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Research Article

Psychophysiological Basis of Age Categories of the Euro-Arctic Region of the Russian Federation

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Abstract

The article presents the results of a study of the correlation of indicators of psychological and psychophysiological state, obtained by methods of psychological testing, bio electrography (gas-discharge visualization) and heart rate variability, galvanic skin response. Since the assessment of the bioenergetic status and the level of stress in the body by the method of gas discharge visualization is becoming more widespread, questions arise about the psychophysiological mechanisms of this method, including at the cellular and molecular levels. In the practice of researching the psychophysiological state of the inhabitants of the Far North, categories of people employed in extreme professions, including the military and athletes, it is important to use express methods for studying the psychophysiological state. This method is the method of gas discharge visualization, which makes it possible to assess the functional state of a person at a given moment in time under certain environmental conditions. In addition, it can be used outside a medical institution, it is convenient to use in the field, compact, mass-produced, and allows you to immediately get a conclusion on the functional state of the body, saving the data obtained for further research. The purpose of our study was to identify the general psychophysiological basis of psychological and psychophysiological express methods of gas-discharge visualization and the assessment of heart rate variability on the basis of conducting coupled studies of assessing the state of the body of children and adults. As a result of the study, multiple significant ($p<0.05$) correlation coefficients were found between the indicators of psychophysiological state, obtained by bioelectrography, heart rate variability, galvanic skin response, and psychological indicators. The results of the correlation analysis show that the criteria for assessing the psychophysiological state using the gas-discharge visualization method reflect the contribution of autonomic regulation to heart rate variability, galvanic skin response, and psychological characteristics. The predominance of sympathetic regulation is reflected in the relationship between the values of indicators of gas discharge imaging and heart rate variability. The results of the study of the general psychophysiological basis of the gas discharge visualization method based on conjugated experiments using other methods for assessing the state of the human body are presented.

Keywords: psychophysiological state; methods of psychophysiological research; heart rate variability; gas-discharge imaging, autonomic regulation, correlation analysis

Introduction

Life activity in the Arctic makes high demands on the capabilities of the human body, which must correspond to the load from the natural and technogenic environment [25]. The psycho-emotional state in high latitudes is most susceptible to the influence of natural Arctic agents that predispose to the occurrence of the "polar tension" syndrome, manifested by psycho-emotional and psycho-physiological disorders. The psychophysiological state of the inhabitants of the Arctic zone, including a high level of anxiety, depends on a combination of factors and their combinations, including gender, age, nature and working conditions, and climatic and geographic and geophysical features of high latitudes. The relevance of the problem of research is due to the high vulnerability of the inhabitants of the Arctic to the effects of high-latitude extreme

environmental factors, indicating the need for continuous monitoring of the psychological and psychophysiological state of the inhabitants using methods of rapid assessment and subsequent correction of the psychophysiological state based on modern mobile information technologies [11]. Psychology considers all children of influences, including extreme factors of the social and natural environment that affect the psychological and psychophysiological state of a person V.I. Panov described different areas of environmental psychology, united by the idea that the psychological problems of studying the consciousness and individuality of a person, his mental development, mental and physical health, etc. should be considered in the context of the systemic relations "man – environment" and "individual – living environment" [10]. In his work on cognitive research in neuropsychology, B.M. Velichkovsky noted the importance of applied types of research: "Applied research is often treated as something secondary that does not deserve to be included in the list of "real scientific...", the discoveries of fundamental science eventually become the basis for applied scientific activity [6, 7]. In psychophysiological studies, in addition to the traditional methods of research, such as encephalography (EEG), magnetoencephalography (MEG), and magnetic resonance imaging (MRI), hardware-computer complexes are used that can be used outside medical and research institutions for mass research of individual groups and categories of people when an express assessment of the psychophysiological state is required [26]. The assessment of the bioenergetic status and the level of stress of the body by the method of gas discharge visualization (GDV) is becoming more and more widespread [8]. In the practice of researching the psychophysiological state of the inhabitants of the Far North, categories of people employed in extreme professions, including the military and athletes, it is important to use express methods for studying the psychophysiological state. These methods must meet such criteria as the ability to assess the functional state of a person at a given time in certain environmental conditions, as well as use outside a medical institution. These criteria are met by the method of gas discharge visualization (GDV). The device for recording GDV is compact, easy to use in the field, commercially available, and allows you to immediately get a conclusion about the functional state of the body. Software and computer software for processing the results allows you to save the obtained data for their further research and analysis [6, 7, 8, 12]. Adaptation processes in the body require certain energy costs. Sufficient energy security is the key to the most adequate adaptation to the external environment. A low level of energy supply can lead to tension in the regulatory systems of the body, disruption of adaptation processes, and general homeostasis [1, 11, 20]. The method of gas-discharge visualization (bio electrography) makes it possible to assess the level of energy reserve, adaptive resources, and the degree of tension of the body's regulatory systems due to stressful influences. Evidence has been obtained to justify the use of the GDV method in medicine [14, 20, 21, 24], psychology [15, 16, 18, 23], and professional sports [15, 16, 19]. At the same time, the question of the psychophysiological basis of GDV measurements remains open. In the monograph by K.G. Korotkov suggested that GDV parameters are determined by the activity of the autonomic nervous system, but no evidence was provided [22]. In the work of G.H. Cioca showed correlations between GDV and HRV parameters and found that in situations where either the sympathetic or parasympathetic nervous system was activated, the HRV parameter corresponding to sympathetic regulation of the heart rate correlated with gas discharge imaging parameters [17]. In a situation that causes a positive emotional state, the HRV parameter, which correlates with GDV indicators, reflects the balance between the sympathetic and parasympathetic nervous systems. The works [5, 13] show the seasonality of joint changes in the parameters of GDV-grams and indicators of autonomic regulation of the heart rhythm. The purpose of the study is to identify the general psychophysiological basis of psychological and psychophysiological express methods of gas discharge visualization and assessment of heart rate variability based on conjugated studies of assessing the state of the body of children and adults. The object of the study is the psychophysiological state of the human body. The subject of the study was the relationship between the psychological and psychophysiological indicators of children and adults obtained by software and hardware systems. The hypothesis of the study is the assumption that the method of gas-discharge visualization has a common psychophysiological basis with the methods of heart rate variability, galvanic skin response, and psychological characteristics of the functional state of a person.

Materials and Methods:

The study of the psychophysiological state was carried out in accordance with accepted ethical standards and scientific requirements. Psychological characteristics were obtained on the basis of questionnaires: AAH - allowing forassessinghealth, activity, mood, SRPA (scale of reactive and personal anxiety) Spielberger-Khanin, assessing the degree of situational and personal anxiety (SA and PA, respectively), the duration of an individual minute (IM).IM reflects the psychophysiological state of the body, and its value is proportional to the degree of emotional stress. In healthy adults, an individual minute is a stable indicator that decreases with a decrease in adaptive resources [3]. The psychophysiological state was assessed on the basis of conjugated studies of the state of the body using the methods of GDV and HRV. Parameters of heart rate variability, based on the assessment of the variability in the duration of the cardio interval, make it possible to identify the contributions of central, autonomic, and neurohumoral regulation to heart rate variability, psycho-emotional state, and stress level. HRV indicators were measured using software and hardware systems "Reacor" and "Omega-M". HRV measurements were made within 5 minutes. HRV indicators were recorded: RR - cardio interval duration, HF - power in the high-frequency range 0.15 - 0.4 Hz, Mo – mode, VLF - power in the very low-frequency range, less than 0.04 Hz, humoral activity, A - leveladaptation, D - adequacy of regulation processes, H –an indicator of autonomic regulation, LF/HF–an indicator of sympathetic-parasympathetic balance. GDV – registration was carried out by the pulse analyzer "GDV-compact", (serial production EYUI 941 0204 0000TU, "Biotech progress", certificate of conformity NPOOC RU. MH05.H00725, N0490215). Psychophysiological indicators of GDV were recorded, such as S – the area of the glow of the fingers, E - entropy, Kf – shape factor, and Sym – symmetry [3, 5, 11]. The values of gas-discharge visualization respectively show the energy reserve, the degree of chaotic processes in the body, the psycho-emotional state and stress level, and the balance of central regulation. Groups of people of different ages (Protocols) living in the Arctic Zone of the Russian Federation were examined: 41 children, aged 5.6±1.28 years, and 113 adults, aged 34.47±7.62 years (24 women and 89 men); and 73 adults aged 58.39±4.59 years (22 women and 51 men). Data on heart rate variability in these groups of subjects were previously published [2, 4, 9].The inhabitants of the arch. Svalbard, working on a rotational basis. In addition to the assessment of the psychophysiological state by the methods of GDV and HRV, 43 volunteers (men and women) in the village of Barents burg, the Svalbard archipelago, blood pressure was measured, blood oxygen saturation (O_2) was assessed using a heart rate monitor, and galvanic skin response (GSR) was recorded from the fingertips using the REACOR complex. The galvanic skin reaction is used in psychophysiological studies as an indicator of "emotional" and "activity" sweating. Psychological characteristics were obtained on the basis of questionnaires: HAM - allowing to assess health, activity, mood, SRPA (scale of reactive and personal anxiety) Spielberger-Khanin, which assesses the degree of situational and personal anxiety (SA and LA, respectively), the duration of an individual minute according to Ilyin E.P. (IMA) [11]. IMA reflects the psychophysiological state of the body, and its value is proportional to the degree of emotional stress. In healthy

adults, an individual minute is a stable indicator that decreases with a decrease in adaptive resources [3]. Correlation mathematical analysis of indicators and their statistical processing were carried out in the STATISTICA-10 program. The level of significant differences was taken at $p<0.05$.

Results:

Correlation analysis revealed significant ($p<0.05$) correlation coefficients between indicators of psychophysiological state obtained using GDV and HRV methods in children and adults (Tables 1, 2). Statistically significant associations ($p<0.05$) of gas discharge imaging parameters and heart rate variability in children are presented: glow area (S) values with heart rate (pulse), cardio interval duration indicator (RR), mode (Mo), adaptation level value (A), an indicator of the psycho-emotional state (D) and the value of autonomic regulation (H); entropy index (E) with high-frequency power index (HF); shape factor values (Kf) with mode (Mo) and autonomic regulation index (H) (Table 1).

HRV/GDV parameters *	Pulse	RR	Mo	HF	A	D	H
S	0.48	-0.55	-0.64		-0.91	0.90	-0.92
E				0.53			
Kf			0.55				0.94

* HRV – Heart rate variability

GDV – Gas Discharge Visualization

Table 1. Significant correlations of HRV and GDV parameters for a group of children, $p<0.05$

In adults, there were also significant associations at the level of $p<0.05$ between the indicators of gas discharge imaging and heart rate variability: between the glow area (S) and mode (M0), parasympathetic activity indicator (HF), sympathetic-parasympathetic balance indicator (LF/HF), level of adaptation (A), an indicator of psycho-emotional state (D), an indicator of autonomic regulation (H);entropy indices (E) correlated with parasympathetic activity index (HF), adaptation level (A), psycho-emotional state index (D) and autonomic regulation index (H);shape factor (Kf) values correlated with fashion (Mo), parasympathetic activity index (HF), sympathetic-parasympathetic balance index (LF/HF), adaptation level (A), psycho-emotional state index (D); symmetry values (Sym) correlated with the indicator of sympathetic-parasympathetic balance (LF/HF) (Table 2).

HRV/GDV parameters	Mo	HF	LF/HF	A	D	H
S	0.19	0.16	-0.21	0.22	0.24	-0.24
E		0.19		0.28	0.28	0.27
Kf	-0.20	-0.15	0.29	0.24	0.24	
Sym			-0.32			

Table 2. Significant correlations of HRV and GDV parameters for a group of adults, $p<0.05$

These data show that GDV-grams, in fact, reflect the contribution of autonomic regulation to heart rate variability, the predominance of sympathetic regulation of performance in the relationship between GDV-gram values and indicators of heart rate variability: the smaller the glow area and the higher the shape coefficients, the greater the contribution sympathetic regulation of the heart rate. Known correlations of indicators of heart rate variability and gas discharge hazard in case of disease damage on a common psychophysiological basis, methods of GDV and HRV, reflecting the psychophysiological state of children and adults. Conducted research on the Svalbard archipelago [3, 4], showed significant ($p<0.05$) positive correlations of psychophysiological criteria of gas discharge visualization - area (S) at the level of $p<0.05$ with psychological indicators - activity, mood, duration of an individual minute (MI) and psychophysiological method - galvanic skin reaction, reflecting the state of the autonomic nervous system (Table 3) [3].

Parameters	S	Kf	Mo R-R-interval	LF (%)
GSR – galvanic skin response	-0.64	0.58		
IMA – duration of an individual minute according to Ilyin E.P.	-0.65		-0.61	0.50
SA – situational anxiety	-0.35	0.30		
PA – personal anxiety	-0.33	0.33		
Activity	0.32	-0.37		
A – level of adaptation	0.39	-0.41		
B – indicator of autonomic regulation	0.34	-0.34		

C – indicator of central regulation	0.33	-0.36		
D – psycho-emotional state	0.36	-0.38		
Health – an integral indicator of the state IARP	-0.43	0.39		
ARI – autonomic regulation index		-0.34		
The contribution of the parasympathetic system to autonomic regulation		0.45		
IARP is an indicator of the adequacy of regulatory processes		0.40		
SI – stress index	-0.37	0.40		
Mo – mode		0.33		

Table 3. Significant correlation coefficients of assessment indicators psychological and psychophysiological state, p<0.05

It is shown that with an increase in the area of GDV, psychological characteristics change: the index of IM decreases, the level of anxiety (SA, PA) decreases, and activity increases. The psychophysiological characteristics of HRV also change accordingly: the level of adaptation (A), indicators of vegetative (B) and central regulation (C), and an integrative indicator of the psycho-emotional state (D). An increase in the value of the shape coefficient indicates an increase in the level of anxiety, and a decrease indicates an increase in activity and an improvement in the integral psychophysiological characteristics of HRV. These data show that GDV-grams, in fact, reflect the contribution of vegetative regulation to heart rate variability, the predominance of sympathetic regulation is reflected in the relationship between GDV-gram values and indicators of heart rate variability: the smaller the glow area and the higher the shape factor, the greater the contribution of sympathetic regulation in heart rate. Significant correlations between heart rate variability and gas-discharge imaging in conjugate studies indicate a common psychophysiological basis for GDV, HRV, GSR methods and psychological tests that reflect the psychophysiological state of children and adults.

Discussion:

The correlation matrix analysis carried out during the study confirmed significant ($p < 0.05$) connections between PF indicators. In the case of linear correlation, when one indicator increases, another indicator also increases; in research in psychology, and often when one indicator increases, another indicator decreases. So, when studying the psychophysiological state using the GDV method, with an increase in the shape coefficient (Kf), the area indicator (S) decreases, which indicates the involvement of the body's systems in the process of responding to the external situation, the response of the sympathetic nervous system.

This example suggests a negative correlation. An example of a linear correlation, when as the level of anxiety increases, Kf may increase. A high Kf with a high S value may indicate high system voltage and serious pathology in the body, requiring immediate medical diagnosis.

Using the express GDV method, we showed differences between study groups of various categories.

The PFS indicators of older men and women were better than those of younger people, which was explained by differences in their adaptation. Also, the PFS of women turned out to be better than men of a similar age and living with them in the same municipal territory.

The conducted studies show that GDV is an adequate new method for screening the health status of the population and monitoring for studying the dynamics of functional state indicators under the influence of environmental factors.

Conclusion:

A comprehensive study of the psychophysiological state of various groups and categories of people who experience similar environmental influences (social, natural-technogenic, informational, etc.), using software and hardware methods, provides ample opportunities for studying the effects of these influences. These methods of studying the

body make it possible to obtain an express assessment of the functional state at a given time in a significant number of people at their workplace (study or professional activity), under experimental conditions in extreme conditions, do not require conditions in a medical institution and are easy to use. This study shows that there is a common psychophysiological basis between the assessment of the psychophysiological state of a person through gas discharge visualization and the methods of heart rate variability and galvanic skin response. This is evidenced by significant coefficients of correlations between the indicators of gas-discharge visualization and the indicators obtained using the HRV and GSR methods. In addition, in preliminary studies, significant ($p<0.05$) correlations were found between indicators of the state of the immune system (the content of leukocytes, monocytes, circulating immune complexes (CIC) in saliva and blood and the values of gas discharge visualization indicators in a sample of preschool children (41 people). The obtained results revealed a common psychophysiological basis of the gas discharge visualization method with other methods for studying the psychological state, such as the level of anxiety and activity; psychophysiological - heart rate variability and galvanic skin response, and physiological - blood oxygen saturation, immune components of biological fluids of the human body. The connection of gas discharge visualization indicators with biological processes in the body at the cellular and molecular level gives impetus to obtaining new fundamental knowledge about the physicochemical, molecular, and systemic mechanisms that mediate the relationship between the state of the internal environment and the psychophysiological response to external influences.

A comprehensive study of the psychophysiological state of the human body is relevant for medicine and science in general, and new scientific studies that clarify the place in the etiology, pathogenesis, and features of the course of many diseases are promising in finding ways to improve the efficiency of detection, prevention, and treatment of psychological disorders and improving the quality of human life.

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