlete also requires the knowledge of psychology, sports physiology, sanitation, and hygiene, as well as other related disciplines [3, 5, 14].

As a result, establishing a psychophysiological basis for improving functional stability in athletes based on newly-developed approaches can be regarded as modern and relevant.

Aim. The articledeals with developing a physiologically and psychologically justified program for improving functional stability in orienteers in the changing conditions of sports performance.

Materials and methods. The study was conducted from 2015 to 2018 on the premises of the scientific laboratory of the Institute of Sports, Tourism, and Service (South Ural State University, Chelyabinsk) and in the field experiment.

25 orienteers (males and females) aged 17-20 years participated in the study. All athletes are the members of the National Team or Chelyabinsk Region Team and have the category of the Candidate for Master of Sports or Master of Sports.

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To establish the peculiarity of the functional status of the central nervous system, we developed and produced a device for controlling a psychophysiological status in orienteers based on microprocessor technologies.

The test was conducted at the beginning and the end of an academic year simultaneously with physiological, psychophysical, and pedagogical experiment. The experiment was conducted as a comprehensive control aimed at the assessment of the vestibular apparatus and physical and technical fitness of a functional and psychophysiological status in athletes.

The vestibular apparatus and balance were studied using the following method: a participant was standing on the upper disk of the device and trying to reach balance. When an athlete reached balance several times, the researcher turned on the button on the device working in the electronic stopwatch mode. Prior to turning the device on, the researcher erased the previous data and warned the participant. The task of the athlete was to preserve balance as long as possible.

To establish the peculiarities of the functional status of the central nervous system, we used the test, which allowed to measure strength and mobility of nervous processes by the duration of latency period to a light stimulus. For conducting such a test, we developed and produced a device for controlling a psychophysiological status in orienteers based on microprocessor technologies.

The device has a small size and works using battery. Therefore, it can easily be used in the field experiment. The device has the following modes:

1. Frequency mode - "FRQ"

In this mode, the critical frequency of flicker is established. After turning the device on and choosing the FRQ mode, the red indicator starts flickering with initial frequency of 20 Hz. The threshold critical frequency is reached with the help of control buttons. The monitor of the device shows the data corresponding to the frequency of flicker in Hz.

2. Speed mode - "Speed"

In this mode, the reaction speed and frequency at which an athlete makes more than 50% of errors in color detection are measured.

Results and discussion.

All orienteers made a significant progress in the development of static and dynamic balance during the year of training.

Table 1 demonstrates that the results of the experimental group improved by 45.4% compared to initial data ($p<0.05$), in the control group – by 5.2% ($p>0.05$).

At the end of the experiment, the orienteers from the first group demonstrated the following results: 7.88±0.2%, from the second group – 5.87±0.33%. This means that orienteers from the first group performed better by 34.2%.

Table 2 shows the results for the speed of sensorimotor reaction (Vp) at the beginning and the end of the experiment. Table 2 demonstrates that at the beginning of the experiment both groups had almost identical results: 0.49±0.008 s in the control group and 0.49±0.01 s in the experimental group. These differences were not statistically significant ($p>0.05$). In the final test, the speed of sensorimotor reaction in the control group decreased by 4.3%, in the experimental group – by 16.7%. It should be noticed that in the first group the decrease was statistically insignificant ($p>0.05$), while in the second group it was statistically significant ($p<0.05$).

Table 3 shows the results obtained for the critical frequency of flicker. A statistically insignificant ($p>0.05$) difference by 1.3% in the experimental group was quickly overcome at the beginning of newly developed training. In the control group, the critical frequency of flicker increased by 5.8% compared to the initial data. At the end of the experiment, the athletes had better results of 12.4%, meaning that they were 2 times more sensitive. The differences established for the indicators of the groups were statistically significant ($p<0.01$).

Therefore, this improvement can be considered as a proof of the advantage of our method [4, 6].

Table 1

The results obtained in control (1) and experimental (2) groupsin the platform balance test

Statistical characteristic	Test											
	Initial data		II		III		IV		V		Result	
	1	2	1	2	1	2	1	2	1	2	1	2
M	5.58	5.42	5.66	5.78	5.69	5.99	5.71	6.27	5.75	6.95	5.87	7.88
M_{max}	7.6	7.2	7.6	7.4	7.6	7.4	7.5	7.7	7.5	8.1	7.8	9.2
M_{min}	3.8	4	4.2	4.8	4.3	5.2	4.2	5.5	4.1	5.6	4.2	6.9
σ	1.17	0.96	1.04	0.78	1.01	0.66	1.01	0.66	1.04	0.75	1.1	0.69
m	0.35	0.28	0.31	0.22	0.31	0.19	0.31	0.19	0.31	0.22	0.33	0.2
K_V	20.91	17.69	18.43	13.46	17.79	10.99	17.73	10.51	18.14	10.78	18.82	8.74
p	>0.05		>0.05		>0.05		>0.05		<0.01		<0.001	

Table 2

The results obtained in control (1)
and experimental (2) groups in a complex sensorimotor reaction test

Statistical characteristic	Test											
	Initial data		II		III		IV		V		Result	
	1	2	1	2	1	2	1	2	1	2	1	2
M	0.49	0.49	0.49	0.48	0.49	0.48	0.49	0.47	0.48	0.44	0.47	0.42
M_{max}	0.51	0.52	0.51	0.51	0.51	0.5	0.51	0.49	0.5	0.46	0.5	0.44
M_{min}	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.42	0.45	0.4
Σ	0.02	0.02	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.01
M	0.008	0.01	0.007	0.008	0.007	0.007	0.007	0.006	0.006	0.004	0.005	0.003
K_V	3.11	3.65	3.12	3.09	3.14	2.49	3.16	1.9	2.54	2.69	3.25	2.83
P	>0.05		>0.05		>0.05		<0.05		<0.001		<0.001	

Table 3

The results obtained in control (1)
and experimental (2) groups in the critical frequency of flicker test

Statistical characteristic	Test											
	Initial data		II		III		IV		V		Result	
	1	2	1	2	1	2	1	2	1	2	1	2
M	28.83	28.46	29.00	28.85	29.33	29.15	29.42	29.54	29.5	30.62	30.5	32.0
M_{max}	31	30	31	30	31	30	31	31	31	32	32	33
M_{min}	27	27	27	28	28	28	28	28	28	29	29	31
σ	1.23	0.9	1.23	0.6	0.92	0.6	0.92	0.9	0.92	0.9	0.92	0.6
m	0.37	0.26	0.37	0.17	0.28	0.17	0.28	0.26	0.28	0.26	0.28	0.17
K_V	4.26	3.16	4.23	2.08	3.14	2.05	3.13	3.04	3.12	2.93	3.02	1.87
p	>0.05		>0.05		>0.05		>0.05		<0.05		<0.001	

It was established that the results obtained in the experimental group in the platform balance test exceeded the initial data by 45.4% compared to 5.2% in the control group. The speed of sensorimotor reaction in athletes from the control group decreased by 4.3%, in the experimental group – by 16.7%. The results obtained for the critical frequency of flicker remained almost the same.

Conclusion.

The critical frequency of flicker is a minimal frequency of flicker which creates a sense of permanent light in human. It is used as the indicator of functional lability of eye retina and other parts of the central nervous system. The critical frequency of flicker depends on the lability of nervous processes, which is quite sensitive to the changes in a functional status of an athlete. The critical frequency of flicker, as well as the speed of sensorimotor reaction,was established with the help of our model of a multifunctional multiprocessor device. We established the main factors determining the development of statokinetic stability, revealed the psychophysiological basis of improving functional stability in orienteers, and studied the specifics of movement interference resistance in sports orienteering [9].We also developed a set of psychophysiological means and methods for improving the stability of functional systems in orienteers, movement interference resistance in highly-skilled athletes, and statokinetic stability in athletes.

In orienteers, sports performance depends on a set of the integral and closely connected elements of cardio- and hemodynamics, psychological status, coordination abilities, and the speed of sensorimotor reactions. This allows us to treat the results obtained using the provisions of the Anokhin's theory of functional systems [1, 2], which proves a multilevel biocontrol mechanism of the athlete's body with the improvements of his sports potential.

Therefore, the improvement of the results obtained can be considered as a proof of the advantage of our method.

Authors' contribution

EvgeniyCherepov – supervision/methodology, VitaliyEpishev – formal analysis, Natalia Stoliarova – writing original draft, Irina Stovba – writing review and editing.

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