

Assessment of Highly Qualified Athletes Psychophysiological State by Vibraimage Technology

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Abstract: *The paper presents the results of using vibraimage, stabilometry and psychological testing methods to analyze the psychophysiological state of highly qualified athletes specializing in bullet shooting. Statistical analysis of athletes vibraimage parameters was carried out under the conditions of performing the Romberg stabilometric test with the priority of the influence of the visual analyzer and proprioception. The relationship between the parameters of emotions, psychophysiological states and stabilometric parameters of maintaining equilibrium in the tests of Romberg and the Target for highly qualified athletes specializing in bullet shooting is determined.*

Keywords: *highly qualified athletes, bullet shooting, vibraimage, psychophysiological state, computer stabilometry.*

Modern information technologies more and more persistently penetrate the field of monitoring the condition and fitness of athletes in preparation for the leading starts of the season. Psychophysiological diagnostics of individual characteristics and functional state is one of the most significant components of assessing the state of highly qualified athletes.

One of the modern technologies of psychophysiology is vibraimage technology (Minkin, 2007; 2020), which includes the method of computer processing of video images, reveals the features of vibrations and movements for investigated objects. As the indicator of body's response to internal and external factors, the characteristics of vestibular system functioning are used, which has multiple afferent and efferent morphofunctional connections with the cortical-subcortical formations of the central and autonomic nervous systems of the brain and spinal cord, as well as with neuroendocrine processes. At the same time, the vestibular-emotional reflex (Minkin & Nikolaenko, 2008) carries out a reflex change in the micromovements of the human head, which is in an upright free state due to muscle contraction that provides head support in the musculoskeletal system of the spine-neck. The vibraimage parameters reflect the results of the systemic response of the body and make it possible to quickly identify persons with impaired psychophysiological adaptation (Minkin, 2020).

Vibraimage technology is successfully used in solving a wide range of problems from lie detection to clinical diagnostics, which is supported by technical characteristics (quantitative assessment of emotions and psychophysiological parameters, information content of the vestibular-emotional reflex, non-contact, easy and friendly obtaining information) and provides an advantage over other psychophysiological technologies.

This actualizes the study of the possibilities of using this approach in the practice of sports training for the purpose of psychophysiological control of highly qualified athletes.

Purpose of the study. To study the informativeness of vibraimage technology using the VibraMed10 program (VibraMed10, 2020) in the field of assessing the fitness of athletes, taking into account the ratio of the recorded indicators with the data of control methods used in sports (Tarasova, Abramova, Nikitina, et al., 2019)

Methods and Results. The research carried based on the Federal Scientific Center for Physical Culture and Sports (FGBU FNTS VNIIFK). In accordance with the purpose of the study, a comprehensive investigation of 16 highly qualified athletes specializing on bullet shooting (5 men and 11 women) was carried out.

The investigation program included stabilometric (Pereyaslov&Sliva, 2002), psychological (Vorobieva et al., 2019) testing and measurement of psychophysiological parameters using the VibraMed10 program (VibraMed10, 2020).

Stabilographic characteristics of the vertical posture were recorded using a computer stabilizer analyzer “Stabilan-01” with biofeedback. To standardize the conditions for carrying out the stabilometric study, athletes were installed on a platform barefoot in a European (heels together, toes divorced at an angle of 30°) installation, for which stabilometric standard indicators were developed and approved.

Maintaining an upright posture was tested in the Romberg test with recording the parameters of holding the main stance in two modes: with eyes open (visual stimulation in the form of alternating circles of different colors) and with eyes closed (sound stimulation in the form of tonal signals). The indicators of statokinetic stability were taken into account (the velocity and square of movement of the common center of pressure — V_CCP and S_CCP , the scatter of oscillations along the coordinate axes — $P(Y)$ and $P(X)$, the quality of the equilibrium function — QEF). In addition, the contribution of the proprioceptive and visual components to the maintenance of the balance function (Romberg coefficient — the ratio of the CCP area in conditions with closed and open eyes). In addition, the “Target” test was carried out, taking into account the QEF and the integral tracking error (ITE).

Psychological examination is represented by an express diagnostic methodical psychological test to identify the level of severity of anxiety as a situational (reactive) variable and anxiety as a personality-typological characteristic of the “Integrative anxiety test” (IAT). Each characteristics includes 6 components that reveal the meaningful nature of self-assessment of an affective state determined by the test: emotional discomfort, asthenic component, phobic component, anxious assessment of prospects, social protection.

In general, IAT assesses anxiety and anxiety and is a tool for individual studies of the level of mental maladjustment, as well as for analyzing the main factors affecting the emotional state of the subject.

The method of measuring psychophysiological parameters by VibraMed10 program (VibraMed10, 2020) included video filming of an athlete’s face with a Sony HDR-CX580 camera, which carried out under conditions of stabilometric testing. Video recording from a Sony HDR-CX580 camcorder was processed by VibraMed10 program. The current psycho-emotional portrait of a person is compiled according to the results of frequency and amplitude analysis of vibraimage (Minkin, 2017), highlighting the parameters of

emotions and psychophysiological states in percentages from 0 to 100%, which can be divided into four groups.

The first group of conditionally negative emotional parameters includes: aggressiveness, stress, tension and suspect level (level of danger person to others). The second group includes conditionally positive emotional parameters: balance, charm, energy and level of self-regulation. The third group of emotional parameters includes physiological parameters: inhibition, neuroticism, depression and the level of happiness. The fourth group consists of psychophysiological parameters: extraversion, stability, satisfaction and period of brain activity (Minkin, 2020).

Results

The data obtained from the results of video processing during the Romberg test, aimed at assessing the possibilities of maintaining the vertical position of the body, indicate that most of the parameters of emotions and psychophysiological states of highly qualified athletes specializing in bullet shooting correspond to the limits of normal values, which is presented in table 1.

Table 1

Statistical characteristics of behavioral parameters (emotions and psychophysiological) of highly qualified athletes specializing in bullet shooting under conditions of the Romberg stabilometric test with the priority of the influence of the visual analyzer and proprioception

Behavioral Parameter	Romberg test, $X \pm \sigma$, %		Psychophysiological Norm, %
	Open eyes	Closed eyes	
E1 (Aggression)	48,0 \pm 5,1	50,5 \pm 4,3	20–50
E3 (Tension)	27,5 \pm 4,2	22,5 \pm 5,1*	15–40
E5 (Balance)	73,5 \pm 8,1	74,3 \pm 10,5	50–100
E7 (Energy)	46,2 \pm 4,7	50,5 \pm 6,5*	10–50
E9 (Inhibition)	13,6 \pm 1,9	15,7 \pm 2,2*	10–25
E11 (Depression)	14,2 \pm 3,0	13,3 \pm 3,8	20–50
E2 (Stress)	18,6 \pm 4,1	17,5 \pm 3,6	20–40
E4 (Suspect)	31,2 \pm 2,9	30,2 \pm 3,0	20–50
E6 (Charm)	81,6 \pm 4,5	83,2 \pm 4,8	40–100
E8 (Self-regulation)	77,5 \pm 5,8	77,8 \pm 3,8	50–100
E10 (Neuroticism)	11,7 \pm 6,1	13,9 \pm 5,8	10–50
E12 (Happiness)	19,2 \pm 5,3	19,7 \pm 4,8	14–60

* $p \leq 0,01$

The exception is, first, the level of happiness that deviates towards a decrease, considered by the authors of the methodology as the ratio of maximum information efficiency and minimum energy costs, reflecting in this case an obvious imbalance in the cumulative state. This is accompanied by tendencies of an increase in the relatively normal limits of the level of aggression and energy against the background of a decrease in neuroticism and stress, which was most significantly manifested in conditions of the priority of proprioception in the Romberg test. It should be noted that the conditions of the Romberg test with closed eyes contributed to increase in the level of energy and inhibition against the background of decrease in anxiety.

Analysis of the relationships between behavioral parameters (emotions and psychophysiological) and the stabilometric characteristics of holding the vertical position in the Romberg and Target tests revealed that the most informative in terms of the correspondence of stabilometry among the psychophysiological parameters obtained when processing video images with the VibraMed10 program is *Energy*. The behavioral parameter *Energy* was defined by the author of vibraimage method as the amount of expended physical energy (Minkin, 2020).

An essential point is the different stabilometric correlates of energy during video recording in various tests. The energy recorded in the Romberg test with a static body position and open eyes, with a high correlation, marks or predicts the main indicators of system behavior to shift CCP in order to match the target, as regards the speed of movement of CCP and the quality of balance function in the Target test (Table 2).

It is important that the concept of *Energy* in this context should be considered negative, because within the framework of the statistically revealed connection, athletes are characterized by high energy — shooters with a low level of QEF and a high rate of oscillation of the CCP, i.e. insufficient current readiness for implementation. The quality *Energy*, determined in the Romberg test with closed eyes (priority of proprioception), at the level of the average connection marks the speed of movement of the CCP while ensuring orthostasis, regardless of the influence of the visual analyzer or proprioception while maintaining the semantic emphasis of the connection: more *Energy* — higher the speed of oscillation — lower orthostatic sustainability. Among other indicators, the relationship may be random due to the small size of the group and the number of correlations. Nevertheless, the negative correlation of the CCP rate and *Happiness* parameter, revealed in various conditions of the Romberg test. At the average correlation level of the relationship indicates the ratio: high speed of movement of the CCP — a reduced level of balance of the system in terms of the proportion of information efficiency and energy costs — insufficient preparedness, which also correlates with the low level of *Happiness* parameter in the group under consideration (Table 2).

Analysis of the relationship between the indicators determined from the video image while maintaining the vertical position in the Romberg tests and the psychological characteristics determined in the psychological IAT showed, that most correlated among the psychophysiological parameters obtained when processing the video image by the VibraMed10 program, are the parameters *Inhibition* and *Aggression*. They negatively correlate with psychological traits in the IAT test (Table 3). Thus, athletes with a high level of *Inhibition* and *Aggression* are characterized by psychological instability associated with psychological fatigue, social insecurity, and an alarming prospect for

the development of a sports career. An important fact is that *Inhibition* parameter when registering with open eyes in the Romberg test largely marks the psychological traits of personal anxiety, while with closed eyes it marks the traits of situational anxiety.

Table 2

The relationship between behavior parameters (emotions and psychophysiological) and stabilometric parameters of maintaining balance in the Romberg and Target tests in highly qualified athletes specializing in bullet shooting

Test		Parameter	Test condition — Romberg test					
			Open eyes			Closed eyes		
			E7 Energy	E12 Happiness	E4 Suspect	E7 Energy	E10 Neuroticism	E12 Happiness
Romberg Test	Open eyes	V CCP		-0,67		0,64		-0,66
	Closed eyes	V CCP			-0,66	0,68		
		P(Y)				0,61		
		QEF			0,65			
Target test	Cursor visible	V CCP	0,74					
		QEF	-0,76					
	Selected area	V CCP	0,78				0,64	
		QEF	-0,79				-0,67	

Table 3

The relationship between behavioral parameters (emotions and psychophysiological) and indicators of the psychological state (IAT) in highly qualified athletes specializing in bullet shooting

Indicator	Test condition — Romberg test			
	Open eyes		Closed eyes	
	E1 Aggression	E9 Inhibition	E1 Aggression	E9 Inhibition
Situational anxiety				-0,73
Emotional discomfort				
Asthenic component of anxiety		-0,76	-0,63	-0,75
Phobic component	-0,61	-0,65		-0,74
Anxious assessment of perspective				-0,67
Social protection				-0,65
Personal anxiety	-0,62	-0,76	-0,64	-0,70
Emotional discomfort		-0,69	-0,77	
Phobic component	-0,71	-0,61		-0,61
Anxious assessment of perspective	-0,74	-0,75	-0,82	-0,69
Social protection		-0,71		-0,85

Conclusion

The conducted studies clearly indicate that the vibraimage technology can be informative and effective when used in the practice of monitoring highly qualified shooters in preparation for the leading competitions. Among the most significant indicators for shooters are the parameters E7 (Energy), E12 (Happiness), E9 (Inhibition), E1 (Aggression), which reflect the state of physiological systems that ensure balance and psychological stability.

At the same time, the pilot level of the research already at this stage opened up the possibilities of using the vibraimage methodology and the VibraMed10 program. Further research in sports practice will make possible to form the information field of the method, supplement and clarify individual concepts in order to use it in the scientific and methodological support of training national team athletes.

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