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These are the conference proceedings from 27 papers presented at the 2nd International Open Science Conference "Modern Psychophysiology. The Vibraimage Technology" by scientists and specialists from Russia, Japan, China, Korea and the EU. The study of behavioral and mental processes using vibraimage technology in the fields of psychophysiology, physiology, medicine, psychology (general, social, sports, clinical) are discussed. The results of research and the use of vibraimage technology in practical areas are presented (safety, psychophysiological detection of deception, pre-shift psychophysiological control, control of the current psychophysiological state of an operator, sports, HR, vocational guidance, recruiting, determination of abilities and multiple intelligences in adults and children). The errors, accuracy, and algorithms for obtaining vibraimages are investigated. The absence of a correlation between the conscious and unconscious response of a person to stimuli is established. The hypothesis of the additive characteristics of personality and substantiated using additive parameters of consciousness and the unconscious was proposed. The concept of chronobiological rhythm of brain activity and the period of brain activity as function from the load on the brain are investigated. The influence of various stimuli on the psychophysiological state of a person are studied. The changes in a person's psychophysiological state with a changing intensity of mental and physical activity are analyzed, taking into account the profile of their main activities and different ethnicities. These studies of psychophysiological parameters were carried out using well-known vibraimage programs (Vibraimage PRO, VibraMed, VibraStaff, VibraMI, PsyAccent) as well as new vibraimage programs and methods (PsyComfort, VibraSport, WelcomEU).

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Part 1. VIBRAIMAGE AND HUMAN SCIENCES

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PSYCHOLOGY VS BIOMETRICS AND CONSCIOUSNESS VS UNCONSCIOUS. ARE CONSCIOUSNESS AND UNCONSCIOUS THE ADDITIVE PARAMETERS?

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Abstract: *This is a study of dependencies and the analysis of the correlation between consciousness and unconscious responses to stimuli upon presentation of line-opposite and complementary questionnaires. The absence of correlation between conscious and unconscious responses to the presented stimuli has been established. A hypothesis was developed to explain the lack of correlation between conscious and unconscious responses. An algorithm was proposed for calculating personality characteristics, including the summation and averaging of conscious and unconscious parameters.*

Keywords: *vibraimage, physiology of consciousness, psychophysiology, psychology, biometrics, conscious, unconscious.*

Modern science is becoming an increasingly narrow specialization as we continue to learn more about how the physical and physiological processes in the human body are interrelated and regulated by feedback (Wiener, 1948; Bernstein, 1967). In the last century, some scientists tried to look at a human as a single mechanism and tried to find common patterns for their characteristics (Pavlov, 1927; Wiener, 1948; Bernstein, 1967; Anokhin, 1966; Simonov, 1986), but in most modern scientific publications this approach is considered to be almost indecent. All this has previously been said by Wiener in the preface to his classic work on cybernetics (Wiener, 1948), and over the past 70 years, specialization in science has only gotten worse. However, such a process cannot go on forever. The accumulation of information in highly specialized scientific areas should lead to a qualitative leap in scientific development. The first Nobel laureate from Russia, the academician Pavlov, wrote: “It is often said, and not without reason, that science moves by impulses depending on the success of the methods. With each step of the technology, it is as if we take a step up, from which a wider horizon opens, with objects that were earlier invisible” (Pavlov, 1951). Vibraimage technology is an example of such a method that combines the processing of conscious and unconscious responses when conducting various studies (Minkin, 2008; 2017; 2018; Minkin & Nikolaenko, 2008). Vibraimage technology combines the methods of biometrics and psychology, allowing for the joint processing of conscious and unconscious human parameters, and characterizes this joint processing with uniform

mathematical parameters reflecting the psychophysiological state (PPS) of a person. The parameters of vibraimage technology make it possible to determine a person's abilities and predict human behavior in both the near and distant future (Minkin, 2018; Minkin et al., 2019). These features give vibraimage technology a competitive advantage over methods that only concentrate on measuring the biometric or psychological characteristics of a testee.

Many researchers have come close to understanding the relationship between the consciousness and the unconscious (Darwin, 1872; Sechenov, 1965; Anokhin, 1966; Simonov, 1986; Polonnikov, 2013). There exists the term *the physiology of consciousness* (Boring, 1933), but without empirical data and vibraimage technology, this theory cannot go beyond the unproven assumptions in existing research. The aim of this study is to prove this hypothesis about the additivity of conscious and unconscious human characteristics.

Method and participants

As an example of the interaction between the conscious and unconscious, we will consider the test results of a group of 855 high school and university students from St. Petersburg (ages 15–25) to questions from VibraMI programs with the Gardner12T questionnaire (Minkin, Nikolaenko, 2017; VibraMI, 2019). A second group of 210 high schoolers from St. Petersburg (ages 15–17 years) were tested by PsyAccent program with the T12 questionnaire (PsyAccent, 2019), conducted in 2017–2018 (Minkin&Myasnikova&Nikolaenko, 2019).

Testing was conducted on computers with IntelCore I7 processors and Microsoft LifeCam Studio webcams with a setting image format of 640×480. The illuminance of the testees was within 500–700 lux, the head size of each testee was at least 200 horizontals pixels, and the quality indicator in

VibraMI and PsyAccent programs exceeded 80%. The duration of each test was approximately 380 seconds.

Results

The results of testing by line-opposite and complementary questionnaires have been described in detail in a number of other articles (Minkin&Nikolaenko, 2017, Minkin&Myasnikova, 2018; Minkin et al., 2019). However, not enough attention was given to the issue of the lack of correlation between conscious and unconscious responses in all the tests carried out. In this paper, we will analyze data from over a thousand tests carried out by various vibraimage technology systems (VibraMI, 2019; PsysAccent, 2019) over the past two years. Since it would be wrong to mix the results obtained from different questionnaires, the results of the correlation matrix for 855 tests of VibraMI program are given as the first example. The results of the correlation matrix between conscious and unconscious responses upon presentation of stimuli by VibraMI program are shown in Table 1.

Table 1

Correlation matrix of conscious and unconscious responses according to the results of 825 subjects tested by VibraMI program

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	AB	IE
IA					-0,06				-0,08			
ET					0,05							
LM	-0,07			0,05		-0,07	-0,06				0,11	
BM									0,06			
VS			0,06					0,08	0,06			
NL		0,05	0,06	-0,07				0,06				
BK								-0,05	0,05			
MR				0,07								
AS					-0,06							
VL							0,05		-0,06			
AB				-0,05	-0,07							
IE				0,05					-0,05		-0,08	

From Table 1, it follows that the maximum Pearson correlation coefficient between conscious and unconscious responses does not exceed 0.11, which is negligible compared to the correlation coefficients obtained inside the conscious and unconscious responses and reaching values of 0.8–0.9 (Minkin&Myasnikova, 2018; Minkin&Myasnikova&Nikolaenko, 2019). We see a similar picture for almost all the studies conducted with a significant test group of at least 200 people. Table 2 shows the results of the correlation matrix between conscious and unconscious responses upon presentation of complementary stimuli by PsyAccent program.

Table 2

Correlation matrix of conscious and unconscious responses according to the 210 subjects tested by the Accent program

	SZ	AN	SS	PS	CC	CF	US	LB	EP	HS	HT	HC
SZ					0,11	0,17	0,17		0,07			
AN			0,07			-0,13		-0,07				
SS	-0,08		0,06			0,06		0,06		-0,15	0,07	
PS	-0,06		0,05				-0,09	0,08		0,07	-0,11	
CC	0,09			0,07	0,17		-0,13		-0,10		0,15	
CF				0,06	0,09	-0,10		0,12			-0,06	
US	-0,10	-0,07	-0,05	0,09		-0,07	-0,08	-0,10	0,05			0,14
LB		-0,19		0,08	0,05	0,05	0,11		-0,11			
EP						0,17		0,07	-0,08			0,13
HS		0,05		-0,06			0,09	0,08	-0,21	0,06		
HT					-0,06	0,17		0,14		-0,05		0,05
HC		-0,13	-0,11	0,08			0,08		-0,07		0,14	0,06

When conducting research, we noticed that increasing the number of testees in the sample leads to an increase in significant correlations and a decrease in random correlations. Therefore, the presence of correlation coefficients (between conscious

and unconscious responses) of level 0.17–0.19 in a sample of 210 subjects decreases markedly when the sample is increased to 800–1000 people. For the contrast of the lack of correlation between the conscious and unconscious responses of the testees, I will present data on the correlation between the conscious and unconscious responses in Tables 3 and 4 respectively.

Table 3

Correlation matrix of conscious and unconscious responses based on the results of 210 subjects tested by PsyAccent program

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		-0,38277																						
2	-0,38277		-0,44639																					
3		-0,44639		-0,54147																				
4			-0,54147		-0,4069																			
5				-0,4069		-0,53241																		
6					-0,53241		-0,44862																	
7						-0,44862		-0,46365																
8							-0,46365		-0,46134															
9								-0,46134		-0,42592														
10									-0,42592		-0,46355													
11										-0,46355		-0,41459												
12											-0,41459		-0,42794											
13												-0,42794		-0,48078										
14													-0,48078		-0,44861									
15														-0,44861		-0,38785								
16															-0,38785		-0,46673							
17																-0,46673		-0,59772						
18																	-0,59772		-0,47366					
19																		-0,47366		-0,41611				
20																			-0,41611		-0,41791			
21																				-0,41791		-0,51536		
22																					-0,51536		-0,5415	
23																						-0,5415		-0,39433
24																							-0,39433	

The average level of negative correlation (Pearson coefficient) between neighboring questions is –0.46 according to the test results of 210 testees in Table 3.

Table 4

Correlation matrix of the conscious responses based on the results of 350 subjects tested by VibraMI program

	IA	PH	LM	BM	VS	NL	BK	MR	AS	VL	CR	IE
IA												-0,30
PH											0,31	
LM										-0,67		
BM									-0,34			
VS												
NL												
BK												
MR												
AS				-0,34								
VL			-0,67									
CR		-0,31										
IE	-0,30											

The correlation matrix of conscious responses according to the results of 350 subjects tested by VibraMI program shows the presence of a negative correlation for opposite centrally symmetric types of MI located on opposite sides of a line-opposite questionnaire (Table 4).

The reduced number of testees in the sample to 350 is associated with the change of stimuli in VibraMI program and the replacement of the opposition pair (2–11) of MI types to the philosophical-creative, explained in a different study (Minkin et al., 2019).

Discussion

What does the lack of correlation between the conscious and unconscious responses to stimuli show? First, it demonstrates the independent functioning of the human physiological systems that are responsible for conscious and unconscious responses to presented stimuli. Another study (Minkin, 2019) showed that the existing significant negative correlation of the unconscious responses upon presentation of neighboring stimuli does not depend on the semantic load linked with the corresponding stimulus. In another paper (Minkin and Myasnikova, 2018), it was shown that for a conscious response there is also a positive correlation to similar stimuli that are temporally separated. Since there was a single technical and methodological apparatus for the processing of conscious and unconscious responses, which would show a correlation in the samples if one was present, the lack of correlation between the conscious and unconscious responses should be considered an objective and proven phenomenon. A conscious response, in keeping with Pavlov (Pavlov, 1951), should be considered a function of higher nervous activity and the work of an independent physiological system responsible for the conscious processing of information or a conditioned reflex. Then the operation of all human physiological systems, the primary aim of which is the performance of the functions of each physiological system separately and the vestibular system in particular, since it is responsible for supporting mechanical equilibrium, should be considered an unconditioned reflex.

Let us consider the same question from a somewhat different viewpoint, having reformulated it into a simplified physical problem. Is it possible to characterize an object's overall properties by measuring its individual characteristics? For example, is it possible to measure the value of a resistance if we take electrical resistance of 1 ohm, but not knowing its value, and measure the electrical current flowing through it many times at different applied voltages, but not measuring this voltage? Even schoolchildren would answer that according to Ohm's law, resistance cannot be measured, even if the electric current is measured a thousand times. In order to determine the resistance value, it is necessary to measure the electric current and the voltage drop on the resistance.

Measuring personality characteristics, emotions, PPS, and abilities are probably more difficult than measuring the value of electrical resistance. However, for some reason this hasn't stopped the majority of researchers who determine personality according to the parameters associated with conscious responses in psychology (Eysenck, 1981) or biometric parameters, such as the genome, in genetics (Deary et al., 2006), or fingerprints in dermatoglyphics (Dholiya, 2017). At the same time, after Freud's foundational work on the unconscious (Freud, 1900), no one doubts that the unconscious plays an important role in a person's behavior, determining a person's abilities and predicting

their actions. Darwin's theory of evolution (Darwin, 1872) proves that, in order for species to survive, nature cannot provide different physiological systems with the same functions. Suppose that nature has given man a consciousness, balancing it with an unconscious (autonomous) physiological algorithm, endowing them with naturally different functions for a more objective assessment of any event taking place. It is possible to call these processes reflexes (conditional and unconditional), or physiological processes (physiology of consciousness and physiology of the unconscious) — it's just a matter of terminology. The results we obtained allow us to draw the following conclusion: a separate analysis of conscious or unconscious information can NEVER provide complete and objective information about the behavior, abilities, and significant characteristics of a given personality. A personality is based on the sum total of conscious and unconscious characteristics.

According to Table 3, the unconscious response of a person is the most rapid and decisive in making decisions on fast stimuli. The conscious response is key in making decisions on stimuli spread out in time. Both of these psychophysiological mechanisms determine a personality and the use of only one of these components cannot accurately characterize a person, just as it is impossible to solve a system of equations in which the number of unknowns exceeds the number of equations. VibraMI, PsyAccent, and other vibraimage programs with biological feedback carry out a simple mathematical averaging of conscious and unconscious characteristics. There is now convincing evidence that this approach is the most correct for an assessment of personality characteristics. How correct this procedure is and whether these parameters are additive needs to be confirmed or disproved in further studies. The proposed processing algorithm is the simplest, which is why it was used for the joint processing of conscious and unconscious parameters.

Conclusions

Vibraimage technology is the first technology in the world to yield psychophysiological measurements, offering automated algorithms for processing conscious and unconscious human responses to stimuli. The proposed algorithms allow for a more accurate assessment and measurement of a person's abilities, capabilities, personality, behavior, and psychophysiological parameters. This study proves that conscious and unconscious parameters are additive and subject to joint mathematical processing to achieve a correct characterization of a personality. The proposed principle of the additivity of conscious and unconscious parameters coincides with expert assessments used to characterize personality. At the same time, automated measurement of personality parameters (multiple intelligences profile, psychological accentuations) is a more objective method of personality assessment than assessment by experts.

The development of vibraimage technology with conscious and unconscious parameters can be used in fields such as education and security, and allows for the achievement of better results in HR, recruiting, career guidance, team compatibility, and personal success in various fields.

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THE PSYCHOPHYSIOLOGICAL FORMATION OF BRAIN ACTIVITY RHYTHM

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Abstract: *We studied the changes in psychophysiological responses with periodic stimuli presentation. It was established that the period of visual and verbal stimuli presentation while conducting various types of questionnaires coincides with a person's physiological response to the presented stimuli. We propose a model of psychophysiological regulation, including the conscious regulation of physiological processes. The natural human psychophysiological rhythm and brain activity period (BAP) are determined in a very low frequency (VLF) range (30–60 seconds period).*

Keywords: *vibraimage, physiology of consciousness, psychophysiology, stimuli, chronobiology, brain activity period (BAP), VLF.*

According to Franz Halberg's chromone theory (Halberg, 1987; Blank M. A., Blank O. A., 2010), it can be assumed that endogenous rhythms of the human brain can occur in all frequency zones of biological rhythms: ultradian (< 20 h), circadian, and infraradian (> 28 h) (Khetagurova, 2010). It is known that with the help of external influences, for example rhythmic photostimulation during electroencephalography, it is possible to diagnose certain brain diseases (Trenité, 1999, 2012). Another well-known method of periodically influencing a person's subconscious mind is the ambiguously interpreted technology of 25 frames (Loftus & Klinger, 1992). However, the conscious formation of physiological rhythms under the influence of the presented stimuli still remains an under-studied phenomenon, despite the theoretical and practical relevance of this problem when studying consciousness or conducting a testing. Work on the physiology of consciousness (Boring, 1933) has been around for a long time, and the term itself was introduced in the 1930s prior to the appearance of chronobiology as an independent scientific direction. Heart rate variability studies are also widely presented (Baevsky et al., 2001; Shaffer & Ginsberg, 2017) as medical and chronobiological research. Researchers of heart rate variability (HRV) have shown the complexity of the mechanism involved in the regulation of cardiac activity (Bayevsky et al., 2001; Chibisov, 2018), including various physiological processes and a two-level model of regulation, one of the components of which is brain activity (Baevsky et al., 2001; Fleischman, 1999, 2014). However, most studies of HRV are focused on the internal regulation of physiological processes without taking into account the work of consciousness.

The aim of this article is to present an experimental study of psychophysiological and chronobiological factors affecting the period of human brain activity in the VLF frequency range.

The first objective of this study was the external formation of the period of brain activity upon presentation of stimuli close to the period of presentation for the natural period of brain activity in the VLF frequency range. The second main objective of this

study was to identify the natural period of brain activity in the VLF frequency range using vibraimage technology.

Materials and methods

For our example of psychophysiological rhythm formation, we analyzed the results of a test group of 825 high school and college students (aged 15–25 years) using VibraMI program with the Gardner12T questionnaire (Minkin&Nikolaenko, 2017; VibraMI, 2019). The second group study of 210 high school students (aged 15–17 years) from St. Petersburg schools was carried out using PsyAccent program with the T12 questionnaire (PsyAccent, 2019), conducted in 2017–2018. The testing was done on computers with an IntelCore I7 processor, Microsoft LifeCam Studio webcam, and setting resolution of 640×480 pxl. The illuminance of the test subjects was within 500–700 lux, the horizontal measure of testees' heads was at least 200 elements, and the image quality indicator in VibraMI and PsyAccent programs exceeded 80%. The duration of each test was approximately 380 seconds.

The results of 100 tests (natural physiological rhythm formation) in the course of the work of five photolithography operators (20 tests done by each operator) were analyzed while the responses for asynchronously generated stimuli were studied. VibraMed10 program (VibraMed10, 2019) was monitored by operators aged 30–59, and this testing was conducted in 2019. Testing was carried out by computers with an IntelCore I7 processor, Microsoft LifeCam Studio webcam, and image resolution of 640×480 pxl. The illuminance of the test subjects was within 500–700 lux, the horizontal measure of testees' heads was at least 200 elements, and the image quality indicator in VibraMed programs exceeded 60%. The duration of each test was approximately 380 seconds.

VibraMI, PsyAccent and VibraMed10 programs measure the psychophysiological state (PPS) and time dependences throughout the test.

Test Results

In the process of testing with VibraMI and PsyAccent programs, subjects are presented with a stimulus image and textual information, to which they (during the presentation time) had to either answer in a Yes/No format or ignore the answer to the presented question. Each question was presented for approximately 16 seconds with slight fluctuations from question to question, since the duration of the presented textual information is slightly different (from 5 words in a question of minimal length to 10 words in a question of maximum length). VibraMI and PsyAccent programs differ in the semantic content of the questions (VibraMI, 2019; PsyAccent, 2019), however, the period of change in physiological parameters identified by these programs and presented in Figures 1 and 2 was approximately the same (34 seconds for VibraMI, 30 seconds for PsyAccent) and approximately equal to the time of presentation of two questions (32 seconds). The averaging of the data from FFT processing spectrograms was carried out by the mean (Avg) and median (Median) values obtained during each test.

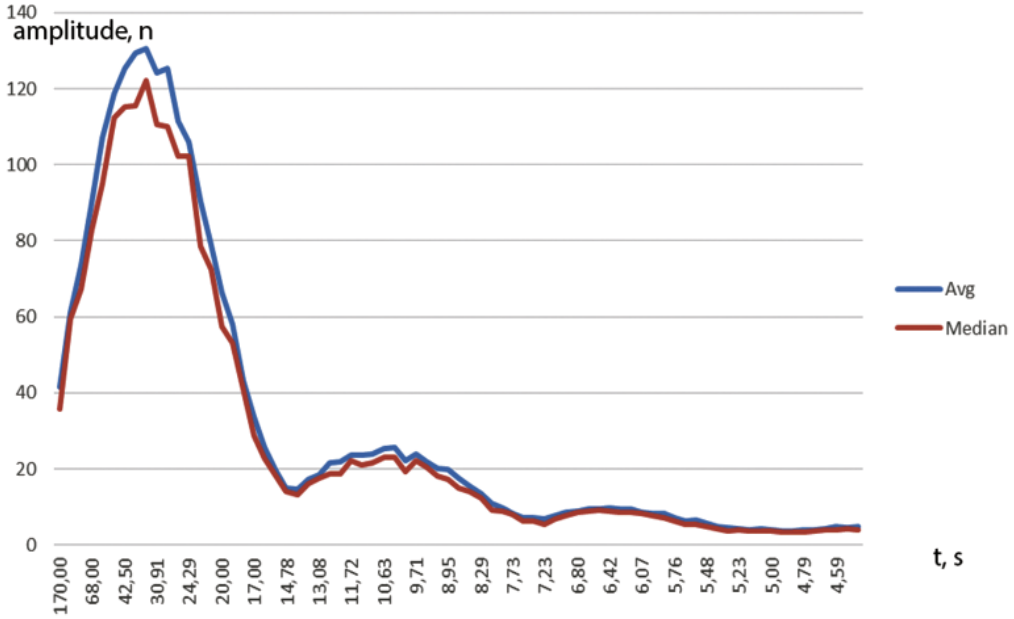

Fig. 1. PPS spectrogram calculated by FFT for 825 tests conducted by VibraMI program

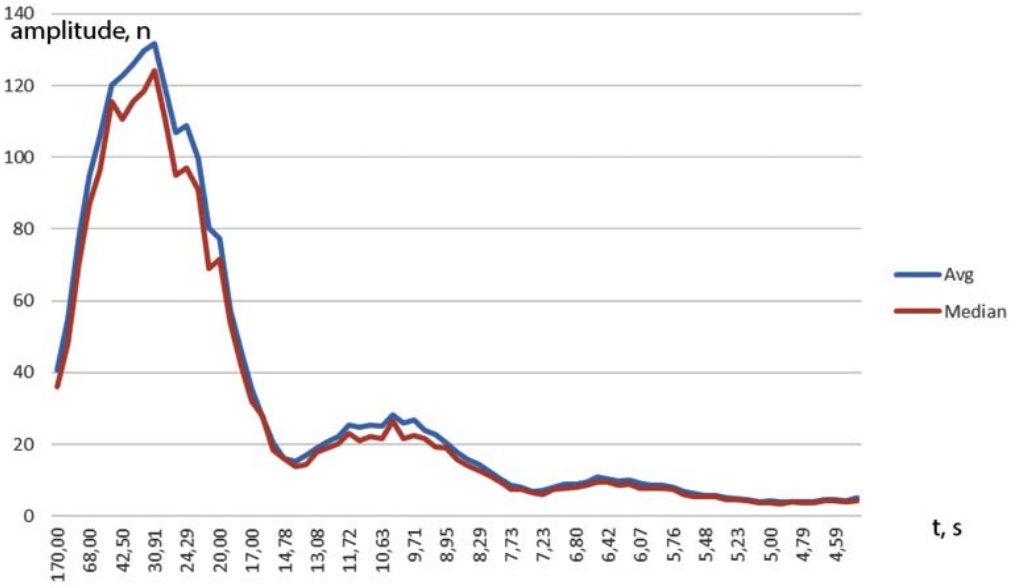

Fig. 2. PPS spectrogram calculated by FFT for 210 tests conducted by PsyAccent program

According to the available data in the maximum range, the discreteness of determining period samples by the FFT was approximately 4 s, therefore it should be considered that the maximum in Figure 1, which is 34, is the closest reading to the period of stimulus presentation, including the presentation of 2 questions — 32 s (Minkin & Myasnikova, 2018). The maximum in Figure 2 corresponds to a period of 30.91 seconds, the next period countdown is 34 seconds. Thus, with an accuracy within one FFT sample, both maximums on the graphs coincided with the stimuli presentation period and, therefore, when conducting surveys with programs using different questions, the period of change in the PPS of the testee does not depend on the content of the questions, but is determined by the external rhythm of presentation of incentives. Figure 3 shows the FFT spectrogram that was obtained by an operator using VibraMed program for the same time of 380 seconds. The work of the operator allows for the emergence of unsynchronized (without a specific presentation period) stimuli, i.e. responses to stimuli can occur at arbitrary points in time.

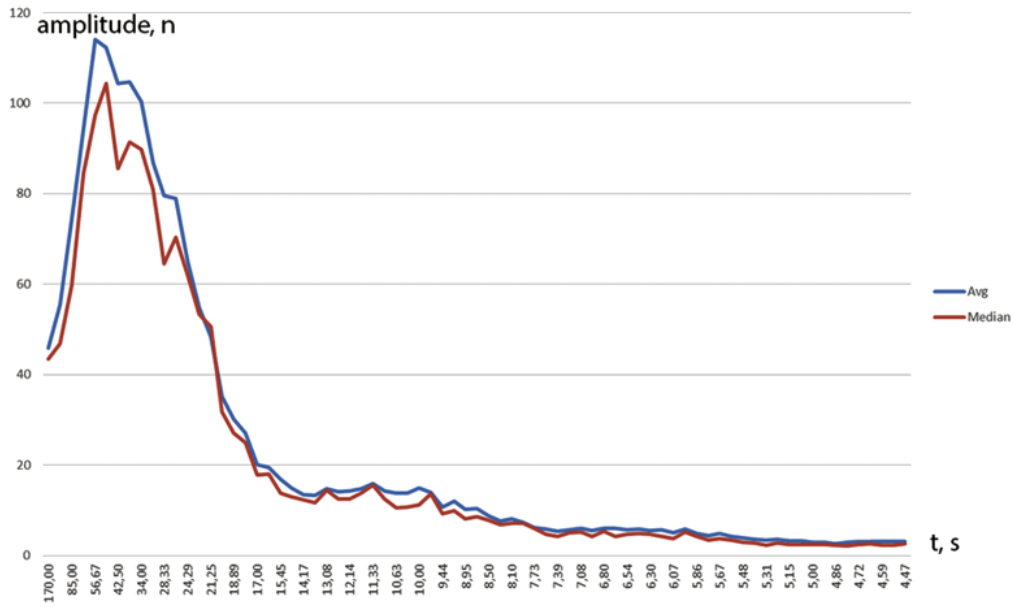

Fig. 3. PPS spectrogram calculated by FFT for 100 tests conducted by VibraMed program

It is interesting to note that when testing photolithography operators in the process of working with arbitrary stimuli, there was a clear shift in the period maximum towards frequencies lower than the tested ones, which were presented with stimuli in a period of 32 seconds. The maximum value of the FFT spectrogram in Figure 3 corresponds to a period of 56.67 seconds on average and 48.57 seconds as a median.

Discussion

In this study, the analysis of changes in the physiological state of the subjects was processed by vibraimage technology (Minkin & Shtam, 2008; Minkin, 2007; 2018, Blank et al., 2012). Testees were in a quasi-stationary state, making barely any movements at all, and only watched the questions and stimuli appearing on the monitor. The physical activity of the subjects was therefore close to zero, the physiological activity can be conditionally considered as a constant, having periodic fluctuations associated with the flow of natural physiological processes in the human body (respiration, heartbeat, etc.). The only unstable value (affecting metabolism) was brain activity, which responds to the presentation (and disappearance) of new stimuli and questions. It is logical to assume that the presentation of a new stimulus to the subject should cause an increase perception processes and information processing in the human brain, and an increase in the energy consumed by the subject. After answering any given question, conscious thinking processes should slow down and energy consumed should decrease. Since the human brain is the main consumer of oxygen (Tamar, 1976), an increase in brain activity intensity should be noticeable by the increase in energy consumption by the whole body. Based on these considerations, one might assume that the period of change in a person's physiological state should coincide with the time of presentation of a question and stimulus to the subject.

However, when we look at Figures 1 and 2, we see that this is not the case. Previous studies (Minkin & Myasnikova, 2018) have shown that the presentation of each individual stimulus disrupts the natural equilibrium of a person's PPS, and the presentation of the next stimulus shifts the PPS back in the opposite direction. If we consider the change in PPS on the axes of information-energy (information efficiency of the physiological systems' functioning — the energy consumed by a person), then upon presentation of significant questions, an inverse correlation was established between a subject's information and energy parameters (Minkin, 2018). This mechanism of psychophysiological regulation means that the period of change for PPS is the presentation time of two questions/stimuli, and the adjustment of physiological mechanisms to the external rhythm occurs almost instantly after the presentation of the first question/stimulus.

It is interesting to note that natural physiological processes (heart rate, breathing) are almost imperceptible against the background of the work of consciousness, which imposes its rhythm onto the work of all physiological systems. It turns out that it is the processes of consciousness (the psyche) that are in this case conducting the work of physiological systems, which is to say that nature gave the brain the right to use the body's resources as it sees fit. In previous studies of HRV, Fleischmann found a noticeable maximum on Fourier spectrograms in the VLF (very low frequency) band with a period in the range of 30–60 seconds (Fleishman et al., 2014 a, b). Moreover, Fleischman connects this maximum to the work of the brain and the psycho-emotional state, and an analysis of the medical diagnostics of the patients being studied was carried out depending on their functional state.

In this study, rather than analyze a testee's medical indicators, we analyzed their conscious and psychophysiological (unconscious) responses to various semantic stimuli, which allows us to suggest a number of new hypotheses. The different shapes and magnitudes of the maximum in spectrograms for free and imposed rhythms shows that the human brain can adapt to the frequency of external stimuli if the stimuli presentation period is less than the natural period of regulation of brain activity, which usually does not exceed 60 seconds.

Along with the active work of the brain, there is natural psychophysiological regulation of brain activity, which does not allow brain activation for more than half a period — 30 seconds. The human body has something analogous to the graphite rods of a nuclear reactor that keep it from overheating. The physiological causes of this phenomenon can be quite complex, but the phenomenon of periodic brain activity should be considered proven. It is possible that this process has an acquired character, is determined by dynamic connections in the human brain and does not have rigid double-circuit regulatory mechanisms as proposed by researchers of HRV (Bayevsky et al., 2001, Fleishman, 1999, 2014). The study of brain activity dynamics using vibraimage technology can establish the mechanism of rhythmic brain activity, since vibraimage technology does not influence testees' brain loads. Naturally, the brain activity period (BAP) has a certain variability (like heart rate) for each person and depends on many factors. In this study, we see the period in the range of 35–60 seconds for natural rhythm and 30–35 seconds for imposed rhythm.

The presentation of external stimuli (imposed rhythm) can slightly change the BAP, but most likely, it will be in the VLF range from 30 to 60 seconds. The study of BAP dependence on various factors needs to be researched further. We believe that, in contrast to heart rate, the lower-frequency process of brain activity is better characterized by period (time) parameters than frequency, and therefore we suggest introducing the term *brain activity period* or BAP. While pulse activity has been studied for over 5,000 years, the study of periodic activity in the brain is just beginning. The use of the term BAP also allows you to distance yourself from the traditional EEG frequency ranges of 1–50 Hz (delta, theta, alpha, betta, gamma) (Tatum, 2014), which characterize the brain's current activity rather than its chronobiological activity. Perhaps this technology will make managers' dreams come true by allowing them to remotely control the process of their workers' mental labor. It is logical to assume that, just as exercise causes an increase in pulse rate, so a mental load should cause a decrease in the period of brain activity. Confirmation of this dependence was given in the article devoted to the study of BAP for varying brain loads of a subject (Minkin&Kachalin, 2019).

Conclusions

The data we obtained on the practically instantaneous adjustment of a person's physiological parameters to an externally imposed rhythm with the help of processes of consciousness is of particular interest, since it reveals a person's adaptive capabilities from the influence of external factors. Data of brain activity period obtained by two independent technologies (HRV and vibraimage) confirm the indisputability of this

phenomenon, despite the fact that BAP is not a widely known subject to date. There is a noticeable lack of attention being paid to the VLF range in the rather widespread and long-studied electroencephalographic studies, which focus on higher frequency ranges, showing current brain activity rather than chronobiological processes.

The heightened sensitivity and informational content of the vestibular system, as an integral characteristic of the PPS (Minkin, 2018) allows for the visualization of integral PPS changes alongside changes in external factors and autonomous chronobiological processes. Measuring blood flow in the brain is too complicated to collect reliable statistics on a large number of subjects and identify brain pulse activity (Butler, 2017), and the study of HRV and ECG is usually performed on electrodes that reflect general blood flow rather than brain activity. At the same time, when subjects (patients) are participating in medical studies (EEG and ECG), they are usually in a relaxed state and do not have significant brain activity, which has also prevented the BAP effect from being established sooner. In conclusion, the objectives of this study were fulfilled, and the period of brain activity that was revealed can be considered as one of the basic psychophysiological characteristics of a person.

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ANALYSIS OF BRAIN ACTIVITY PERIOD IN VARIOUS HUMAN ACTIVITIES BY VIBRAIMAGE TECHNOLOGY

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Abstract: *An experimental study of a person's brain activity period in the very low frequency (VLF) range during the performance of three different activities. The variation in brain activity period according to type of work being performed is demonstrated. A hypothesis is proposed explaining the dependence of brain activity period on the brain's mental load.*

Keywords: *vibraimage, psychophysiology, brain activity period (BAP), natural regulation of brain activity, response to stimuli, VLF.*

In the study of the psychophysiological mechanisms of brain activity period formation (Minkin, Blank, 2019), it was hypothesized that the period of brain activity in the VLF range (very low frequency, period of 30–60 seconds) (Fleishman, 1999, 2014, 2015) is a function of the mental burden on the brain. The purpose of the present study was to test this hypothesis and to obtain statistically reliable measurements of the brain activity period of a testee solving various mental problems.

Methods and Materials

We measured the brain activity period of a subject, a 29-year-old man who works as a programmer and who holds the title of CM in chess. The measurements were obtained during working hours while the subject performed production tasks from 11 a.m. to 6 p.m. in March 2019. The subject's activities consisted of programming and working with documentation. As a break between solving production problems, the subject played blitz games of chess online with a limit of one minute per game (approx. 1 move every 2 seconds). The period of brain activity was measured by vibraimage technology (Minkin, 2008, 2017, 2018) while controlling the vestibular-emotional reflex (Minkin & Nikolaenko, 2008, Blank et al., 2012).

Microsoft LifeCam Studio web camera with a resolution of 640×480 elements and frame rate of 30 Hz was fixed to the monitor in front of the test subject. The image of the subject's head on the webcam's photodetector was not less than 200 elements horizontally. Video processing and the determination of data on the current value of the subject's psychophysiological state (PPS) was determined by VibraMed10 program (VibraMed10, 2019). The default program settings were used, except for the PPS measurement time, which was set to 380 s.

The statistical processing of the results was done by the VibraStat program (VibraStat, 2019), which carried out the summation and averaging of the current

PPS using the Fourier fast transformation (FFT) algorithm (Heideman et al., 1984). 78 measurement results were captured while the subject was occupied with documentation, 38 measurement results were captured while he was occupied with programming, and 38 measurement results were captured while he was playing chess. Each PPS measurement by VibraMED 10 testing included 380×5 = 1900 counts of the PPS, since the frequency of PPS measurements was 5 counts per second.

Results

The results of FFT processing and the averaging of 78 PPS spectrograms when the subject was occupied with documentation and reading technical literature are given in Figure 1.

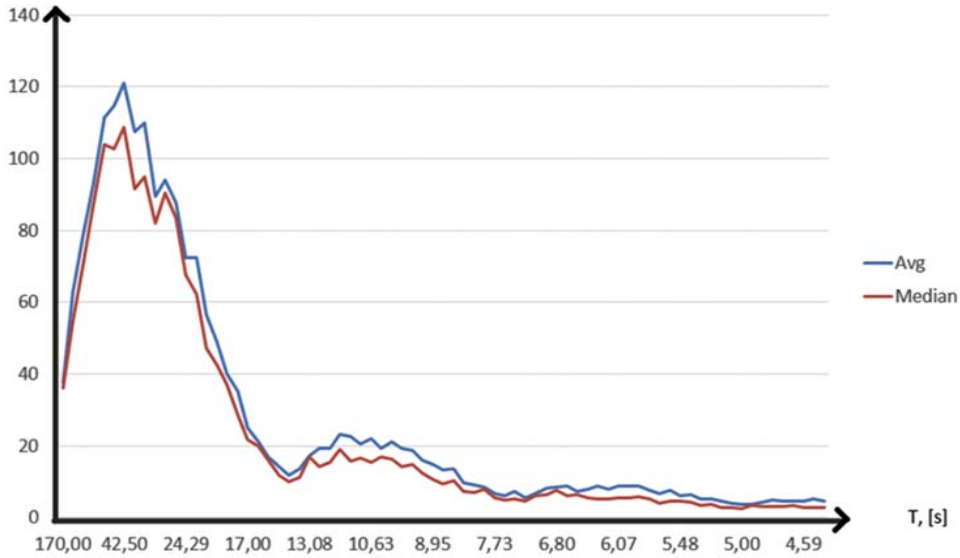

Fig. 1. Averaged FFT spectrogram of PPS changes in subject's brain activity when occupied with documentation

The averaged spectrogram obtained in Figure 1 has a maximum of 48.5 seconds. The maximum determined by the mean and median value when averaging the Fourier spectrograms coincides with this value.

The results of the FFT spectrogram averaging when measuring the subject's PPS during programming are shown in Figure 2.

The spectrogram obtained in Figure 2 has a maximum of 42.5 seconds. In this case, the maximum determined by the mean and median values when averaging the Fourier spectrograms coincided with the results.

The results of averaging the FFT spectrograms measuring the subject's PPS while playing chess are shown in Figure 3.

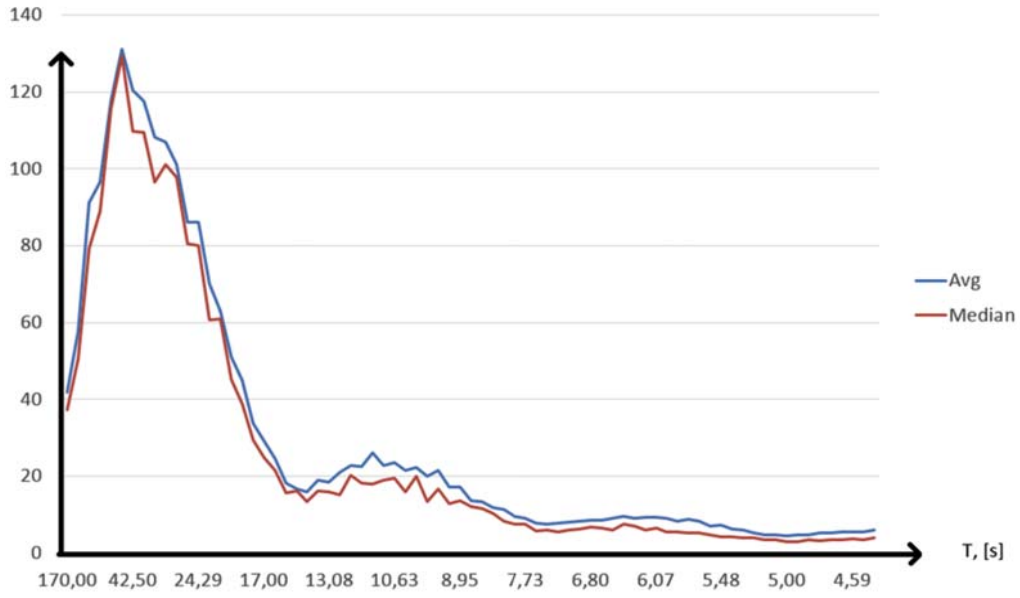

Fig. 2. Averaged FFT spectrogram of PPS changes for subject's brain activity when occupied with programing

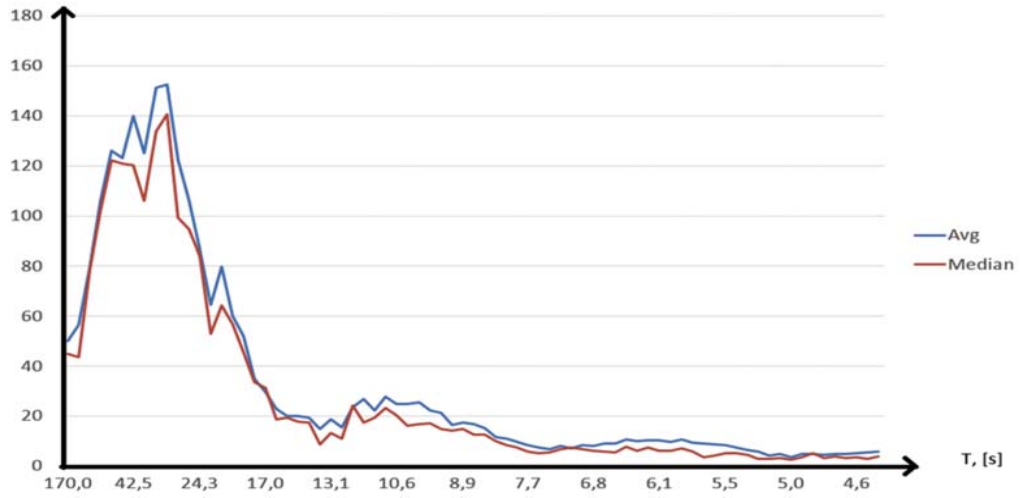

Fig. 3. Averaged FFT spectrogram of PPS changes for subject's brain activity while playing chess

While these measurements were being taken, the subject was engaged in playing chess. The spectrogram obtained in Figure 3 has a maximum of 34 seconds, meaning the period of maximum brain activity was 34 seconds.

Figure 4 shows the dependence of the maximum value (brain activity periods) of the averaged spectrograms of the data in Figures 1–3 on the type of activity the subject was engaged in while being tested.

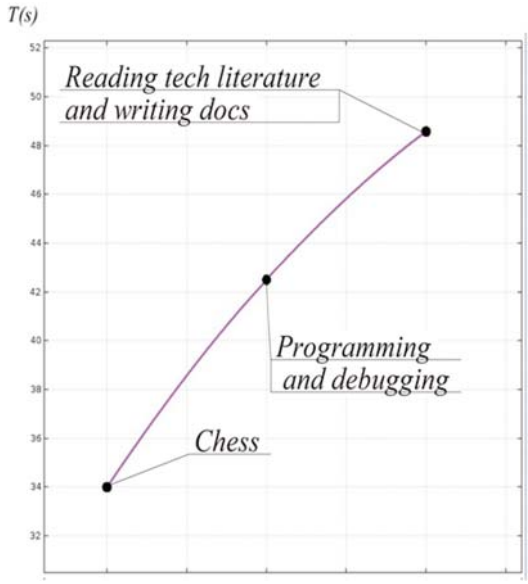

Fig. 4. Dependence of brain activity period (in seconds) on type of activity

The number of tests for different types of activity turned out to vary based on the subject's current production load, since one of the objectives of this study was to influence the subject's standard production process as little as possible. To that point, the identity of the maximum estimates for the arithmetic mean and median average confirms the reliability of the estimates obtained (Novitsky, 1975).

Discussion of the Results

Studies have demonstrated the dependence of the period of change in PPS on the type of activity of the subject being tested. Since the subject was not engaged in physical labor during this test, it had previously been proposed (Minkin, 2019) to associate the change in the subject's PPS with the burden on the brain. Consequently, it is logical to assume that a difference in mental burden on the brain leads to a change in the period of brain activity, just as an increase in the physical load on the human body leads to an increase in heart rate (Fleischman, 1999).

Since the period is an inverse function of frequency, then, by analogy with the heart rate, it turns out that the subject expends the maximum energy when playing chess, slightly less when programming, and working with documents takes the smallest mental toll. It is interesting to note that, according to the subject's testimony, he considers himself excellent at chess, average at programming, and below average

in working with documents. If we summarize the data, it turns out that the brain activity that is pleasant for a person places a greater burden on the brain and requires a large amount of energy from it, while an activity that is unpleasant for a person requires less brain activity.

To clarify, we mean the physical expenditure of energy on brain activity. Physically, the assumption looks logical enough, because if a person is highly skilled at a certain kind of activity, then naturally her brain works as efficiently as possible, that is, it performs the maximum number of operations, and the maximum number of information transfers between brain neurons occurs. Activity that is unpleasant is characterized by low efficiency and low transmission of information between the neurons of the brain, which means less energy is spent on it. Some may argue that this is nothing new, that this has all been discussed before by Wiener and Bernstein (Wiener, 1948; Bernstein, 1967), and are partially correct. But this study succeeded in obtaining experimental confirmation of the human cybernetic model using vibraimage technology to analyze the work of the vestibular system.

Analysis of the vestibular system functions turned out to be more effective psychophysiological tests than EEG, heart rate, and MRI studies (Standards, 2014), most likely due to the following reasons. The functioning of the vestibular system in the control of the head's micro-movements automatically filters high-frequency oscillations due to mechanical inertia. These same high-frequency processes are the main subject of study when it comes to EEG and heart rate. MRI equipment doesn't allow for normal human activity, so it is quite difficult to conduct similar studies and collect statistics in hundreds of measurements during MRI studies.

Of course, this study needs independent confirmation, which is quite simple to do since VibraMed10 program (VibraMed10, 2019) has a Demo mode that allows any interested party to conduct a similar study.

Conclusions

The results of this study confirm the hypothesis that the brain activity period measured by vibraimage technology is dependent on the type of activity and brain load of a person.

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CRITERIA FOR INDIVIDUAL EMOTIONAL EVALUATION OF IMAGES ON THE BASIS OF VIBRAIMAGE PARAMETERS

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Abstract: *A group of male volunteers categorized portraits of people shown on monitors as most pleasant and most unpleasant. Vibraimage parameters were recorded during the second presentation of the most pleasant and unpleasant images to the subjects. Formalized decision rules and evaluation criteria have been developed according to the data of vibraimage indices comparison by means of discriminant analysis, allowing the probability of identification of emotional reactions (along the axis of sympathy–antipathy) caused by visual stimuli to be measured, with an average accuracy of more than 90%. The authors suggest that the results obtained show the prospects of using vibraimage technology to solve a variety of problems, including the objectification of sociometrics, psychodiagnostic results, and marketing research.*

Keywords: *Vibraimage technology, emotional responses, portraits of people, visual image, sympathy–antipathy.*

From their very first days of life, a person becomes acquainted with reality and forms their attitude toward various objects and phenomena of their surroundings as well as their personality. Charles Darwin's work "The Expression of the Emotions in Man and Animals", first published in 1872, proved the important adaptive and regulating role of emotions for humans and animals with a high level of social organization (Darwin, 1872). Emotions are a mechanism of communication and survival based on evolutionary adaptation with a genetic basis (Romanova, Grebennikov, 1996). Since a person has a wide spectrum of possible emotional reactions, how one chooses to behave depends on the integral assessment of a given situation in a continuum ranging from total acceptance to total rejection. However, the same environmental phenomena can trigger reactions of acceptance or rejection in different people, differing in their degree of expression as well as being opposite in their sign. These differences may be associated with a wide range of individual personal characteristics ranging from a person's genotype to his values, age, gender, life experience, habits, social environment, and other factors.

Emotions are most often classified as being either primary or secondary. Primary emotions are considered basic and manifest themselves in direct reaction to various stimuli, primarily those that pose a threat to a person or animal, and the limbic system of the brain is responsible for these. Secondary emotions are not automatic and imply an assessment of the situation and further actions according to circumstances, i.e. they involve the higher centers of the cerebral cortex (Bekoff, 2010). In social psychology, social emotions are called "the experience of a person of his attitude to the people around him; they arise, are formed, and manifest in the system of interpersonal relationships" (Rean, 2002), and to define the poles of the axis of acceptance and rejection of another person, the terms sympathy and antipathy are used.

Many researchers agree that the sympathy of some people toward others depends on their degree of similarity, regarding not only such important characteristics as social values and attitudes, individual personality characteristics, gender, age, and lifestyle. The social attractiveness of people is also influenced, for example, by the degree of similarity in their perception of literature, music, habits and even style of dress (Myers, 1997; Ilyin, 2001), as well as specific social conditions (Ilyin, 2001). At the same time, for women similarity in social values is more important, whereas for men similarity in interests, habits, and activities is more important (Hill&Stull, 1981). It has also been shown that the significance of others' similarities and dissimilarities may differ depending on whether that person belongs to the same social group as the person making the assessment (Chen&Kenrick, 2002).

People are rarely aware of the factors that cause them to feel sympathy or antipathy towards other people since they act upon us at an unconscious level, something that is especially true of information that enters the brain through non-verbal communication channels. This is confirmed by the fact that in the first months of their lives, children are able to interact with adults on an emotional level, manifesting social emotions (Rean, 2002; Ilyin, 2001) and selective emotional attitudes towards others. The reasons that young children and animals perceive strangers differently and show positive or negative emotions towards them remain little studied (Ilyin, 2001; Belik, 1999). One can only assume that they are able to "read" non-verbal signals from people and, on that basis, distinguish strangers who pose a threat to them. Social emotions are part of the spectrum of secondary emotions, but they can also include basic primary emotions. This applies not only to animals and children, but also to adults, although the expression of these emotions in adults at a behavioral level, as a rule, is subject to the substantial "censorship" of consciousness. However, at the level of the psychophysiological reactions of a person, the influence of such a "censorship" can manifest itself to a much lesser extent.

When planning this study, the authors proceeded from the fact that in the first stage of acquaintance, due to the lack of information about each other, emotions of sympathy and antipathy in people can be based primarily on non-verbal stimuli and, in particular, on the person's appearance. To achieve the goal of this study, portraits of people were selected as the stimulus material to be evaluated by the subjects using a point system to indicate the degree of sympathy or antipathy they triggered. Since Viktor Minkin and Yana Nikolayenko (Minkin&Nikolaenko, 2017) have shown that by using vibraimage parameters, one can judge a person's positive or negative perception of stimuli, this technology was used to register individuals' unconscious psychophysiological reactions that were recorded during the presentation of the portraits. Our hypothesis is that people's vibraimage parameters recorded in the process of viewing portraits of people differ depending on what kind of emotion they trigger — sympathy or antipathy.

The aim of the study was to develop criteria for a person's emotional evaluation of an image based on vibraimage indicators.

Materials and Methods

Forty-five male volunteers age 25 to 65 participated in the study. Portraits of people with mental disabilities (e — epileptoid tendencies, hy — hysterical manifestations, k — catatonic manifestations, p — paranoiac tendencies, d — depressive-melancholic features, m — manic tendencies) from the Leopold Szondi test set were used as visual stimuli (Yuttner, 2002). The choice of stimulus material was based on the fact that Szondi, who came up with the concept of genotropism, systematized portraits of people with mental disabilities to assess emotional reactions (sympathy or antipathy). In order to trigger more pronounced emotional reactions, only female portraits were used. Due to the fact that in this set there were no portraits of women with sadistic inclinations, and none of the portraits of people of homosexual orientation can be uniquely assigned to women, this series was supplemented.

Portraits of two women from the first half of the twentieth century were used, one of whom was known for her pronounced sadistic (s — sadism) inclinations, and the other for homosexual inclinations (h — sexual undifferentiation). In addition, a portrait of a female astronaut was used, who was highly likely to be mentally healthy. The additional portraits were stylized to look like portraits from Szondi's test.

The study was conducted in two stages:

1. The subjects were asked to use a point system to indicate how much they liked or disliked the portraits shown onscreen. For evaluation, a scale with 11 virtual keys from +5 to –5 was placed under the portraits; all keys except 0 were active, thus, the subjects could not give a neutral answer. This stage allowed us to determine which images were most pleasant and unpleasant for each subject. The portraits that received ratings close to neutral (in the range from –2 to +2) were not included in this list.

2. The subjects were shown the most and least pleasant images again. During the examination of each portrait, a vibraimage recording was made using Vibraimage 10 PRO software, with a registration time of 15 seconds.

The quality level of vibraimage recording was always above 90%.

The results obtained were analyzed using the STATISTICA v.8.0 software package.

Research Results

For the purpose of the study, all vibraimage parameters stored in Vibraimage 10 PRO database were used.

In order to select informative vibraimage parameters that reliably differentiate the responses to portraits that caused sympathy or antipathy in the subjects, a step-by-step discriminant analysis was used (Kim, Mueller, Klekka, at al., 1989). Table 1 shows vibraimage parameters ranked in order of informativeness. The ranking was carried out by the value of the Wilks' lambda criterion. The designations of indicators correspond to those stored in the database: X — mean values, Vi — variability, S — standard deviation of the indicator.

Table 1

Parameters ranked in order of informativeness

Indicator name	Informative rank	Wilks' criterion value	p-level
F8-Vi	1	0,46	0,000
Stability (P27)-X	2	0,38	0,013
S6-Vi	3	0,37	0,030
A1-Vi	4	0,37	0,033
Charm (P17)-Vi	5	0,36	0,100
S5-S	6	0,36	0,105
S5-Vi	7	0,35	0,121
F1-Vi	8	0,35	0,151
S1-S	9	0,35	0,260
S4-S	10	0,34	0,351
P3-Vi	11	0,34	0,566
F7-S	12	0,34	0,582
S2-S	13	0,34	0,618
F2-X	14	0,34	0,665
P1-S	15	0,34	0,684
P1-Vi	16	0,34	0,689

Using the method of automatic classification by informative vibraimage parameters, all observations were divided into three groups. An analysis of the negative/positive attitudes towards visual stimuli showed that Group 1 included positive observations, Group 3 negative, and Group 2 shows an uncertain assessment of the image.

Figure 1 shows the distribution of these groups on the axes of the canonical discriminant functions Root 1 and Root 2 (Kim, et al., 1989).

As follows from the above data, positive reactions are localized in the region of negative values, and negative ones in the region of positive Root 1. Uncertain reactions occupy an intermediate region between the two. This makes it possible to use Root 1 as an integral indicator of the nature of perception (II_PERC). It is a quantitative criterion for evaluating the negativity/positivity of attitudes toward visual stimuli by the vibraimage parameters, given in Table 1. According to the discriminant analysis, the average accuracy of recognition of positive reactions is 94.3%, and 93.1% for negative reactions.

For a formalized assessment of the negativity/positivity of attitudes towards the visual stimuli used, rules were developed and implemented as a probabilistic nomogram (Fig. 2).

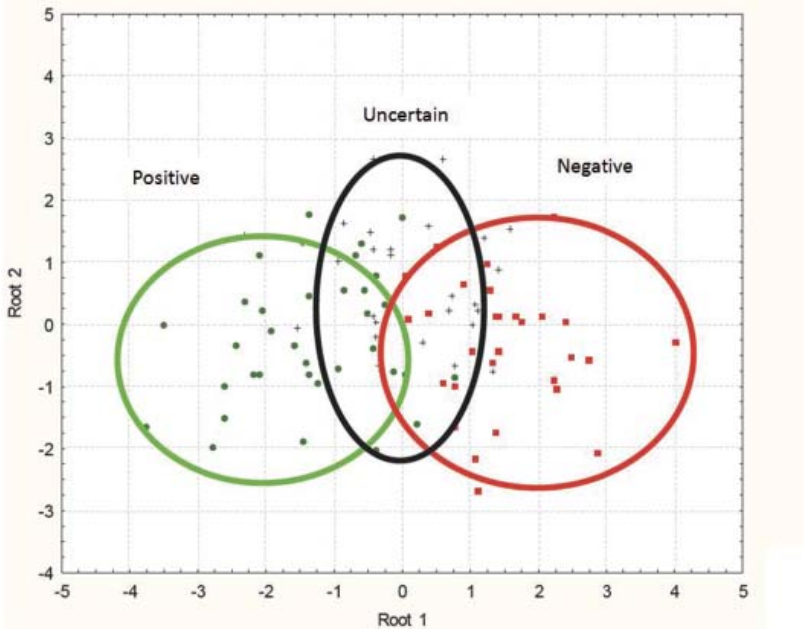

Fig. 1. The distribution of observations on the axes of canonical discriminant functions Root 1 and Root 2

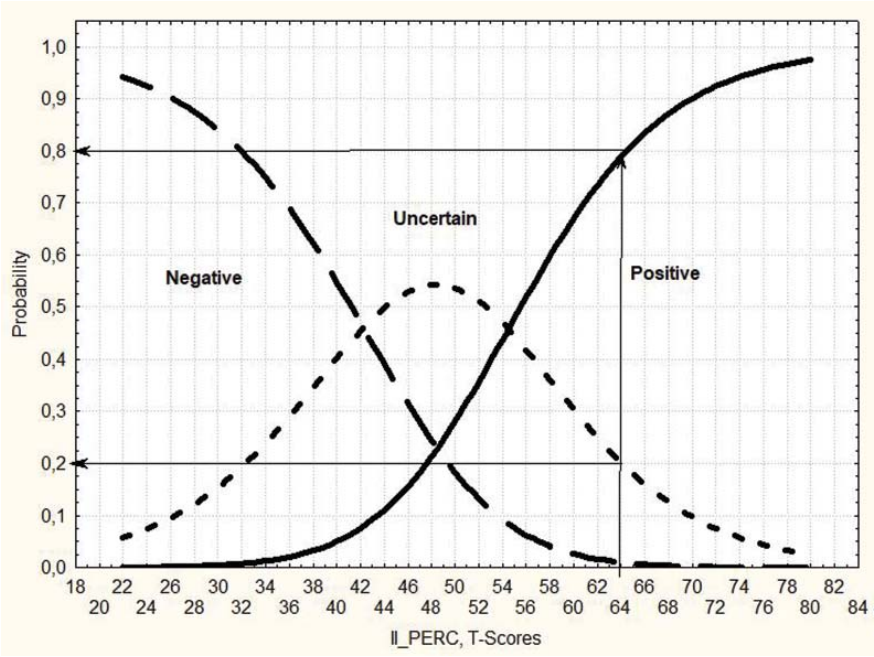

Fig. 2. Probabilistic nomogram for assessing the negativity/positivity of attitudes towards visual stimuli

The values of II_PERC, derived from Root 1 by changing the sign and transfer to the T-score scale are plotted on the abscissa axis, and the probability (P) of identifying the character of the perception of the stimulus is indicated on the ordinate axis. For example, with II_PERC = 64 points, the probability that a visual stimulus for a person is positive is 0.8, and uncertain — 0.2.

Conclusions

1. Vibraimage technology is a promising tool for assessing a person's positive and negative emotional states in reaction to visual stimuli presented.
2. The formalized rules and criteria developed allow for the estimation of a person's level of sympathy or antipathy in relation to images of other people with a rather high degree probability.
3. The task of objectification in assessing a person's positive and negative emotional states when exposed to various stimuli requires further research to reduce the area of uncertainty.

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POLYEFFECTOR METHOD OF DIAGNOSING THE PROFILE OF IMPULSES AND NEEDS OF PSYCOMFORT TO ASSESS EFFECTIVENESS OF EMPLOYEES' INDIVIDUAL ACTIVITY STYLE

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Abstract: *In order to prevent occupational deformities and reduced effectiveness of Individual Activity Style (IAS) for employees, the PsyComfort program and method was developed. It includes an assessment of the conscious and unconscious level of an employee's individual characteristics, the motivating mechanisms of his psyche, and the needs of his personality. The development of this diagnostic method was possible with the help of the polyeffector (polygraphic) approach. The use of this methodology in the assessment of a person's professional development will significantly improve the quality of an employee's personality assessment. It may result in the phenomenon of a deep psychological assessment of the effectiveness of an Individual Activity Style (IAS).*

Keywords: *individual activity style (IAS), Szondi, Lüscher, vibraimage.*

A person's professional development is a rather complicated process with a cyclical nature. This means that a person not only improves his knowledge and abilities while developing his professional skills, but may also experience a negative impact at this stage, which leads to the emergence of various kinds of unmet needs and states that not only stand in the way of his professional success, but also negatively manifest in everyday life. In this regard, V. E. Orel emphasizes the ascending (progressive) and descending (regressive) stages of professional development. Negative impact on a person's profession is manifested in the appearance of various professional deformations or specific conditions, such as the phenomenon of mental burnout or a decrease in the effectiveness of an **Individual Style of Activity** (E. A. Klimova, V. S. Merlin, A. N. Leontyeva, N. S. Leites et al.).

Individual style of activity (ISA) is a system of the distinctive signs of a given person's activity based on his individual personality characteristics. It is a system of psychological means for the best balancing of their individuality with the conditions and requirements of the activity (Merlin, Klimov, 1976). The function of ISA is manifested in a person's adaptation to the requirements of the activities, taking into account his personality and needs. ISA is variable in the process of adapting the subject to the requirements of the activity, the environment of its flow, to the characteristics of the partners in the activity, as a form of adaptation of the subject to different environmental conditions and activities. E. A. Klimov's research (Klimov, 1989) has shown that according to the assessment of the dependence of ISA on the properties of the mobility of the nervous processes, that among successful employees, both inert and mobile processes were exhibited. These employees have different strategies and different ISAs. Inert employees take a long time to prepare their work, so they don't have problems that arise and take time to be dealt with. Mobile employees identify

and eliminate problems quickly. By means of different strategies, a similar result is achieved. However, ISA is not always effective. It may not be effective due to the lack of certain personality traits or the lack of awareness and lack of development of its formation by the employee. To date, the assessment of ISA does not include an assessment of the unconscious level of the employee's individual characteristics, the motivational mechanisms of the psyche, and the need for the sphere of personality. It is possible to embody such a method of diagnostics using the polyeffector approach (Chaynova, Kulaikin, Miroshnik, et al). The polyeffector method (or polygraphic method) is a simultaneous registration of several bodily reactions that occur in response to the action of the stimulus.

Research aims

To prevent professional deformation and increase the effectiveness of an employee's ISA by identifying employees' accentuated features and states and their reactions in difficult situations, and to analyze the nature of the relationship between the parameters of conscious and unconscious choices in the employee's psychic profile.

Materials and Methods

Portraits of people with mental disabilities were used as stimulus material to identify the incentive and needs spheres of employees (e — epileptoid tendencies, hy — hysterical manifestations, k — catatonic manifestations, p — paranoiac tendencies, d — depressive-melancholic features, m — manic tendencies) from Leopold Szondi's test set (Szondi, 1998; 2007; Yuttner, 2002). Szondi's fate-analytic concept is based on the position that the basis of unconscious human behavior is an impulse profile, which can be represented by combinations of eight basic needs. Each of them, depending on the formalized indicators, with the help of Szondi's test reveals one or another mental pathology and imposed automatisms. Eight additional portraits of women and men who were likely to be mentally healthy were also used. The above additional portraits were stylized to look like portraits from Szondi's test. Eight basic colors from the Luscher test were also added (Chudnova, 2010). The eight-color test is a projective technique based on an experimentally established relationship between a person's preference for certain colors (shades) and his current psychological state, based on vibraimage technology (Minkin, 2002; 2017; Minkin & Shtam, 2008; Minkin & Nikolaenko, 2008). VibraImage 10 PRO program records the level of amplitude and frequency of microvibrations (micro movements) of a human head and, based on this, determines ten parameters of the psychophysiological state, including levels of aggression, stress, anxiety, and the potential threat level posed by a person (T1–T10). The simultaneous use of the above methods in a multi-pattern approach for a short time (10 minutes) gives a deep and extensive characterization of a person's internal dispositions free from subject's conscious control.

The study according to the PsyComfort method was conducted as follows:

1. The test subjects were forty male volunteers aged 22 to 44. The stimulus material consisted of two portraits for each factor of mental pathology and four portraits of relatively healthy women. Four portraits of relatively healthy men were added, as well as eight basic colors, resulting in a total of 24 portraits and eight basic colors.

2. The test subjects were asked to evaluate in points how much they liked or disliked the portraits and colors shown onscreen. For evaluation, a scale with 11 virtual keys from +5 to –5 was placed under the portraits and colors; all keys except 0 were active, so the subjects could not give a neutral answer. This stage allowed us to determine the most pleasant and unpleasant images for each subject, excluding portraits that received ratings close to neutral (in the range from –2 to +2).

3. During the subjects' examination of each portrait, vibraimage was recorded using the PsyComfort program (modified by Vibraimage PRO (Vibraimage 10, 2019)), and the stimulus presentation time did not exceed 15 seconds per stimulus.

The quality level of vibraimage processing was always above 90%.

Results

The RS Result sampling analysis (40 tests) was carried out by the Stat1_04.xlsm program (VibraStat, 2019).

For the purpose of the study, all vibraimage parameters stored in VibraImage 10 PRO database were used.

Figure 1 shows the histogram of the distribution of subjects' psycho-emotional states.

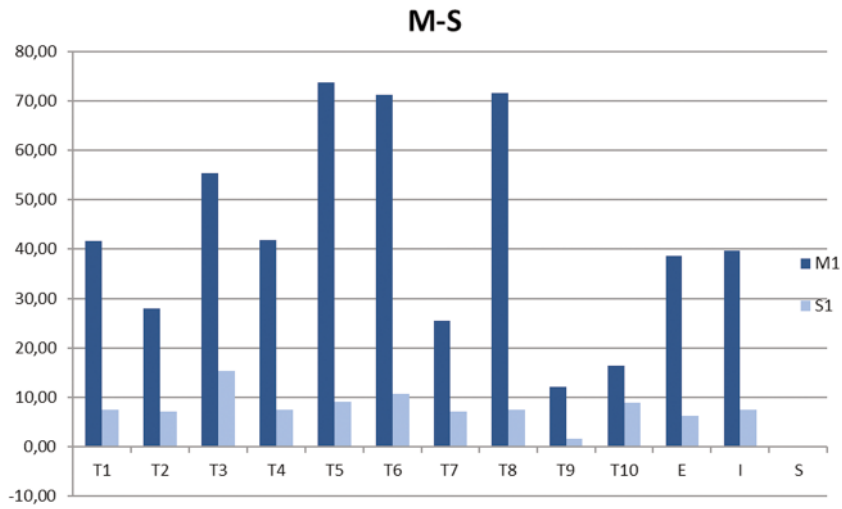

Fig. 1. The histogram of the distribution of subjects' emotional states (psychophysiological parameters) (M — the average value of the parameter in the sample, S — RMS parameters in the sample)

The mean values of psychophysiological parameters (PPP) in the sample are within the established norms. The largest variation of the PPP is observed in the T3 parameter, anxiety, which indicates the heterogeneity of the sample in this parameter. The smallest variation in the T9 parameter is inhibition, which means that all the subjects were paying attention to the test and passed it in a concentrated state.

Figure 2 shows the distribution of subjects by parameters T3 and T9.

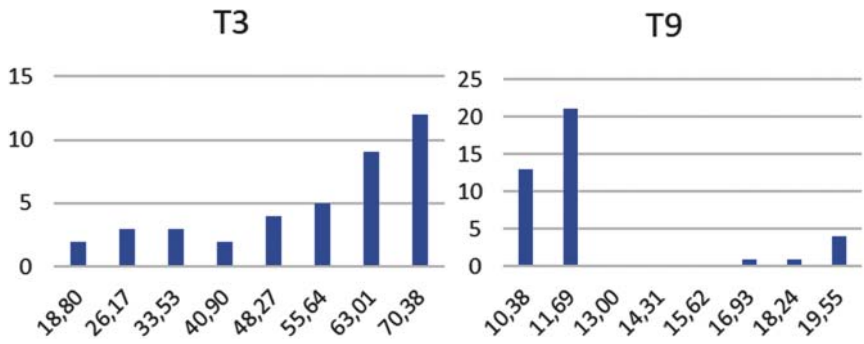

Fig. 2. Histogram of T3 and T9 parameter distribution

Both of these parameters are differ most noticeably from the normal distribution and allow for the confirmation of our conclusion about the presence in the group of subjects with a high level of anxiety and a high level of inhibition.

Figure 3 shows a histogram of the distribution of the information efficiency of the subjects in the testing process.

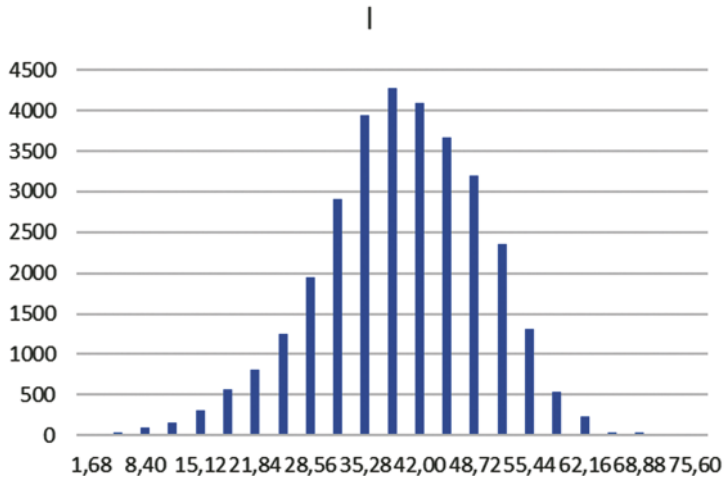

Fig. 3. The histogram of the distribution of the information effectiveness of the subjects

The histogram of informational efficiency distribution is quite close to the normal distribution, which indicates the correct organization of the testing itself and the absence of the effect of additional errors on the result obtained.

Conclusions

1. The polyeffector approach of the PsyComfort method, which includes vibraimage technology and psychological projective techniques, is a promising tool for assessing a person's profile of needs and impulses.

2. The revealed patterns of conscious and unconscious components of visual choice allow for the 10 parameters of vibraimage (especially T3 — anxiety and T9 — inhibition) to rank the parameters of a person's needs and impulse profile with high probability.

3. The use of the PsyComfort technique in the assessment of a person's professional development will significantly improve the quality of the assessment of Individual Style of Activity (ISA). It may result in the phenomenon of a deep psychological assessment of the effectiveness of ISA.

4. The application of the PsyComfort polyeffector technique does not have intellectual, linguistic, or age limitations. The technique works precisely with deep mental processes and conditions.

5. The task of objectification in assessing the profile of motives and human needs requires further research with a larger number of respondents.

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THE OPTIMAL SEQUENCE OF STIMULI PRESENTATION FOR PROFILING AND PSYCHOPHYSIOLOGICAL DETECTION OF DECEPTION

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Abstract: *A study of the changes in psychophysiological responses to the presentation of different sequences of stimuli. The dependence of the probability of changes in the direction of psychophysiological responses to a line-opposite questionnaire and complementary questionnaire were calculated. Correlation matrices of psychophysiological responses for various questionnaires were calculated. Based on the obtained data, the sequence of stimuli presentation I-C-I-R-I can be recommended for psychological detection of deception and profiling.*

Keywords: *vibraimage, psychophysiology, detection of deception, stimuli, profiling, I-C-I-R-I.*

Modern psychophysiology suggests that the sequence of stimuli presentation is important for the correct analysis of the subsequent psychophysiological responses (Bauer, 2006; Alekseev, 2011). Different researchers offer various forms of questionnaires that include questions of different significance for testees (Bauer, 2006; Alekseev, 2011). The most common approach is the Zone Comparison Test (ZCT) developed by Cleve Backster in 1961 (Backster, 1961; Bauer, 2006). Indeed, if we consider the detection of deception from the measurement theory point of view, the method including comparison of responses to the relevant and control (comparison) question need to be attributed to the methods of balanced transformation, which, in general, have higher accuracy than the measuring methods of direct transformation (Novitsky, 1975). Currently, a number of standards for deception detection have been developed (ASTM E2386-04, 2017). While psychophysiological detection of deception (PDD) has a large number of supporters and opponents who are convinced that modern lie detection has no scientific substantiation, that accuracy characteristics given by PDD supporters are not true, and that the decision to detect lies is subjective and greatly depends on the personality of the examiner (Maschke, 2018; Alekseev, 2011). It should be recognized that many opponents' arguments about lie detection look quite convincing, and that a large portion of scientific publications on lie detection are declarative and do not have statistical scientific evidence (Maschke, 2018, Bauer, 2006). In spite of this, the psychophysiological detection of deception continues to develop, and the conclusions of polygraph examiners are accepted by the courts of many countries and yield practical results.

The purpose of this study is to consider the issue of PDD from the standpoint of the physiology of consciousness (Boring, 1933) and to determine statistical patterns upon presentation of various stimuli. I hope that this research will make PDD more scientifically sound and the results obtained will improve accuracy in practical PDD testing.

Psychophysiological response to stimuli. Some theory

Practically, all modern PDD developers and researchers are convinced that a lie is a rather complex psychophysiological state (PPS) (Ekman, 2016) having multiple

physiological manifestations and can be detected when compared with normal PPS or upon presentation of comparison stimuli. The main axiom or hypothesis of PDD says that a more significant physiological response corresponds to a more significant stimulus presented to a testee (Ekman, 2016; Alekseev, 2011). In this case, the PDD task is reduced to determining the intensity of physiological signals (for a contact polygraph, these are heart rate (HR), arterial pressure (AP), galvanic skin response (GSR), and breathing frequency (BF), depending on the presented stimuli. The developers of the contact polygraph historically use the time dependences of these physiological signals, which were previously recorded by analog polygraphs, and now are recorded and processed using computer programs (Varlamov, 2010). The proposed hypothesis looks relatively logical, since upon presentation of a significant stimulus, the human brain requires greater energy consumption. It increases metabolism, which should lead to an intensification of all physiological processes, including heart rate, blood pressure, an increase in sweat (reduction of electrical resistance of the skin) and an increase in the frequency of respiration to provide more oxygen to the brain.

However, studies conducted with the help of vibraimage technology have shown that the psychophysiological response to the presented stimuli does not look exactly the way that PDD supporters' hypothesis predicted (Minkin&Myasnikova, 2018; Choi, 2018). Let's start with the fact that these physiological processes truly reflect the energy processes occurring in the human body, but the work of sensory physiological systems is associated not only with energy consumption, but is primarily based on the exchange of information signals both within one physiological system and between different physiological systems (Minkin, 2018). The time dependences of the signals used in the contact polygraph practically do not reflect the informational efficiency of signal transmission, but the informational efficiency of the exchange of physiological signals is the main indicator of the change in PDD (Minkin, 2018; Minkin&Myasnikova&Nikolaenko, 2019). The intensity of the psychophysiological response (PPR) is not identical only to energy metabolism, which is why most PDD researchers make the mistake of putting an equal sign between the intensity of the PPR and its energy component. In addition, the developers of lie detectors do not take into account the chronobiological and regulatory processes that are constantly occurring in the human body (Minkin & Blank, 2019). The function of the human vestibular system is to provide mechanical balance for the whole body. To complete this function, the vestibular system constantly receives sensory signals from all organs of the human body, including the autonomous maintenance of the human head in an upright state. Any change in the functioning of a person's physiology, including brain activity changes to relevant stimuli, leads to changes in the functioning of the vestibular system. This effect is called the vestibular-emotional reflex (Minkin & Nikolaenko, 2008). Moreover, these changes in the work of the vestibular system can be characterized not only by energy processes in the human body, but also by information exchange efficiency (Minkin&Nikolaenko, 2017; Minkin, 2018). In addition, the efficiency of information exchange in a human body can be determined by analyzing the correlation of various physiological systems' operation (Minkin, 2018), which opens up the possibility of using the obtained results for any technology of psychophysiological detection, including the contact polygraph.

Methods and Materials

To analyze the PPS, we will look at the test results of a group of 210 high school students (aged 15–17) from St. Petersburg schools by VibraMI programs with the Gardner12T questionnaire (Minkin, Nikolaenko, 2017; VibraMI, 2019) and PsyAccent with the T12 questionnaire (PsyAccent, 2019) conducted in 2018 from September to December. Testing was conducted on a computer with an IntelCore I7 processor and Microsoft LifeCam Studio webcam with an image format of 640×480. The illuminance of the test subjects was within 500–700 lux, the head size during the test was at least 200 elements horizontally, and the image quality indicator in VibraMI and PsyAccent programs exceeded 80%. The duration of each test was approximately 380 seconds.

Test Results

The order of stimuli presentation in VibraMI (VibraMI, 2019) and PsyAccent (PsyAccent, 2019) programs is different. In VibraMI program, pairs of opposite stimuli are presented, and in PsyAccent programs there are stimuli pairs of similar meaning. Otherwise, these programs are quite similar to each other. In both, 24 questions and pictures are presented on the monitor screen. The testees answer Yes, No, or miss answering the question if they cannot choose an answer. From the point of view of normal physiology, it can be considered that the only difference in the presented stimuli was in the order in which the stimuli were presented, since the significance of stimuli in different programs should be approximately the same for testees. In previous experiments with VibraMI program, it was shown that if opposite stimuli were presented, a noticeable negative correlation was observed in the psychophysiological responses to neighboring questions with the average Pearson correlation level of P = –0.45 (Minkin & Myasnikova, 2018). A similar result was confirmed in the course of the new experiment. The correlation matrix of the psychophysiological responses to the 24 questions of VibraMI program is given in Table 1.

Table 1

Correlation matrix of 210 psychophysiological responses tested by VibraMI questionnaire

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		-0,45703																						
2	-0,45703		-0,4849																					
3		-0,4849		-0,40663																				
4			-0,40663		-0,45076																			
5				-0,45076		-0,4294																		
6					-0,4294		-0,43926																	
7						-0,43926		-0,4848																
8							-0,4848		-0,3372															
9								-0,3372		-0,52338														
10									-0,52338		-0,3722													
11										-0,3722		-0,46834												
12											-0,46834		-0,4149											
13												-0,4149		-0,5187										
14													-0,5187		-0,44842									
15														-0,44842		-0,34989								
16															-0,34989		-0,49213							
17																-0,49213		-0,44221						
18																	-0,44221		-0,47759					
19																		-0,47759		-0,31757				
20																			-0,31757		-0,47029			
21																				-0,47029		-0,46784		
22																					-0,46784		-0,31599	
23																						-0,31599		-0,26619
24																							-0,26619	

The results in table 1 confirm the previously obtained data on the prevalence of negative correlation between neighboring questions in a line-opposite questionnaire. The average Pearson coefficient for the tests performed using VibraMI program for neighboring replies was P = –0.44. The correlation matrix of the psychophysiological responses to the 24 questions of PsyAccent program is given in Table 2.

Table 2

Correlation matrix of 210 psychophysiological responses tested by PsyAccent questionnaire

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		-0,38277																						
2	-0,38277		-0,44639																					
3		-0,44639		-0,54147																				
4			-0,54147		-0,4069																			
5				-0,4069		-0,53241																		
6					-0,53241		-0,44862																	
7						-0,44862		-0,46365																
8							-0,46365		-0,46134															
9								-0,46134		-0,42592														
10									-0,42592		-0,46355													
11										-0,46355		-0,41459												
12											-0,41459		-0,42794											
13												-0,42794		-0,48078										
14													-0,48078		-0,44861									
15														-0,44861		-0,38785								
16															-0,38785		-0,46673							
17																-0,46673		-0,59772						
18																	-0,59772		-0,47366					
19																		-0,47366		-0,41611				
20																			-0,41611		-0,41791			
21																				-0,41791		-0,51536		
22																					-0,51536		-0,5415	
23																						-0,5415		-0,39433
24																							-0,39433	

The results in Table 2 are strikingly similar to the correlation matrix in Table 1. The average value of the Pearson coefficient for the 210 tests performed by PsyAccent program was P = –0.46. It turns out that the statistics of testees' psychophysiological responses practically do not depend on the semantic content of the stimulus questions, but are rather determined primarily by the form of stimuli presentation (Minkin et all, 2019). A testee's PPS varies relative to the PPS center and does not depend much on whether a testee has a positive, negative, or neutral attitude to the stimulus. Even if two negative stimuli are presented sequentially, the PPR to the second negative stimulus will be positive, not negative, since the psychological adaptation of the body and the internal mechanisms of physiological regulation are stronger than the conscious negative attitude to the presented stimulus. A similar PPR is observed when two positive stimuli for a testee are presented sequentially: the second positive stimulus is still perceived as negative. Vibraimage technology captures PPS changes in the information-energy axes (Minkin, 2018). Typical changes in PPS when conducting polls with opposing stimuli by VibraMI program and thee complementary PsyAccent program are shown in Figures 1 and 2, respectively.

In the case of each specific test, the picture of PPS changes is not so ideal, but general statistical patterns (such as the inverse correlation between the information-energy parameters and oscillations around a common center) are clearly traced in Figures 1 and 2. Let's consider not only changes in PPS upon the presentation of stimuli, but also the magnitude and direction of these changes depending on the value of the previous response. According to the available data, we will determine the probability of PPS direction changes depending on the previous response and deviation

from the center by setting the threshold value of the PPS, /P/ = 0.12 separating all psychophysiological responses in the performed experiment into two equal parts.

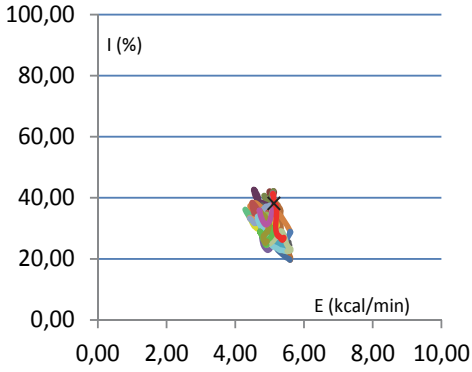

Fig. 1. PPS changes during VibraMI testing

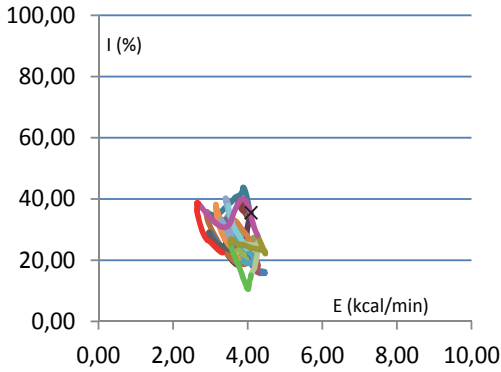

Fig. 2. PPS changes during PsyAccent testing

The probabilities of changes in the subsequent PPR with a large and small deviation of the previous PPR value for the tests performed by VibraMI and PsyAccent programs are shown in figures 3 and 4, respectively.

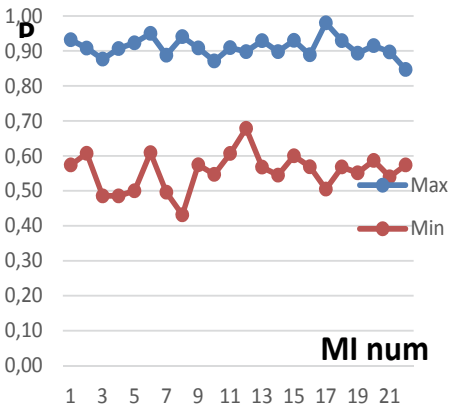

Fig. 3. Probability of PPS changes by VibraMI testing. Probability for Max and Min deviation from previous response

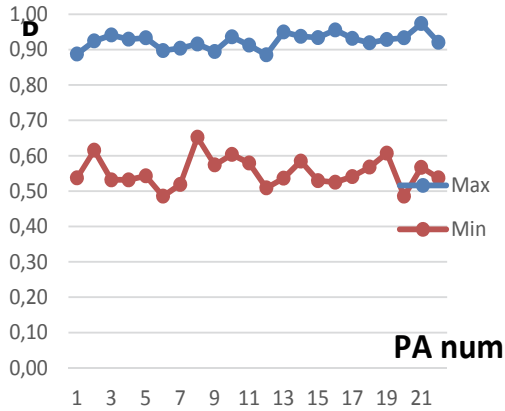

Fig. 4. Probability of PPS changes by PsyAccent testing. Probability for Max and Min deviation from previous response

The data obtained in Figures 3 and 4 show that the probability of a subsequent change in the PPR depends little on the content of the question, but depends significantly on the previous deviation of the PPR. The averaged probabilities of PPR changes based on the available data and the dependence of the probability of a change in the direction of the PPR from the previous value of the PPR are given in Figures 5 and 6.

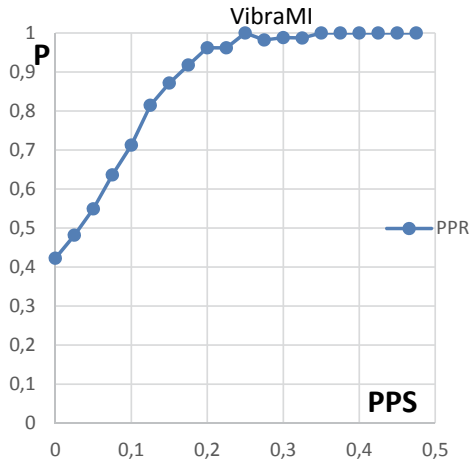

Fig. 5. Probability of PPR changing direction depending on the previous value of the PPR with VibraMI program testing

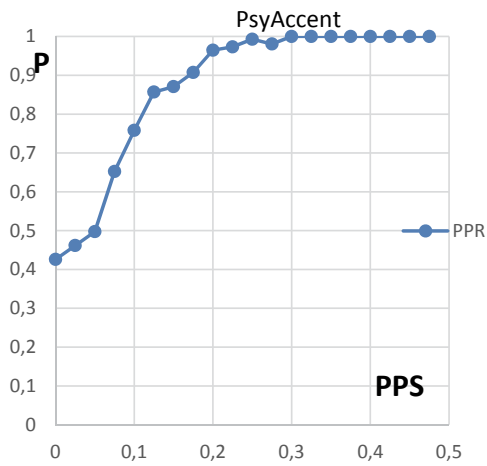

Fig. 6. Probability of PPR changing direction depending on the previous value of the PPR with PsyAccent program testing

The data presented in Figures 5 and 6 convincingly proves that the results of PPR direction changing for both programs are almost the same, and with a significant PPR to the previous question (PPS > 0.2) the probability of changing the direction of the PPR is almost equal to 1. That means that with a significant PPR to the previous question, the magnitude of the subsequent response is less than the previous one, and this phenomenon does not depend on the type of questions presented.

Discussion

It seems that the main problem with modern PDD is the perception of a lie as a separate and independent psychophysiological state (Ekman, 2016; Alekseev, 2011) and the concentration of PDD only on examples when the testee tells a lie. This approach to the PPR problem does not generate scientific proof of the validity of the methods being used. It results in a weak evidence base, since it is almost impossible to achieve significant motivation for testees when conducting statistical tests for lies, and the practical results of real suspect detection are poorly amenable to statistical evaluations, since each real crime is individual in nature. At the same time, specific methods of psychophysiological testing are based on the comparison of the testee's PPR for different stimuli (Bauer, 2006), therefore all theoretical and practical results obtained in the study of testee responses to presented stimuli should be relevant for PDD, which is only a particular case of psychophysiological response manifestation. The proposed approach to PDD, as a particular manifestation of the physiology of consciousness, will allow us to establish correct test methods that can be scientifically confirmed.

For a correct understanding of the physiology of lying, it is necessary to have a clear and statistically proven representation of the testee's normal psychophysiological responses upon presentation of stimuli. Only a clear understanding of the norm will allow for the analysis and correct classifcation of deviations from the norm. Starting with the Backster Zone Comparison Test (ZCT) method, the most used question sequences are the following (or close to the data) variants of questions sequences (Baur, 2006; Varlamov, 2010):

I-SR-SYM-C-R-C-R-SYM-C-R;
I-I-I-I-C-R-I-C-R-I-C-R-I-C-R;
I-SR-SYM-C-R-C-R-C-SYM;

Where I — Irrelevant;
SR — Sacrifice Relevant;
SYM — Symptomatic;
C — Comparison;
R — Relevant.

The main method of processing comparitive questions is to compare the PPR for comparison-control (C) and relevant (R) questions, which, as we see from the given sequences, are placed in successive pairs. In this case, the declared principle of comparing responses implies that PPR should be compared to the presented stimuli. However, from the data in Figures 3–6, it follows that the PPR for stimuli depends not so much on the stimulus as on the current deviation of the PPS from the zero (central) position. Thus, the presentation of the first comparison stimulus (C) shifts the test PPS from the center position, and the presentation of the control (R) stimulus has a high probability (more than 0.9) of pushing the PPS in the opposite direction if the control question was really significant for the test. Therefore, the goal of ZCT is not achieved, or is achieved with low accuracy, since the mechanism of conscious physiological regulation prevents the testee from perceiving the control and significant stimuli in the same way. To avoid this inequality in the perception of stimuli, the sequence of presentation should be, for example, the following:

I-C-I-R-I-C-I-R-I-C-I-R-I

In this case, the insignificant questions established between the controls and the significant questions will allow the PPS to return to a position close to the center. Therefore, the testee's next PPR will depend only on the presented stimuli, since the influence of the regulatory physiological mechanisms is close to zero on the PPS, thus being near the center, and is equally likely to change in any direction (the probability of a change in direction is 50%). Objections are to be expected from proponents of the classical polygraph, namely, the opinion that an increase in time between presented stimuli should lead to the testee's PPS returning to the center. However, previous studies (Minkin & Myasnikova, 2018; Minkin et al., 2019) show that this is not always the case. A testee's PPR prior to the presentation of the next question in most cases continues to move slowly in the same direction as when the

previous question was presented (Minkin & Myasnikova, 2018; Minkin et al., 2019). The return of the PPS to its initial state is determined by the brain activity period (Minkin & Blank, 2019), not by an increase in the time between questions, giving uncertainty to the results. In addition, the lack of presentation of stimuli for a long time leads to a greater change in the PPR than when a certain rhythm is set by the presented stimuli. The psychophysiology of consciousness (Minkin & Blank, 2019) relatively quickly adjusts the body to the proposed rhythm of stimuli presentation, and the period of change in PPR corresponds to the period of presentation of stimuli after the presentation of the second stimulus (Minkin & Myasnikova, 2018; Minkin & Blank, 2019).

Conclusions

This study has shown that the concept of norms for psychophysiological responses to relative comparison stimuli makes PDD more objective and scientifically based. It is necessary to rely on a cybernetic approach to a person, as to a living system, operating not only with known physiological parameters and energy consumption, but also with the information efficiency of physiological processes. In this case, PDD should be considered a special case in the physiology of consciousness.

Vibraimage technology proves that the information-energy approach and vector analysis of PPS changes has significant advantages over traditional temporal dependencies of physiological parameters to improve the accuracy of PDD and reduce testing and profiling time. Vibraimage technology is based on the past experience of PDD, moving on to a new level of understanding physiological processes and physiological regulation in the human body. The proposed sequence of stimuli presentation (I-C-I-R-I) can be implemented in various PDD systems, including profiling and interviewing.

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CONSCIOUS AND UNCONSCIOUS RESPONSES AS INDEPENDENT COMPONENTS OF A PERSON'S CURRENT PSYCHOPHYSIOLOGICAL STATE

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Abstract: *A person's conscious and unconscious responses are defined in reaction to the presentation of oppositional stimuli in the process of testing multiple intelligences. The unconscious response is measured with the use of vibraimage technology, which allows one to quantify the dynamics of the psychophysiological state (PPS). Statistical and mathematical methods demonstrate the expediency of using a periodic presentation of oppositional stimuli to control a person's PPS. The quantitative characteristic, combining conscious and unconscious responses, demonstrates the high level of adaptive regulation and the desire to maintain psychophysiological balance due to the efforts of human consciousness and physiological systems. It was also established that conscious and unconscious responses complement each other in the absence of intercorrelation. The developed methodology allows one to jointly analyze the process of conscious and unconscious responses, reducing them to a single characteristic of personality or psychophysiological state. The identified dependence of psychophysiological control allows one to reconsider the practical methods of conducting interviews and surveys, as well as the prediction of abilities, lie detection, and the more effective choice of stimuli sequences when conducting profiling.*

Keywords: *conscious, unconscious, vibraimage, psychophysiological state, vestibulo-emotional reflex.*

The terms conscious and unconscious (Freud, 1900) are used by various researchers in related sciences and are often understood differently; therefore, we will first give our own definitions based on a quantitative assessment of these terms as psychophysiological characteristics. In this article, a conscious response is understood as verbal or nonverbal responses to questions presented in a Yes/No format, or the absence of an unambiguous response to the given question. An unconscious response is understood as the subject's change in psychophysiological state (PPS), which is analyzed by vibraimage technology.

Vibraimage technology

Vibraimage technology (Minkin&Shtam, 2008; Minkin, 2017; 2018) converts streaming video into two different image components, reflecting the amplitude and frequency characteristics of vibrations and movements of objects in the frame. Vibraimage technology differs from other psychophysiological detection technologies in its use of statistical processing to obtain information about a person's physiological characteristics. Traditional psychophysiological technologies use direct measurement of human physiological characteristics, such as pulse rate (Berntson, 1997; Baevsky&Chernikova, 2017), respiratory rate (Simoes, 1991), skin electrical conductivity (Ogorevc, 2013), electroencephalography (Tatum, 2014) etc.

for information about a person's psychophysiological state. A direct physiological signal for vibraimage technology is a video image of a human head, and informative psychophysiological parameters are determined by mathematical and statistical processing of the streaming video signal.

The amplitude component of each vibraimage point (Minkin&Nikolaenko, 2008) is determined by the equation (1):

$$A_{x,y} = \frac{1}{N}\sum_{i=1}^{N}\left|U_{x,y,i} - U_{x,y,(i+1)}\right| \tag{1}$$

Where: x, y — the coordinates of the point;

$U_{x,\,y,\,i}$ — signal value at the point x, y in the i-th frame;

$U_{x,\,y,\,(i+1)}$ — signal value at the point x, y in the $(i + 1)$ frame;

N — is the number of frames for which the amplitude component of vibraimage is accumulated.

The frequency component of each vibraimage point (Minkin&Nikolaenko, 2008) is determined by the equation (2):

$$F_{x,y} = \frac{F_{in}}{N}\sum_{i=1}^{N}\left\{\begin{array}{l}\left|U_{x,y,i} - U_{x,y,(i+1)}\right| > 0 : 1 \\ other : 0\end{array}\right\} \tag{2}$$

where F_{in} — video signal processing frequency.

The amplitude and frequency components of vibraimages are parallel video streams similar in image format to the original video signal. Each frame of the amplitude and frequency component contains temporal and spatial information about the past of this video stream, limited in time by N, the number of frames of frame difference accumulation. Vibraimage technology transforms these video streams into the primary parameters of vibraimage (Minkin, 2017), which are then converted into the informative parameters of the investigated object depending on the purpose of the study. Vestibulo-emotional reflex (Minkin&Nikolaenko, 2008) is physiological reason of human head movement informativity.

The main characteristics of a person's vibraimage that informatively reflect the psychophysiological state, were suggested to consider the parameters based on the mathematical expectation and standard deviation (SD) of vibraimage frequency component (Minkin&Myasnikova, 2017; Minkin, 2018), defined across a whole or partial frame limited by the image of the subject's head. Earlier it was demonstrated that the average value of the expectation of a vibraimage characterizes a person's energy expenditure (Minkin, 2009), and the SD of a vibraimage characterizes the information efficiency of a person (Minkin, 2018). The equation for calculating a person's energy expenditure (E) using vibraimage technology based on the calculation of the average frequency of vibrations in a frame defined by equation (2),

reduced to the maximum input frequency of vibraimage Fproc, was first given by Minkin (Minkin, 2009).

$$E_c = \frac{10\sum_{i=1}^{n} F_i}{nF_{proc}}, \tag{3}$$

Where: E_c — value of energy consumed by a person;
F_i — value of the frequency component of vibraimage of the *i*-th element;
F_{proc} — main frequency of vibraimage processing;
n — number of pixels for photosensitive matrix.

The equation for determining a person's current information efficiency (information characteristic) using vibraimage technology (4) has been described in previous articles (Minkin, 2018; Minkin&Myasnikova, 2017; VibraMI, 2018).

$$I_c = \frac{F_{proc} - 5\sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(F_i - \overline{F}\right)^2}}{F_{proc}} \cdot 100\,\% \tag{4}$$

Where: I_c — the current value of the information efficiency;
F_{proc} — the main frequency of vibraimage processing;
$\overline{F}$ — the average frequency of vibraimage;
F_i — the value of the frequency component of vibraimage of the i-th element;
n — number of pixels for photosensitive matrix.

Constant coefficients in equations (3) and (4) were experimentally determined in such a way as to bring the resulting numerical values to the measured physical quantity determined by alternative methods (Gorman E. et al., 2013; Ceaser, 2012). For equation (3), it was historically accepted to measure a person's emitted and consumed energy in kilocalories per minute (Weir, 1949; Broderick, 2014). The efficiency of any system is determined in a percentage, and the constant coefficient for equation (4) was chosen so that the magnitude of the changes along the information axis (Minkin, 2018) is approximately equal to the magnitude of the changes along the energy axis for people who are in an active psychophysiological state. At the same time, for people in a depressed or any other psychophysiological state, the information coefficient of efficiency should not be negative. Since it is necessary to add only the physical quantities of the same name, then for the energy axis it is also bound to percentages or relative units. Based on accepted data on energy consumed by a person, energy consumption of 10 kcal/min is taken as 100%. Theoretically, a person's energy consumption can exceed the specified value (Gorman E. et al., 2013; Ceaser, 2012), but only with active human movement. Vibraimage system is designed to measure the psychophysiological parameters

of a person in a quasi-stationary state, so the indicated physical units linked to percentages can be considered valid.

Based on changes in the information component (I) and the energy component (E), the current psychophysiological state of a person is determined using formulas (5) and (6), respectively, proposed in previous works (Minkin, 2018; Minkin&Myasnikova, 2017). It was also shown that when testing using a line-opposite questionnaire (LOQ), the results obtained by formulas (5) and (6) are quite close.

$$dP_2 = (I_{i-1} - I_i) + (E_{i-1} - E_i) \tag{5}$$

Where: I_{i-1} — the reference point of the information efficiency in a person's initial state;
I_i — the changed coordinate of the information efficiency in a person's current state.
E_{i-1} — the coordinate of the energy consumption in a person's initial state ;
E_i — the changed coordinate of the energy consumption in a person's current state;

$$dP_1 = (I_i - I_{i-1}) + 2\,|E_{i-1} - E_i| \cdot \sin A \tag{6}$$

Where: I_{i-1} — the initial coordinate of information characteristics of a person in the i-th period of time;
I_i — the final coordinate of information characteristics of a person in the i-th period;
E_{i-1} — the initial coordinate of energy consumption of a person in the i-th period of time;
E_i — the final coordinate of energy consumption of a person in the i-th period of time;

$$\sin A = (I_i - I_{i-1}) / \sqrt{(I_i - I_{i-1})^2 + (E_{i-1} - E_{\mathrm{i}})^2}$$

In this paper, we investigated the results obtained by vibraimage technology when testing multiple intelligences (Gardner, 1983), so we will dwell on this term in more detail.

Multiple intelligences

Initially, human intellectual activity was understood as a single factor, called by Spearman (Spearman, 1904) and his followers as the "general" (g) factor. From this perspective, intelligence was viewed as an indivisible whole (Sternberg, 1975; Stein, 2000). Gardner (Gardner, 1983) is an adversary of the theory of indivisible intelligence and of the test approach to the diagnosis of abilities, which in his opinion reflects the level of awareness that is positioned within the framework of a particular subculture. This framework contains the "learning/awareness" factor, but not ability parameters. At the same time, it is precisely the concept of "multiple intelligences" that allows for the exploration of the links between abilities and the methods of their implementation in various spheres of life. Gardner's multiple intelligences are equal and independent,

though they also complement each other. This shows the integrity of a person's mental organization. Each of the seven basic types of intelligence represent a certain way of interacting with one's surroundings, reflecting a person's abilities in a particular field of study. "It is evident that, with few exceptions, societies are not interested in "pure" intellectual competences: there are few occupational roles that the idiot savant of linguistic, logical, or bodily intelligence can perform. Rather, in nearly all socially useful roles, one sees at work an amalgam of intellectual and symbolic competences, working toward the smooth accomplishment of valued goals" (Gardner, 1983).

However, the seven-component model of multiple intelligence (MI) (in later works, the number of components cannot exceed 10–12 items, Gardner, 2008, 2011), from practical and methodological points of view, has disadvantages, including:

a) the absence of a dominant principle for MI profile structuring as a holistic phenomenon;

b) the uncertainty of the scientific approach, objectively reflecting the principle of structuring.

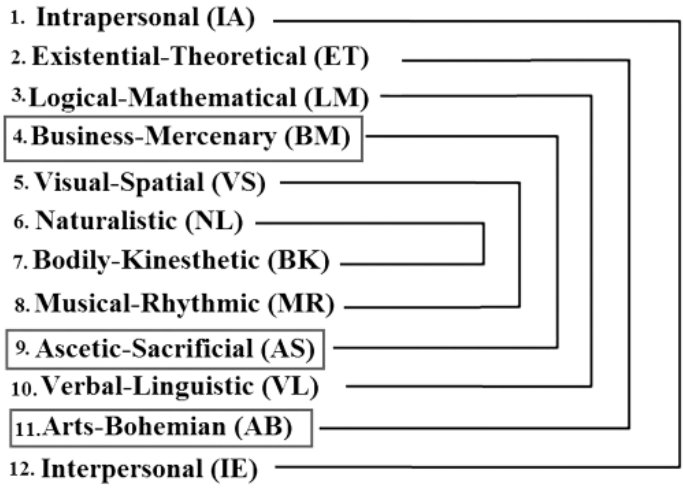

Fig. 1. Structured and extended model of Gardner's multiple intelligences (Minkin&Nikolaenko, 2017)

VibraMI program (VibraMI, 2018), based on vibraimage technology, presents Gardner's classification of multiple intelligences structured and expanded to include 12 MI types (Minkin&Nikolaenko, 2017) (fig. 1), indicating the possibility of self-realization in a certain professional field. Business-mercenary, ascetic-sacrificial, and bohemian-artistic types of MI have been added to Gardner's classification. A questionnaire consisting of 24 questions diagnoses the rating of MI types based on the psychophysiological response and the conscious answers of the subject. The resulting profile of multiple intelligences can be viewed from the perspective of an individual profile of abilities, sphere of interests, and preferences.

1. Review of conscious and unconscious stimulus response studies

Human mental activity is associated with obtaining information from different sources and at different levels (conscious and unconscious) of mental organization. The basis of any knowledge is the stimulus, which can also be obtained from different sources. In the works of Freud (Freud, 1900), the conscious level of the psyche is described as a representation that exists in our consciousness, and which we perceive as such. Accordingly, the unconscious can also be viewed as a set of representations (stimuli) that a person owns, but on a level not perceived by mental organization. If the conscious and unconscious are based on ideas formed as a kind of response to a stimulus, then they can be revealed using a certain stimulus. The analytical approach of Jung (Jung, 1971) in the form of a "collective unconscious" does not deny the fact that generational experience can be passed on to a specific person in the form of certain stimuli: latent, temporarily unconscious, or repressed into the sphere of the unconscious. The Jungian understanding of the unconscious can be found in other psychological schools that go beyond psychoanalysis. For instance, Assagioli's concept of psychosynthesis (Assagioli, 1965) and his model of the inner world map, which focuses on the linguistic form of the reflection of the unconscious. It is worth nothing that regardless of the general orientation of a psychological school, the study of the conscious and unconscious affects the understanding that a person's views are formed under the influence of certain stimuli that need to be investigated (analysis of dreams, associative series, speech activity, etc.).

Beginning with Freud's classic works (Freud, 1900), psychology and psychophysiology began to pay considerable attention to the joint analysis of the conscious and unconscious components of human behavior. Most research in the field of psychology and medicine analyzes the mechanisms of consciousness and the unconscious when analyzing or solving practical problems, such as the learning process (Cleremans, 2014). Another portion of the research analyzes a person's behavior and his reaction to the presentation of individual stimuli (Eimer, 2002; Fahrenfort, 2009; Railo, 2012). Starting with the classic work of Darwin (Darwin, 1872; Dimberg, 2000; Janssen, 2009), much research has been devoted to the study of conscious and unconscious reactions' influence on the facial expressions of people demonstrating aggressive and depressive behavior. If researchers of the conscious and unconscious try to find common patterns and an understanding of the processes taking place, they are predominantly occupied with qualitative analysis and avoid obtaining and analyzing experimental data (Baumeister&Bargh, 2014; Bargh, 2014). Some medical technologies, such as the analysis of heart rate variability, are quite advanced in the study of unconscious or physiological processes (Berntson, 1997; Baevsky&Chernikova, 2017), but they do not take into account a person's conscious response, which limits their use to medical tasks only. Moreover, most researchers of the conscious and unconscious use different terminology to describe similar processes (Herzog, 1991; Edwards & Jacobs, 2003).

Thus, the main task, which has not been solved at the modern level of research of conscious and unconscious processes, is the development of a methodology that

allows for the joint analysis of these processes and concentrates the processes of consciousness and unconscious reactions together into personality diagnostics or a psychophysiological state.

The approach we propose differs somewhat from the traditional general reasoning about the conscious and unconscious or individual studies on separate physiological processes as manifestations of the unconscious. Closest to our view of the existing problem is the classic work of Wiener (Wiener, 1948) and the works of Bernstein (Bernstein, 1967), which laid the foundations of modern cybernetics and biomechanics. The cybernetic approach to man as a physical object leaves no room for abstract assessments and definitions. In our understanding, the conscious response of a person is understood in the form of conscious decisions, for example, in the form of verbal or non-verbal responses to presented stimuli. In our opinion, an unconscious reaction is characterized by a change in a person's physiological parameters, but for a correct assessment of the unconscious reaction, the integral physiological characteristics should be measured, rather than the local characteristics associated with the work of individual physiological systems. This approach to a person as an object of study is used in psychophysiological lie detection (Baur, 2006), where researchers analyze the signals of individual physiological systems, and the result is obtained by processing different physiological signals together. However, local time signals of a limited number of sensors used in traditional psychophysiological lie detection cannot provide an extensive aggregated picture of the changes in a person's psychophysiological state, which is provided by the matrix principle of obtaining information by means of vibraimage technology (Minkin, 2017).

2. Methodology for determining conscious and unconscious responses

The results of psychophysiological testing are analyzed using the data obtained by VibraMI program (VibraMI, 2018) to determine the multiple intelligence profile. In order for the reader to understand the results, we must describe in detail the testing method and elaborate on the structure of the questionnaire, which are generally described in various articles (VibraMI, 2018; Minkin&Nikolaenko, 2017). Testing of multiple intelligences involves the sequential presentation of 24 questions and stimuli images on a monitor screen in front of the examinee . Images of stimuli are chosen in such a way as to enhance the relevance of the presented questions. The sequence of presented questions is linearly oppositional, where 24 questions are grouped in pairs and each pair of opposing questions refers to a specific type of multiple intelligence (Minkin&Nikolaenko, 2017). The linearity of the questionnaire is determined by the linear increase in the level of extroversion inherent in each type of intelligence, whereas opposition is observed in the presentation of opposite questions in a pair, aimed at determining a person's response to each type of intelligence. Another principle of oppositional use of the questionnaire is the symmetrical arrangement of opposite types of multiple intelligences relative to the center of the questionnaire. In fact, the first four types of intelligence — intrapersonal, philosophical, logical-mathematical, and business — are the opposite manifestations of the interpersonal,

creative, verbal-linguistic and ascetic types of MI respectively. Thus, the questionnaire in use has a double opposition structure, within each type of intellect and between opposite types of MI. In addition, it should be kept in mind that of the proposed 12 types of MI, only eight are independent, since the first four and last four types of MI are the opposite manifestations of the same human characteristics. However, since psychology has historically used opposing characteristics as conditionally independent, we will not break with the established tradition.

2.1. Structure of line-opposite questionnaire

In psychophysiology, it is known that the final psychophysiological response (PPR) of the subject depends not only on the presented stimulus, but also on the sequence of stimuli presentation (Baur, 2006). Therefore, we will dwell in greater detail on the structure of the presentation of each stimulus in VibraMI program using the example of the second question from the G12 questionnaire (VibraMI, 2018): *<RQ delay = ”5” length = ”7” text_delay = ”1” text_length = ”0” img = ”images/G12/02.jpg” sign = ”–1” > Talking to strangers is usually a comfortable task<*

We will examine the conditional scheme of stimuli presentation in VibraMI program, including the sequential presentation of three questions and stimuli (images), given in figure 2. The Qi parameter shows the amount of time that the question was presented, and the Ti parameter shows the amount of time that the stimulus-image was presented, which enhances and explains the question asked. Ri shows the subject’s response time to the question asked, which can be significantly less than the Qi interval (as in the case of Ri-1), approximately equal to Qi (as in the case of Ri), or even exceed the time of Qi, depending on a testee’s speed of response to a question.

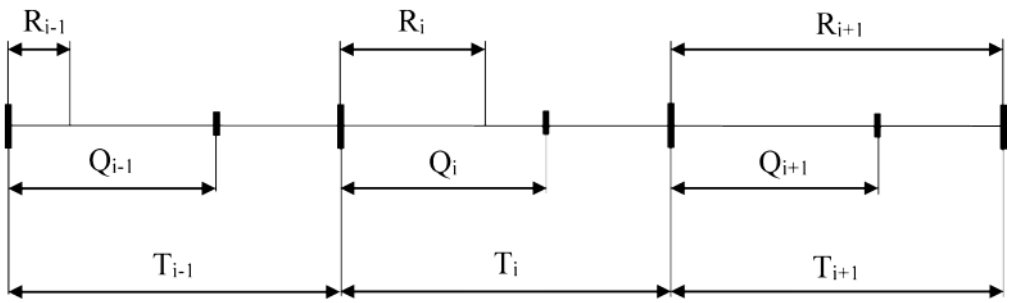

Fig. 2. Diagram of questions and stimuli presentation

In VibraMI program, it is proposed that the questions and stimuli presented are conditionally divided into control and relevant stimuli, analogous to classic lie detection. Even-numbered questions are relevant and are expected to be answered with NO by subjects who have developed a type of intelligence corresponding

to the presented stimulus. Odd questions are control questions, and are expected to be answered with YES by subjects who have developed a type of intelligence corresponding to the presented stimulus. The determination of the PPR occurs during the entire test, and it is assumed that the PPR corresponding to the presented stimulus begins from the moment the question and image of the stimulus on the monitor screen appear. A few seconds (depending on the length of the text) are necessary for the subject to read the question, then seven seconds are given for a conscious answer in the Yes/No format, then the text of the question disappears, but the unconscious response to the presented stimulus is still being measured. If an answer of Yes or No is not received, then this is considered to mean that the subject cannot decide on an answer. After the text of the question disappears, there is five second pause in order to minimize the effect of the change in the PPS from the previous question to the next one. After this pause, an image of the next stimulus appears on the screen and the analysis of the psychophysiological response to the next question begins.

VibraMI program allows the user to adjust the specified delays independently in the text of the questionnaire while taking into account the following factors specified by the program developer regarding the default settings:

– It is preferable to minimize total testing time, since it is assumed that the subject's fatigue negatively affects the information content of the PPR (Minkin&Nikolaenko, 2017). With the existing settings, the total test time, which includes 24 questions, is just over six minutes (381 seconds).

– Vibraimage technology uses the principle of the accumulation of frame difference for analysis of the PPS. Using the default settings, the accumulation time is 10 seconds, therefore, the result of calculating the parameters of the PPS carries information about 10 seconds of the subject's previous state, and the change in the PPS itself has a certain time lag. Therefore, it is preferable to have a pause between the presented stimuli in order to minimize the influence of the previous stimulus on the next one. Given this factor, it is necessary to increase the pause between tests, however, this contradicts the previous factor.

The choice of optimal time intervals during testing is a rather important characteristic that can significantly impact the results. At the same time, it is rather difficult to test the optimality of the settings, since testing a single person with different time settings will not reveal the effect of time settings on the result, since repeated presentation of the same stimuli will give different PPR, and the effect of this factor on the result will be more meaningful than the effect of temporal settings. In this study, we used the default time intervals specified in VibraMI program.

2.2. Information and energy characteristics of a psychophysiological state

Equations (3) and (4) for determining the information and energy characteristics of a subject using vibraimage technology are given in the introduction of this article. From the point of view of data analysis, we are primarily interested in two types of dependencies of these characteristics: the direct relationship between information

and energy characteristics (information efficiency and energy consumption) during testing, and the temporal dependence of these characteristics during testing. VibraMI program builds the dependencies obtained during testing, which are individual for each subject. Figure 3 shows an example of the dependence of changes in a subject's information and energy parameters in scales reflecting the information efficiency (%) and the energy consumption.

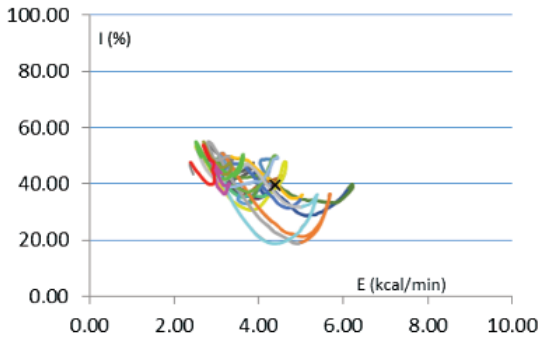

Fig. 3. Changes in information and energy characteristics in the scales of information efficiency (I) and energy consumption (E)

In the paper from Minkin and Myasnikova (Minkin&Miasnikova, 2017), it was proved that the predominant relationship between information and energy parameters has an inverse correlation, which in general follows from figure 3.

Figure 4 shows an example of the time dependence of the subject's information and energy parameters.

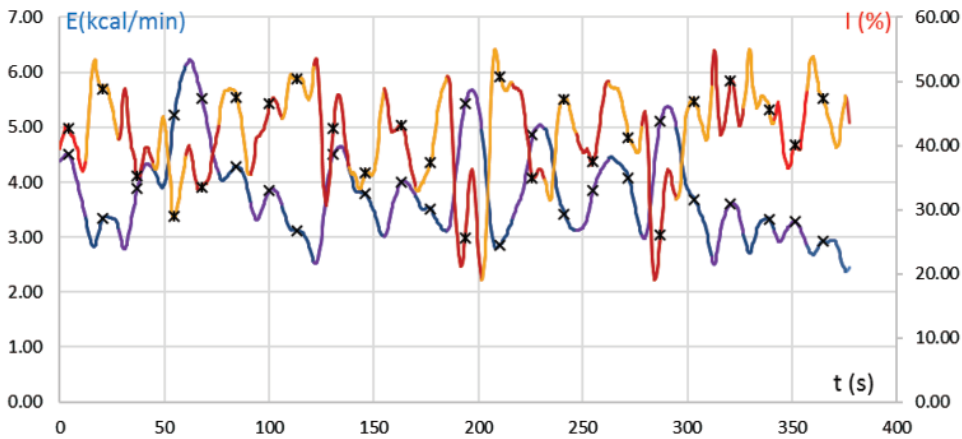

Fig. 4. Time dependence of changes in information and energy characteristics in the process of testing MI

The crosses in figure 4 indicate the time of the next stimulus presentation in a sequential line-opposite questionnaire. From Figure 4 it follows that the time for presenting a new question most often does not coincide with the moment of changing the direction of each characteristic studied, meaning that there is a certain psychophysiological time lag that exists for both the information and energy components. We hope that the typical information-energy dependencies depicted in figures 3 and 4 will aid the reader in understanding the following research material.

2.3. The time dependence of the change in psychophysiological components

Equations (5) and (6) for determining the psychophysiological state of the subject were given in the introduction of this article. Of course, we know Norbert Wiener's definition that "*Information is information*, *not matter* or *energy*" (Wiener, 1948). We clarify that this definition does not exclude a relationship and transition between these concepts, for example, implemented for the basic formula of the theory of relativity $E = mc^2$ (Einstein, 1905). In Minkin's paper (Minkin, 2018), it was suggested that the information and energy components of a person's psychophysiological state are interconnected and determine a person's overall psychophysiological state. Naturally, for the joint processing of these characteristics, it is necessary to bring these different values to one dimension, which is determined as a percentage of the possible maximum for each value. Despite the seeming simplicity of this approach, it should be noted that the authors are not familiar with scientific publications linking information and other physical quantities, except for some articles in theoretical physics (Toyabe, 2013) and Simonov's research (1986).

Shannon's work (Shannon, 1948), a classic approach to information laid the foundations of modern information theory and does not link information with other physical quantities.

The general structural equation (7) for determining any emotion was proposed by Simonov (Simonov, 1986):

$$E = f\,[P, (In–Is), \ldots] \tag{7}$$

Where Simonov proposed the following for emotion calculation:

E — emotion, its degree of quality and sign;

P — the strength and quality of the current need;

(In-Is) — assessment of the probability (possibility) of satisfying the need on the basis of innate and ontogenetic experience;

In — information about the prognostic means necessary to satisfy the need;

Is — information about the means that the subject has at the moment.

At the same time, Simonov frankly wrote in the conclusions of his work (Simonov, 1986): "*We are far from the intention to draw practical conclusions from the theoretical ideas we develop*."

We believe that the equation for determining emotions (or rather the psychophysiological state) proposed by Simonov is not as far away as he thought from practical implementation. However, it is necessary to understand his equation in another way, considering the person as an object of measurement and determining the information and energy costs of the person directly tested. Then the equation (7) can be transformed into the equations (5) or (6) which allow for the practical measuring of the current psychophysiological state.

A typical time dependence of the unconscious, or in our understanding of the psychophysiological response of a subject when testing MI, is shown in figure 5.

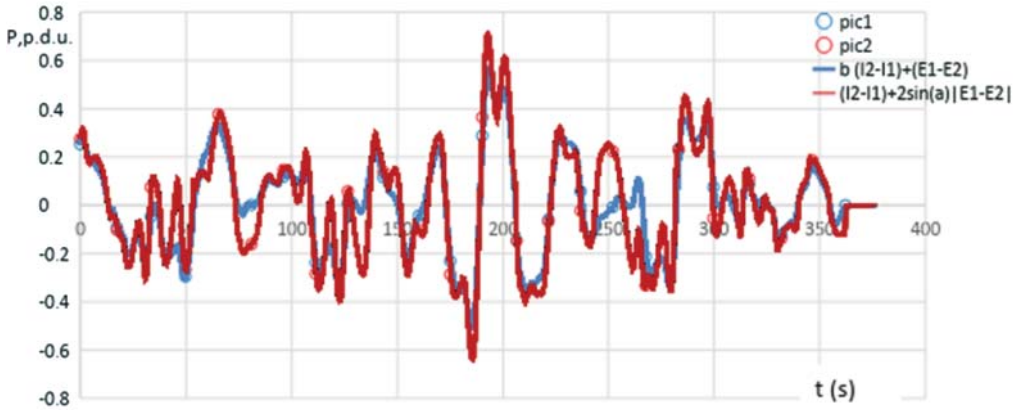

Fig. 5. An example of the time dependence of a subject's current psychophysiological response

In the time dependence of the psychophysiological response shown in figure 5, calculated using formulas (5) and (6), the points of presentation of the next stimulus are indicated by dots. From this dependence, it follows that the shift in the direction of change of the PPR does not always coincide with the moment of stimuli change.

3. The results of the study of conscious and unconscious responses to the presented stimuli

The majority of well-known scientific papers summarize the results of studies of a conscious reaction to periodic stimuli given in psychological and psychophysiological questionnaires (Baur, 2006) or to single stimuli in psychophysiological studies (Railo, 2012; Van den Noort, 2003). However, the joint quantitative analysis of conscious and unconscious responses to stimuli has been rather poorly studied. In this paper, we will try to evaluate a person's conscious and unconscious response to a stimulus using uniform standard processing and statistical approaches. To do this, we will carry out mathematical processing of the experimental results of MI for tested subjects upon presentation of a line-opposite

questionnaire using VibraMI program. The MI profiles obtained as a result of testing and analyzed earlier (Minkin&Nikolaenko, 2017) are not investigated in this article, since this is not the goal of the present work.

3.1. Materials and Methods

In this paper, the results of MI testing for groups of 512, 167, and 62 tested subjects are provided. Processing was done by VibraMI program (VibraMI, 2018). The aforementioned groups were tested in the Russian Federation in 2017–2018. Initially, VibraMI program did not connect the timing of the psychophysiological response to the questions asked. Therefore the study of the conscious response (not requiring the time connection of psychophysiological reactions) will be demonstrated on the basis of 512 test results. Most of the research on the unconscious (psychophysiological) response was conducted on the basis of 167 and 62 test results. The source data and the full results of processing the data from multiple intelligence testing are given in the appendices to this paper. During the study, two changes were made to VibraMI program. The first change was made after conducting 345 studies, adding a time tag to the program for all measured parameters. After 512 tests were conducted, stimuli were changed in the pairs of questions 3–4 and 21–22 and a base with 62 test results was added with a modified questionnaire.

Characteristics of tested group

In the course of our research, we studied 574 people ranging in age from 14 to 55 years. The average age of the test subjects was 24.3 years. The level of education ranged from incomplete general secondary (high school students) to graduates of higher education (university graduates, as well as people with a postgraduate degree). The study included 142 secondary school students, 40 students in vocational school, 281 college students, 111 people who have completed secondary, vocational, or higher education, 7 of whom hold an advanced degree. The subjects' fields range from the humanities (musicians, philologists, linguists, journalists) to classical technical specialties (accountants, economists, programmers, engineers). 534 of the subjects were law-abiding citizens who had never faced criminal prosecution, and 40 had faced prosecution. The ethnic composition of the subjects is as follows: 70% European Russian; 25% Caucasian Russian; 5% citizens of foreign countries.

3.2. Subjects' conscious response to stimuli related to oppositional types of intelligences

As mentioned earlier, when testing MI with VibraMI program, 24 questions are presented to the subject. He can answer Yes or No, or he may fail to answer a question if he does not know which answer corresponds to his understanding of the question. The correlation matrix between conscious answers to 24 questions by 512 subjects is given in table 1.

Table 1

The correlation matrix of conscious responses to 24 questions, obtained from 512 test subjects (correlations (P) higher than 0.2 in absolute magnitude are shown)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1																								-0,20051
2													-0,30517								-0,25689	-0,2628	-0,23731	-0,22983
3																	0,204274							
4													-0,29247											
5					0,440749														-0,54097	-0,33268				
6				0,440749						0,220539									-0,52371	-0,2275				
7												-0,21069					-0,27565	-0,20242		-0,21121				
8																	-0,26958							
9																								
10					0,220539															-0,2049				
11											0,237738													
12							-0,21069				0,237738													
13		-0,30517		-0,29247													0,225596					0,205558	0,237238	0,245657
14																								
15																								
16																					0,241027	0,275086		0,208181
17			0,204274				-0,27565	-0,26958					0,225596					0,231968						
18							-0,20242										0,231968							
19					-0,54097	-0,52371														0,344323				
20					-0,33268	-0,26275	-0,20121			-0,21049									0,344323					
21		-0,25689														0,241027						0,236485		
22		-0,2628											0,205558			0,275086					0,236485			
23		-0,23731											0,237238											
24	-0,20051	-0,22983											0,245657			0,208181								

The expected result for a conscious response to opposite stimuli was the presence of a negative correlation, highlighted in the diagonal in table 1, between centrally symmetric (similar in meaning) questions (1–24, 2–23, etc.) for the first and last four MI types (negative values on the matrix diagonal). The result given in Table 1 partially confirmed the expectations, however it showed a large number of superfluous correlations and the absence of a predicted correlation between questions 3–22 and 4–21.

Upon receipt of the final conscious response corresponding to each type of intelligence, a conscious response for every question is processed using equation (8):

$$Pc = Po - Pe \tag{8}$$

Where: *Pc* — the numerical value of the final conscious response in %,
Po — the numerical value of the conscious response to an odd question in %,
Pe — the numerical value of a conscious response to an even question in %.

The calculation according to equation (8) is explained by the fact that in the line-opposite questionnaire used, the first (odd) question relating to each type of intelligence has a conditionally positive value for the subject (it is anticipated that a reply of Yes indicates a positive attitude toward this type of MI and the presented stimulus). The even question following it has a conditionally negative value for the subject (it is anticipated that a reply of No, also indicates a positive attitude toward this type of MI but a negative attitude toward the presented stimulus). Thus, the answer Yes to the first question and No to the second question gives the maximum positive conscious response (100%) to this type of MI. For maximum continuity of the conscious response, the developers of VibraMI program proposed the following system for evaluating the conscious response for each type of intelligence, given in table 2.

Table 2

The system of conscious response assessment for each type of intelligence

Reply	Y;N	Y;–	–;N	Y;Y	–;–	N;N	–;Y	N;–	N;Y
Pc; %	100	75	75	60	50	40	25	25	0

In table 2, the answer “Yes” is indicated by the symbol Y, the answer “No” is indicated by the symbol N, and the lack of a choice between Yes and No is indicated by a dash (–).

The correlation matrix of the conscious responses for each type of intellect, recalculated with regard to the proposed rating system for 512 data points, is given in table 3.

Table 3

Correlation matrix of conscious responses for MI types obtained from 512 subjects (P > 0.3)

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	AB	IE
IA												-0,33
ET												
LM										-0,58		
BM									-0,39			
VS												
NL												
BK												
MR											0,34	
AS				-0,39								
VL			-0,58									
AB								0,34				
IE	-0,33											

In the resulting correlation matrix for 12 types of MI, almost all random correlation dependences between independent types of MI disappeared, with only the negative correlation between opposition types of MI remaining in the diagonal. The only positive relationship was between the musical-rhythmic and artistic-bohemian types of MI, which is understandable since the artistic-bohemian type of MI, which is absent from Gardner (Gardner, 1983) and proposed by Minkin and Nikolaenko (Minkin&Nikolaenko, 2017), needs correction of both its name and stimuli. Our discussion of the need and effectiveness of such a correction will be presented in the next section. At this stage, we state that in the resulting correlation matrix of the conscious response, there is no expected connection between MI types 2 and 11 (ET-AB), and there is an superfluous positive connection between MR and AB.

The lack of connections in a conscious reaction between conditionally oppositional but relatively closely located types of MI (5–8; 6–7) was predicted in the research of Minkin and Nikolaenko (Minkin&Nikolaenko 2017), so this assumption was experimentally confirmed.

3.3. Unconscious (psychophysiological) responses to successive questions. Determining the optimal algorithm that characterizes an unconscious response

VibraMI program used in this work allows one to independently calculate a subject's conscious and unconscious reaction to the stimulus presented, and then builds an MI profile depending on the data obtained on a given subject's conscious and unconscious responses. A subject's unconscious or psychophysiological response to the presented stimuli is determined by vibraimage technology (Minkin, 2008; 2017) based on the two main characteristics of information and energy (Minkin, 2018). First we will examine the correlation matrix for the psychophysiological responses of 512 subjects during a line-opposite questionnaire containing 24 questions and stimuli. It should be noted that the analysis of the subject's unconscious reaction gives the researcher a much greater scope for analyzing the results, since the subject's unconscious reaction is determined by the time dependencies obtained, as shown in figures 4 and 5. At the same time, different PPR results can be obtained not only when taking into account various formulas, but also when choosing different time intervals for analysis. As a criterion for choosing the optimal setting of the algorithm for determining the PPR, we propose to consider the maximum negative correlation coefficient between adjacent questions given in table 4.

Table 4

Correlation matrix for unconscious responses (24 answers) from 512 subjects (P > 0.2)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		-0,44475																						
2	-0,44475		-0,41195																					
3		-0,41195		-0,36541																				
4			-0,36541		-0,45746																			
5				-0,45746		-0,44311																		
6					-0,44311		-0,48581																	
7						-0,48581		-0,49895																
8							-0,49895		-0,47279															
9								-0,47279		-0,44612														
10									-0,44612		-0,45539													
11										-0,45539		-0,45631												
12											-0,45631		-0,3744											
13												-0,3744		-0,39841										
14													-0,39841		-0,45351									
15														-0,45351		-0,32479								
16															-0,32479		-0,49135							
17																-0,49135		-0,46755						
18																	-0,46755		-0,52057					
19																		-0,52057		-0,49345				
20																			-0,42345		-0,49225			
21																				-0,49225		-0,45502		
22																					-0,45502		-0,47472	
23																						-0,47472		
24																								

At first glance, table 4 shows that the correlation matrix, determined by unconscious reaction, is significantly different from the correlation matrix determined by an unconscious reaction that is shown in table 1. In the correlation matrix for the unconscious reaction, there is only a negative correlation between neighboring questions, and it is about the same both between opposing questions within each intelligence and when moving from questions of one type of MI to the next. The average value of the Pearson negative correlation coefficient between neighboring responses, as defined in table 4, will be –0.43371.

The fact that the correlation in the last lower pair of the diagonal amounts to a value significantly lower than the average (–0.16137, not shown in table 4, since P > 0.2)

is explained by a purely psychological effect and the subject's desire to finish the testing as soon as possible. Naturally, according to subjects' psychological settings, the beginning and end of testing are somewhat different from the middle, even for relatively short tests. Therefore, there is a small pause (5 s) before the presentation of the first stimulus at the beginning of VibraMI testing. At the end of testing, there is also a pause before the presentation of the result, but since the subjects knows the number of questions in advance, the pause at the end cannot eliminate the natural change in the subject's psychological state.

Let's slightly change the method of calculating the PPS and move on from the measurement of the PPS between the moments when the stimulus is presented to the measurement of the PPS by the maximum interval within the time a stimulus is presented. In this case, the correlation matrix shown in table 5 has slightly higher values of negative correlation between adjacent PPRs. The average value of the Pearson negative correlation coefficient between neighboring questions, as defined in table 5, will be –0.56647.

Table 5

The results of the correlation matrix of the unconscious responses (24 answers) obtained from 167 subjects (P > 0.3). Maximum response to stimulus within every time interval

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1		-0,62678																						
2	-0,62678		-0,51982																					
3		-0,51982		-0,53927																				
4			-0,53927		-0,54726																			
5				-0,54726		-0,576																		
6					-0,576		-0,41835																	
7						-0,41835		-0,60084																
8							-0,60084		-0,56187															
9								-0,56187		-0,59842														
10									-0,59842		-0,60976													
11										-0,60976		-0,58382												
12											-0,58382		-0,60853											
13												-0,60853		-0,6126										
14													-0,6126		-0,53374									
15														-0,53374		-0,45481								
16															-0,45481		-0,54192							
17																-0,54192		-0,6777						
18																	-0,6777		-0,5465					
19																		-0,5465		-0,56639				
20																			-0,56639		-0,53379			
21																				-0,53379		-0,63777		
22																					-0,63777		-0,489	
23																						-0,489		
24																								

At the same time, the overall picture of the correlations given in tables 4 and 5 is almost unchanged. Let's try to clarify the result. It is obvious that the tables show a high negative correlation between opposing questions within each type of MI. However, the high negative correlation between neighboring questions concerning different types of MI, at first glance, is surprising. What could be the cause of this phenomenon? To understand the result, it is necessary to return to figures 3, 4, and 5, which show the real fluctuations of the PPR relative to the center of mass, which determines the average PPS of a subject during testing. Each presented stimulus leads to a deviation in the subject's state from his center of mass in a certain direction.

This direction and magnitude of change is determined by the significance and associativity of the presented stimulus for the subject, and the response to each subsequent stimulus depends not only on the new stimulus, but also on the magnitude of the previous bias of the PPS, since the natural mechanisms of regulating the PPS are always aimed at returning the changed PPS to the center of mass. We will examine the response to the

subsequent stimulus when determining the probability of a state change depending on the magnitude and direction of the stimulus on the existing data from 512 subjects' results.

Figure 6 shows the probability of a change in direction of a PPR depending on its magnitude.

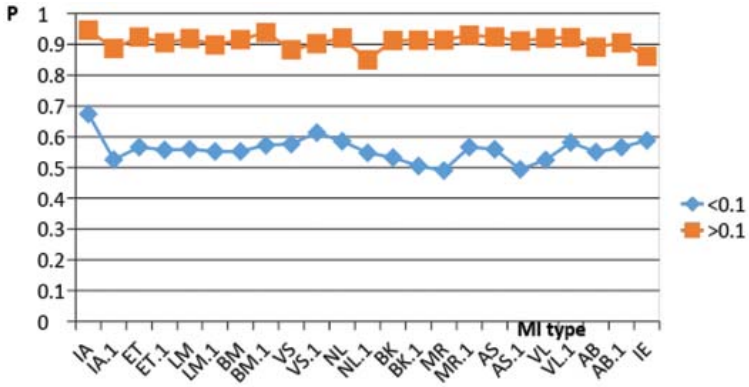

Fig. 6. The probability of a change in the direction of the PPR depending on its magnitude (the proportion of subjects who have a change in response direction)

At the same time, the number of subjects in the groups with strong and weak reactions for the selected threshold (0.1) is approximately the same for each MI type. The approximately equal number of results with a weak and strong reaction with different likelihoods of a change in direction allows for the following conclusion. With a weak PPR, the change in the direction of the PPR is close to 50%, i.e. it is about equally likely for PPR to move in one direction as in the other direction when the value of the PPR is near the center of mass. However, the probability of a change in the direction of a PPR exceeds 90% in the presence of a strong PPR, as shown in figure 6. Thus, it is shown that after a strong response to opposite stimuli, the next stimulus or question, although it is not oppositional in essence, has a high probability of being perceived by the subject as oppositional. In this case, an arbitrary alteration in the direction of change in the PPR is quite likely if the question is not significant for the subject. So the probability of changing the direction of the PPR is close to 50% when the subject has a weak psychophysiological response to a given question.

We understand that for the practical use of the above results, it is necessary to present more convincing evidence that vibraimage technology is a real technology for psychophysiological detection, the results are not random, and the information and energy characteristics described are indeed the main indicators of the PPS. In order to do this, we must apply the Fourier frequency transform (FFT) (Oppenheim & Schafer, 2010; Bendat & Piersol, 1986) of information, energy, and current psychophysiological characteristics, and identify how much the calculated periods of these functions coincide with the period of stimuli presentation in the line-opposite questionnaire (LOQ). We will also clarify that the time period for the presentation of each stimulus in the LOQ is a quasi-constant value and its changes are insignificant. The difference in time of the

stimuli presentation is determined by the different amount of textual information in the questions and, despite the fact that the developers of VibraMI program tried to make questions of approximately the same length, it wasn't possible to achieve complete identicality. The duration of the presentation of each question-stimulus is given in table 6, and the average time of presentation of test questions is 15.82 seconds.

Table 6

The duration of stimuli presentation in MI LOQ

Question number	Time elapsed from start of test (in seconds)	Presentation time of each stimulus (in seconds)
1	0	17.2061
2	17.2061	16.0029
3	33.209	16.4788
4	49.6878	15.6245
5	65.3123	15.7621
6	81.0744	15.2014
7	96.2758	15.4122
8	111.688	15.417
9	127.105	16.781
10	143.886	16.803
11	160.689	15.599
12	176.288	15.424
13	191.712	16.381
14	208.093	15.2
15	223.293	15.196
16	238.489	15.599
17	254.088	15.808
18	269.896	15.509
19	285.405	16.405
20	301.81	16.792
21	318.602	14.812
22	333.414	14.407
23	347.821	15.608
24	363.429	16.195

For each of the 229 tests using the FFT, the period spectrograms for information, energy, and psychophysiological characteristics were determined. After averaging (taking the median and arithmetic average), generalized spectrograms were obtained, shown in figures 7, 8, and 9 respectively.

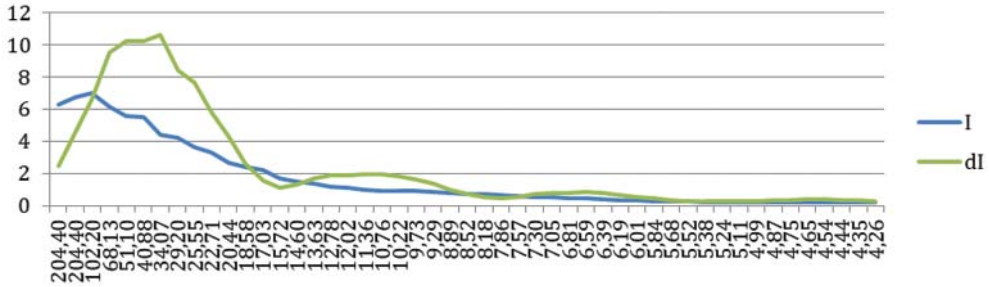

Fig. 7. Spectrogram of information characteristics (I) and differential information characteristics (dI) for 229 subjects

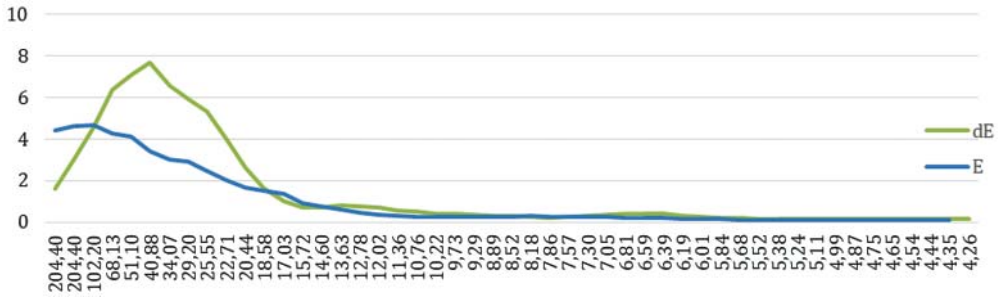

Fig. 8. Spectrogram of energy characteristics (E) and differential energy characteristics (dE) for 229 subjects

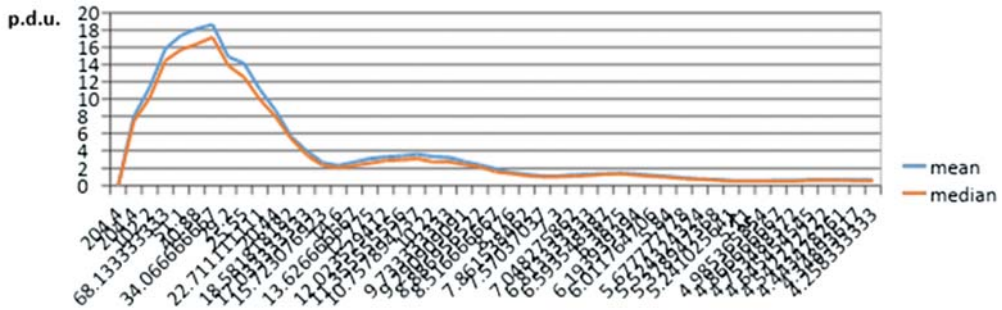

Fig. 9. Spectrogram of the PPS characteristics for 229 subjects

The spectrograms of information and energy characteristics shown in figures 7 and 8 show a rather wide spectrum maximum, shifted significantly towards low frequencies despite the recession of the trend (Bendat & Piersol, 1986). In these graphs, the worst manifestation of the maximum of the spectrum is observed for the energy characteristic (fig. 8). This means that the energy exchange is minimally sensitive to the presented stimuli, although energy changes in physiological parameters are traditionally used in the psychophysiological detection of lies.

In contrast to the information and energy spectral component, the spectrum of the PPS period has a clearly pronounced maximum, corresponding to a period of 34.06 s, which practically coincides with the period of presentation of opposite stimuli (31.64 s). The discreteness of the PPS period calculation by FFT in the maximum is relatively large, with the left reading from the maximum showing 40.88 s and the right reading 29.2 s. Thus, the maximum in graph 9 (34.06 s) falls on the closest reading to the real time of the presentation of stimuli t can therefore be considered proven that the frequency of changes in the PPS, determined by equations (5) and (6), changes with the same frequency as the presentation of oppositional stimuli, so vibraimage technology correctly captures changes in the psychophysiological state.

Note that the current value of the PPS, determined by equations (5) and (6), depends only on the change in the energy and information characteristics when the response to the next question is switched (~16 sec). So as we are based precisely on changing the values of these characteristics plays a key role in conveying the periodic nature of changes in the PPS with the presentation of oppositional stimuli. Unlike the spectrograms of current values of information and energy, the spectrograms of the differentials of information and energy values have pronounced maximums. In this case, the spectrum of the information characteristic has a maximum corresponding to the period of presentation of stimuli, and coinciding with the maximum of the spectrogram of the PPS (fig. 9). The change in energy, however, occurs with some delay, as reflected by the spectrogram of this characteristic.

However, the absence or not so obvious expression of this period in the temporal dependencies of the information and energy components of the PPS is possible only if the information and energy exchange is constantly carried out in the human body. It is no less important a component of the vital activity process than the well-studied metabolism (Weir, 1949).

An important property of the information and energy characteristics is the presence of a one-sided (opposite) trend in the indicated time dependencies. In order to correctly calculate the maximum of the frequency spectrum by the Fourier method, the linear trend is removed (Bendat & Piersol, 1986), however, at the same time, the maximum expression of the low-frequency components is preserved. This suggests that each of these characteristics separately does not provide a periodicity in the change in the PPS corresponding to the period of question presentation. Thus, the combination of information and energy characteristics gives the most complete picture of the period of change in unconscious responses.

The presence of an oppositely directed trend in informational and energy characteristics seems to be quite important, since it confirms the assumptions made that during psychophysiological studies, time should be minimized in order to eliminate errors due to changes in the test subject's PPS at the beginning and end of testing. The time dependencies of the information and energy components show in figure 10 confirm the existing divergent trend averaged for all 229 subjects.

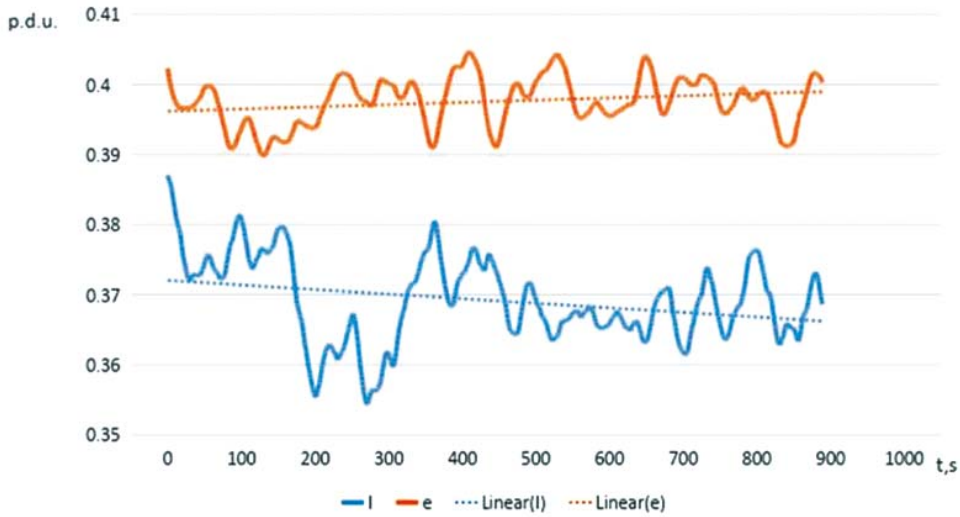

Fig. 10. Time dependence of the averaged values of the information and energy components during testing time

The time dependencies in figure 10 show that a subject's psychophysiological state is constantly changing during testing, and with an increase in testing time there is a noticeable increase in energy consumption and a decrease in information efficiency. The obtained dependencies confirm the assumption made in research by Minkin and Nikolaenko (Minkin&Nikolaenko, 2017) that it is necessary to minimize testing time to reduce the error from the general change in the psychophysiological state and the subject's growing fatigue.

3.4. Development of criteria and determination of norms for a subject's conscious and unconscious responses during line-opposite questionnaires

Conscious response

Let us return to the examination of the results obtained when constructing the correlation matrices of conscious reactions given in table 3 and the absence of the expected correlation between the FI (questions 3 and 4) and AB (questions 21 and 22) types of MI. Questions for these types of MI used in testing the group of

512 subjects are shown in table 7. Keep in mind that the results of 512 tests did not reveal the expected correlation in the conscious reaction between ET-AB types of MI (table 3).

Table 7

Questions for the existential-theoretical and artistic-bohemian types of MI for 512 subjects

Question №	Question text
3	A philosophical way of thinking prepares for any change in life
4	A person should act and not debate in any situation
21	I easily adapt to what is necessary
22	Standing out from the crowd isn't an interest of mine

As the mathematical analysis showed a lack of a supposed connection between opposite types of MI, this means that the stimuli used in VibraMI program need to be corrected to adequately reflect the oppositional approach to the centrally symmetric types of MI described in Minkin and Nikolaenko (Minkin&Nikolaenko, 2017). It turned out that the categorical apparatus (questions and stimuli) of the ET and AB types of MI have a common overlap zone at the level of an associative array and socially desirable answers. Given that the question pairs for ET and AB were formulated sufficiently correctly, no significant differences (in the form of negative correlation) were obtained because of the tendency to give socially desirable answers without delving into the details of the differences between the questions. The situation was aggravated by the presence of visual stimuli with respect to the neutral content (as became clear during the experiment). For example, questions 3 & 4 and 21 were mostly answered positively. Their content was perceived as a model of socially desirable behavior, and not a real way of life or a category of value orientations.

In this case, a positive or negative answer to question 22 no longer mattered.

The problem was solved through the use of contrasting stimuli: the replacement of two stimuli, their four visual stimuli, and the introduction of more rigid and less detailed question formulations. We also considered it necessary to change the name of the Artistic-Bohemian type of MI to Creative, since the term *creative* corresponds more to the modern understanding of MI types and is more opposed to the philosophical one. The philosophical type of MI replaced Existential-Theoretical, since the term ET introduced by Gardner (Gardner, 1983) turned out to be difficult to understand for VibraMI users. In addition, this approach solves the problem of eliminating the parasitic positive correlation between the musical-rhythmic and bohemian-artistic types of MI, which is present in table 3. The corrected questions to the opposite pair of Philosophical-Creative (PH-CR)

are listed in table 8. Naturally, the stimulus pictures were changed together with their corresponding questions, but we will not list them in this article so as not to increase its length. The corrected stimulus pictures can be viewed in the description of VibraMI program (VibraMI, 2018).

Table 8

Corrected questions for philosophical and creative types of MI for 62 subjects

Question №	Question text
3	Lying on the couch and thinking is more important than bustling around.
4	I can create something new and unusual
21	You must act in order achieve the desired result
22	I like to philosophize and dream about everything

An additional study conducted by the authors on a group of 62 subjects with the modified (with the stimuli for ET-AB replaced for PH-CR) LOQ showed the appearance of the expected negative correlation between questions-stimuli 3–22 and 4–21. The results of the updated correlation matrix are presented in table 9.

Table 9

Correlation matrix of conscious reaction by type of MI, obtained from 62 subjects (P > 0.2)

	IA	PH	LM	BM	VS	NL	BK	MR	AS	VL	CR	IE
IA												-0,20
PH											-0,20	
LM						0,28				-0,34	0,34	
BM									-0,35			-0,31
VS							-0,33			-0,22		
NL			0,28				0,37				0,23	
BK					-0,33	0,37						
MR												
AS				-0,35								
VL			-0,34		-0,22							0,33
CR		-0,20	0,34			0,23						
IE	-0,20			-0,31						0,33		

Naturally, with a relatively small number of subjects of the correlation matrix of table 9, there is a large number of additional correlations, compared with the statistics obtained from 512 subjects. However, the general tendency of the presence of a negative correlation in the diagonal between opposing MI types remained unchanged, except for the correlation between MI Types 2 and 11 that appeared.

The experiment conducted with the correction of certain stimuli showed that the mathematical apparatus, namely the correlation matrix, can be used to identify and correct stimuli that are inappropriate for the proposed concept. In addition, the change in stimuli showed that the choice of stimuli presented is decisive for the subject's response and no one is immune from errors, including the developers of

the LOQ and the modernized MI structure (Minkin&Nikolaenko, 2017). Most likely, the introduced bohemian-artistic type of intelligence was not chosen successfully as a type of MI oppositional to existential-theoretical. The proposed change from the ET-AB pair to the philosophical-creative (PH-CR) pair better satisfies the LOQ concept, which is confirmed by the additional experiment carried out and table 9, demonstrating the presence of a negative correlation between the questions of the PH-CR pair.

Unconscious response

Consider the correlation matrixes for the unconscious responses determined by different approaches to the time period when the psychophysiological response was determined, including those given in table 4 and 5, as well as other options for determining the PPS given in table 10.

Table 10

The average value of negative correlation between adjacent stimuli for different options of PPS measurement

N	1	2	3	4
PPS definition option	PPS measurement in the period from the presentation of the stimulus till the response	PPS measurement in the period from the presentation of the stimulus to the end of the stimulus	PPS measurement in the period from the presentation of the stimulus to the end of the stimulus with a shift of 50%	PPS measurement between the minimum and maximum values during the presentation of the stimulus
Average value of negative correlation between adjacent stimuli	–0.23	–0.42	–0.41	–0.57

Taking into account the mechanism of natural PPS regulations examined earlier, upon presentation of opposite stimuli, it is logical to assume that the maximum value of the inverse correlation between neighboring stimuli corresponds to a statistically optimal algorithm for determining the PPS, since this figure shows natural psychophysiological regulation. There is variability in the psychophysiological time lag in responses to the stimulus and differing significance of the presented stimuli for specific subjects. The significant decrease in the negative correlation for the first variant of the calculation (table 8) is most likely due to a noticeable decrease in the time interval in which the PPS is determined. The average response time to a question is about 4 seconds, which is significantly less than the total time of 15.82 seconds for stimulus presentation. We assume that the individual dispersion of the PPR affects the short time intervals significantly more than in the calculation

over the entire period of stimulus presentation. It is interesting to note that a shift in stimulus presentation time, even to half the amount of time, has practically no effect on the resulting value of the negative correlation between adjacent responses (variants 3 and 4 of table 8). In our opinion, this suggests that the psychological time lags of the studied group of people has significant variability, and if some react to the stimulus almost instantly, others react to the same stimulus with a significant delay. That is why the average correlation depends little on the time of the shift to the beginning of the stimulus presentation, but depends significantly on the total length of the determination of the PPS. The period of stimuli presentation is set by the program, but the response of each subject, regardless of his psychophysiological time lag, corresponds to the programmed period.

Thus, the criterion of maximum negative correlation between neighboring questions can be considered significant when designing stimuli in the LOQ. Therefore, a lower value of the inverse correlation between neighboring and especially opposite stimuli indicates less opposition between the presented stimuli. In addition, the data given in Table 8 allows you to select the optimal algorithm for calculating the PPS, namely, determining the PPS between the minimum and maximum values during the presentation of the stimulus. It is this algorithm for calculating the unconscious reaction that was introduced into VibraMI program after this present research was completed (VibraMI, 2018).

4. Discussion of the results

The results of the study of conscious and unconscious responses allow us to make a number of interesting and practical suppositions that are not obvious at first glance. At first, we assumed that a conscious response should have a correlation with an unconscious response, but the results actually showed its absence. It is probably the independence of the conscious and unconscious human response that is an evolutionarily correct decision, since the presence of a significant correlation between such integral psychophysiological systems reduces their significance. The results show that in each individual case, the conscious and unconscious reactions may or may not coincide, or, more accurately, have different meanings. At the same time, a unified approach to processing the results of conscious and unconscious responses proved that the obtained results for conscious and unconscious responses can and should be added, and it is the sum of the reduced conscious and unconscious responses that determines the positive or negative significance of the presented stimulus for a particular person.

In the introduction to this article, we said that the purpose of this research is not to study the MI profile. The data obtained during MI testing is used only for joint and separate analysis of a conscious and unconscious reaction. It should be noted that the proven lack of correlation between a person's conscious and unconscious response to a stimulus is direct evidence of the ability to conscientiously process (add or average) these reactions, which is the basis for obtaining the MI profile (Minkin&Nikolaenko, 2017). Studies show that mathematical processing of the

results confirms the accuracy of the theories put forward here. For example, the proposed intelligence pair of ET-BA did not pass the test for statistical accuracy and should be replaced by the pair PH-CR, which is confirmed by the test results. The refined structure of MI is thus presented in figure 11. Of course, the main factor for obtaining statistically correct test results is not the label of the intelligence types, but the correctly selected questions and stimuli (images); one could simply change the stimuli without changing the names of MI types. However, we believe that we must admit our mistakes, and if the negative correlation between the ET and BA types of MI did not find statistical confirmation, then it must be recognized openly and the pair changed to the philosophical-creative MI type.

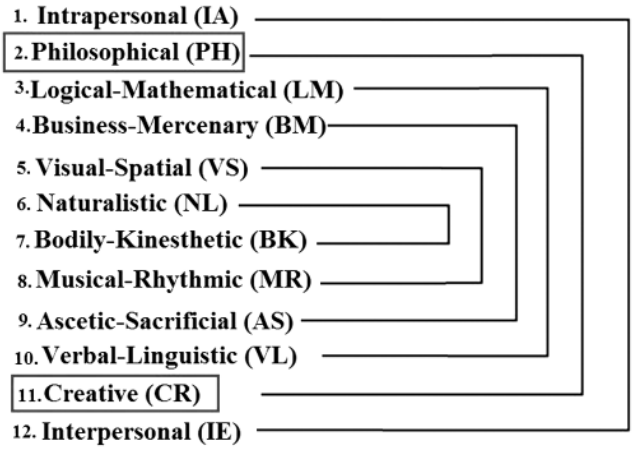

Fig. 11. Updated MI structure. Version 2.0

The correlation matrix between conscious and unconscious responses is given in table 11. From table 9 it follows that a significant correlation with a level of more than 0.2 is missing between conscious and unconscious reactions.

Table 11

Correlation matrix between the conscious (horizontal row) and unconscious responses (vertical column) obtained from the results of 167 MI tests

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	AB	IE
IA									-0,15			
ET											0,15	
LM												
BM										-0,16		
VS						-0,17						
NL	-0,15			-0,15			-0,17					
BK												
MR												
AS												
VL									-0,17			
AB												
IE												

At the same time, various diagonals (let's call them stepwise — the diagonal between neighboring questions and the main one — the diagonal between centrally symmetric questions relating to opposite types of intelligences), obtained in the correlation matrices of conscious and unconscious responses (tables 3 and 4), allow us to make an assumption about the different temporal natures of these responses.

Conscious attitudes have a pronounced remote character in time. It turns out that in reply to test questions presented in the immediate time proximity (in a row), subjects are less likely to give opposite conscious answers than to almost the same opposite questions (stimuli) distributed over time. Conscious responses practically do not work on stimuli that are close in time; such an explanation is obvious due to the absence of negative correlation in the stepwise diagonal of conscious reaction between adjacent questions in table 1. The unconscious response given in the correlation matrix of tables 4 and 5 has the opposite nature with respect to the conscious responses. Unconscious response has a negative correlation only for nearby stimuli and has practically no negative correlation for the same, but spaced out questions. This multi-temporal defense system allows a person to more adequately respond to emerging stimuli and is more evolutionarily stable than any other adaptation option. In addition, conscious and unconscious responses vary in the type of stimulus presented. The human conscious response is manifested in responses to stimuli that are close in meaning, and unconscious to opposing stimuli. Such an approach is likely the most progressive for evolutionary development, since when making a final decision a person can focus on a comprehensive analysis, and nature, in the form of a conscious and unconscious responses, offers one the maximum information to make the right decision.

We assume that in addition to our scientific and theoretical results, the present article allows for practical conclusions to be drawn as well, for example when conducting interviews or lie detection. It is well known that the most common method of psychophysiological detection of deception is the comparative testing model, which includes the multiple presentation of three questions of the I-C-R structure (Backster, 1963; Baur, 2006), which includes irrelevant (neutral), control, and relevant questions. In this case, a comparison of the psychophysiological response is carried out between the control and the relevant questions. The results show that the most common presentation should be inferior in effectiveness to the questionnaire consisting of the I-C-I-R structure (irrelevant-control-irrelevant-relevant), since it was shown that after a significant response to the control question, a significant response to the subsequent question is close to 90% regardless of its significance for the subject. However, the psychophysiological response after an irrelevant question more adequately reflects the true significance of the question presented to the subject. It should be emphasized that the presentation of several relevant questions in a row, also recommended during interviews (I-R-R-R) (Baur, 2006), should be even less effective than the presentation of the ICR format questionnaire, since the natural psychophysiological regulation virtually eliminates the natural psychophysiological response to the second and third relevant questions.

Of course, the studies we conducted do not provide an answer to all questions related to the analysis of conscious and unconscious human responses to stimuli. We understand that many researchers will not immediately agree with our proposed approach to quantifying a person's conscious and unconscious responses. Other scientists may disagree with our proposed method of co-processing conscious and unconscious human responses. The third group of objections will be directed at vibraimage technology as a means of measuring the human psychophysiological response, which is still not well known to most modern scientists. We are ready to provide all the initial materials and we believe that subsequent studies will confirm the proposed concept as a whole, although it can of course be adjusted in particular.

The statistical dependences of the conscious and unconscious response to opposing stimuli show a high degree of determinism and the manifestation of conditioned reflexes (Pavlov, 1927; Sechenov, 1965) in human behavior. Of course, even in the example shown in Figure 5 of the time dependence of the subject's current psychophysiological reaction to the LOQ, it can be seen that, depending on the importance of the stimuli, the direction of the PPR changes with different delays from the moment the stimulus is presented. That being said, the general patterns of changes in PPS practically confirm the conclusions made by Pavlov (Pavlov, 1927) about the high significance and individuality of acquired conditioned reflexes.

In particular it should be noted that the amount of information contained in the files of a joint study of conscious and unconscious human reactions is much higher than the amount of information contained in standard psychological studies obtained using questionnaires. For example, the size of data files for 512 MI results (and even 167) is noticeably larger (in bytes) than the size of data processing 1.5 M questionnaires with identification of personality types (Gerlach, 2018), since it includes not only conscious answers in the Yes/No format, but psychophysiological data obtained at a frequency of 30 frames per second throughout the image format. Of course, the size of the source data does not always matter, but if this data conveys meaningful information about a person, then certainly more data allows for more accurate conclusions. In general, the random error in determining an arbitrary parameter decreases in proportion to the square root of the number of accounts (Finkelstein, 2008).

We believe that in this article, a quantitative analysis of the functioning of the integral psychophysiological regulation is given for the first time. Previously, researchers have limited themselves to analyzing the regulation of individual physiological systems (Wiener, 1948), for example, cardiovascular (Baevsky and Chernikova, 2017) or vestibular (Bernstein, 1967).

Of particular interest is the identified tuning of the human body to a given rhythm upon presentation of opposing questions. In our opinion, the periodic changes shown in the psychophysiological state can provide additional information for the study of new and already known chronobiological processes (Halberg, 1987; Reddy,

1984), including the use of vibraimage technology for the study of chronobiological processes. Most of the known works aimed at studying chronobiological processes analyze the time dependences of biological parameters on external natural factors (Halberg, 1987; Reddy, 1984) or on the internal resources of the body (Baevsky and Chernikova, 2017; Fleishman, 2014).

In our opinion, the possibility of imposing a controlled external rhythm of changing physiological parameters can be of independent value for applications in medicine, psychology, and psychophysiological testing. There is a method of imposing a physiological rhythm that relatively close to the one proposed and used in medicine and electroencephalography. To identify various diseases, intermittent photic stimulation is used, which consists in illuminating the human head with short light pulses (stimuli) with a certain frequency (Trenité, 1999, 2012). The frequency of photic stimulation is shown in electroencephalographic signals reflecting brain activity. The method of photic stimulation can be used to implement a conditionally telepathic connection between people (Jiang et al., 2018). Thus, the method of intermittent photic stimulation allows for a certain rhythm to be imposed on a local physiological parameter, but it is not comparable in complexity to the processes occurring in a person upon presentation of an LOQ and does not include the entire aggregate and interconnectedness of conscious and unconscious responses. The process of presenting complex stimuli causes a conscious and unconscious response, including influencing the functioning of almost all physiological systems of the human body, and the interaction of these physiological systems determines the periodic change in a person's psychophysiological state.

We did not set a task in this article to deal with the internal physiological processes occurring in the human body, although we see this possibility in further research. The search for general laws in the management and transfer of information in living organisms is the main approach in cybernetics (Wiener, 1948).

It seems to us that in today's difficult times filled with fake news, it is necessary to fundamentally review and improve the objectivity of the system for assessing human abilities, behavior, emotions, and psychophysiological state. Only the rejection of the subjective habitual qualitative terms characterizing a person's state (for example, aggressive, happy, depressed, stressed, etc.), the transition to measuring physical quantities and the cybernetic approach to a person as a physical object will make psychology an accurate and modern science using psychometrics. We understand the time lag of human thinking and the impossibility of instantly replacing the established psychological terms with unusual physical and cybernetic ones when evaluating a person. As a transition period, it is proposed to use the established terms in modern psychology, but at the same time to develop generally accepted methods for calculating these terms in physical quantities and information indicators. Such an approach will allow us to bring humanity to a new stage of evolution and understanding of its place in physical nature.

5. Conclusion

Studies have shown the feasibility of using the periodic presentation of opposite stimuli to control a person's psychophysiological state. The results show a high degree of adaptive regulation of the integral characteristics of a person's psychophysiological state and its effort to maintain the psychophysiological balance through the work of consciousness and physiological systems. It was found that the conscious and unconscious responses complement each other and do not correlate with each other.

Using spectral analysis, it was shown that the information and energy characteristics, taken separately, do not provide a predetermined periodicity in the change of the unconscious reaction corresponding to the period of questioning. This result confirms the need to integrate these two indicators for the most complete picture of the periodic nature of PPS changes in the testing process.

The high efficiency of vibraimage technology demonstrates that it is a psychometrics technology with the widest use, including determining the quantitative evaluation (measurement) of the conscious and unconscious human response. The possibility of determining the optimal parameters of psychophysiological testing using the methods of mathematical statistics has been proved. The revealed dependences of psychophysiological regulation make it possible to review practical methods for conducting interviews, surveys, and lie detection, and to more efficiently choose incentives and a sequence of stimuli for profiling.

The human cybernetic model used (Wiener, 1948; Minkin, 2018) and the information-energy approach to determining conscious and unconscious responses as well as measurement of psychophysiological state proved their practical feasibility, accuracy, and effectiveness.

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Part 2. VIBRAIMAGE AND PSYCHOLOGY

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PROFESSIONAL SELF-REALIZATION OF ACCENTUATED PERSONALITY

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Abstract: *The problem of the professional development of accentuated personality at different levels of mental organization is investigated. The problem of matching the abilities of a particular type of professional activity is analyzed. Special abilities are considered in the framework of Howard Gardner's multiple intelligence theory, and in its modification. Ways to implement special abilities are analyzed in relation to different types of professional activity. The rationale for the rational and irrational distribution of information and energy resources is given.*

Keywords: *personality, profession, abilities, accentuations of character, vibraimage technology*

A person's professional development implies a balance between the presence of abilities for a specific sphere of professional self-realization and personal readiness. Personal readiness is understood as the projection of accentuated personality traits onto professional activity at different levels of mental organization: conscious and unconscious. Professional activity is associated with the irrational distribution of information and energy resources, due to the imbalance of special abilities and personal readiness for their implementation. Under the irrational distribution of energy resources are those types of professional activity that are associated with high energy costs for the particular individual due to insufficiently developed abilities and/or the presence of such personality characteristics (or personality accentuations) that can directly or indirectly impede the mastery of professional skills or cause a decline in the quality of their implementation.

A new understanding of human abilities and professional skills was suggested by Howard Gardner in his theory of multiple intelligences (Gardner, 1983; Minkin & Nikolaenko, 2017). Vibraimage technology allows one to obtain multidimensional dependences of a person's psychophysiological state (PPS) parameters. The current PPS of a person is defined as the point of intersection of the coordinates of the information (I) and energy (E) axes (Minkin, 2017) when assessing abilities (multiple intelligences) and personality accentuation profiles.

Traditionally, professional abilities as well as professional and personal motivation are considered as the key components of an individual's professional development. These abilities are considered to be individual psychological features

of an individual, the ability of a person to successfully perform a particular type of activity with a minimum expenditure of internal resources and time. Professional or special abilities, as opposed to general ones, imply the possibility of developing individual mental qualities for a specific type of activity (Teplov, 1985; Karpov, 2015; Leites, 1960; 1996). In describing the process of professional development, such a concept often appears as "professional self-consciousness", which reflects the synthesis of individual-typological and professional qualities of an individual. "The process of interaction between an individual and a profession is two-way: personal characteristics determine the choice of a profession and the ways to master it. The mastered profession, in turn, begins to determine the peculiarities of the formation of a personality" (Borisova, 1995). Often, the essence of professional self-determination is defined as "the search for and finding of personal meaning in the chosen, mastered and already performed work activity, as well as the finding of meaning in the very process of self-determination" (Pryazhnikov, 1999). Thus, the process of fusing personality and profession is continuous and covers most of the person's conscious life. The problem of diagnosing borderline mental disorders is one of the central problems of psychiatry, psychology, and related sciences. This issue was raised quite sharply in connection with the specification of diagnostic criteria for borderline states of character — accentuations (Lichko, 2010; Leonhard, 1989). The results obtained are used to make a clinical diagnosis and, as a rule, are rarely extrapolated to the area of professional and personal competence. At the same time, the study of this problem in the aspect of professional deformation of a personality or professional burnout indicates this type of communication as a category of professional and personal competence (Ermachenko, 1997; Bessonova, 2012).

In this paper, I will consider various options for an individual's professional self-realization from the standpoint of rational and irrational distribution of information-energy and personal resources. Under the irrational distribution of information and energy resources are those types of professional activity that are associated with high energy costs for this particular individual due to insufficiently developed abilities and/or the presence of such personality characteristics that can directly or indirectly impede the mastery of professional skills or cause a decline in the quality of their implementation.

Hypothesis

It is assumed that the imbalance of special abilities and personal readiness for their implementation is manifested in the irrational distribution of information and energy resources. Personal readiness is understood as the projection of accentuated personality traits into professional activity at different levels of mental organization: conscious and unconscious. The irrational distribution of information and energy resources is considered to be a category of personality deformations and professional burnout.

Methods

The methodological basis for the study of special abilities was Howard Gardner's theory of multiple intelligences. Diagnostics of borderline conditions were carried out with the support of Karl Leonhard's concept of personality accentuations (Lichko, 2010). Both concepts are implemented on the basis of the programs VibraMI (Minkin & Nikolaenko, 2017; VibraMI, 2019) and PsyAccent (VibraMI, 2019; Nikolaenko, 2018; VibraPA, 2019), using vibraimage technology developed by Viktor Minkin (Minkin, 2017). This technology allows for real-time tracking of the dynamics of human psychophysiological responses by means of a number of parameters. The change in energy released (consumed) by a person from the initial state to another energy state is measured in kcal/min. This information refers to a person's efficiency, measured as a percentage, reflecting the loss in transmission of information to physiological systems (signal-to-noise, or entropy-information) (VibraMI, 2019).

The questionnaire consisting of 24 questions allows for the diagnosis of the rate of each of the multiple intelligences (VibraMI) or the tendency toward one or another type of personality accentuation (PsyAccent) based on the current psychophysiological state and the subject's conscious answers. VibraMI program also allows you to diagnose professional interests and abilities with reference to the international classifier of specialties ISCED 2013 (UNESCO 2010/2013), (Baturin, et al., 2015; ISCED fields of education and training, 2013).

Vibraimage technology allows real-time recording of both the conscious (responses in YES/NO format) and the unconscious (energetic and informational components) responses to stimuli. The questions on the questionnaire and the photos are the stimulus material. The presence of stimulus material is due to the need to increase the questions' emotional and information load. Unconscious attitudes are much less plastic than conscious ones, not tied to situational factors.

In total, 50 people underwent testing, in the age range of 25–38 years. All subjects have a higher professional education. Analysis of the research results included the following steps: a) analysis of the profile of abilities and the profile of personality accentuations, for the presence of connections; b) the possibility of projection of accentuated personality traits onto professional activities (from the position of information and energy distribution of resources) c) comparison of the obtained results with biographical data. In addition, I will consider in detail the profiles of two people as an indicator of the successful (rational) and unsuccessful (irrational) distribution of information and energy resources.

Results

It is difficult to overestimate the importance of conscious attitudes in the field of professional personality development. At the same time, professional self-awareness is a process mediated by conscious attitudes and unconscious impulses, the ratio of which is difficult to determine. We can only insist that this relationship

exists with a certain degree of confidence. An analysis of group trends using the Pearson correlation confirms this. Significant correlations (for $p \leq 0.05$) between the individual parameters of VibraMI and PsyAccent methods were obtained (Nikolaenko, 2018; Minkin, 2019). The greatest number of connections (3 and more) was obtained between various types of MI, the dysthymic and emotive types of personality accentuation. On the one hand, the results obtained indicate the presence of links between abilities (represented by MI) and personality accentuations at different levels. On the other hand, the study of group trends does not give an idea of the rational or irrational distribution of information and energy resources, which can be obtained in relation to an individual person, as part of its projection onto professional activities.

Consider a specific example of an individual's professional formation, from the position of rationally distributing energy resources (Example 1).

Example 1. Sergey is 37 years old and has a higher technical education. Successfully combines his training with conducting business. He characterizes himself as a purposeful and moderately sociable person. Overall, his self-assessment of his character traits and level of aspirations do not contradict his real traits.

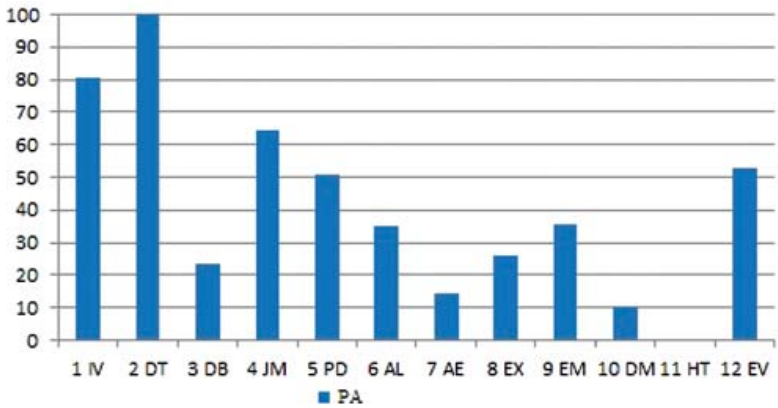

Fig. 1. Subject Sergey. Personality accentuations profile

Abbreviations in Figures 1 and 3. IV — Introverted, DT — Dysthymic, DB — Disturbing, JM — Jamming, PD — Pedantic, AL — Affective-labile, AE — Affective-exalted, EX — Excitable, EM — Emotive, DM — Demonstrative, HT — Hyperthymic, EV — Extroverted.

Analysis of the data according to PsyAccent method showed the prevalence of the dysthymic (DT, 100%) type of personality accentuation, with general introversion (IV, 84%) (Fig. 1). Comparison of the obtained results with the data of conscious (YN) and unconscious (IE) attitudes showed the coincidence of results in the dysthymic (DT 100%) type of accentuation, Figure 1. The discrepancy between one's conscious ideas about one's personality and unconscious attitudes, as a category of intrapersonal conflict, was not identified. Let's compare the results with VibraMI data.

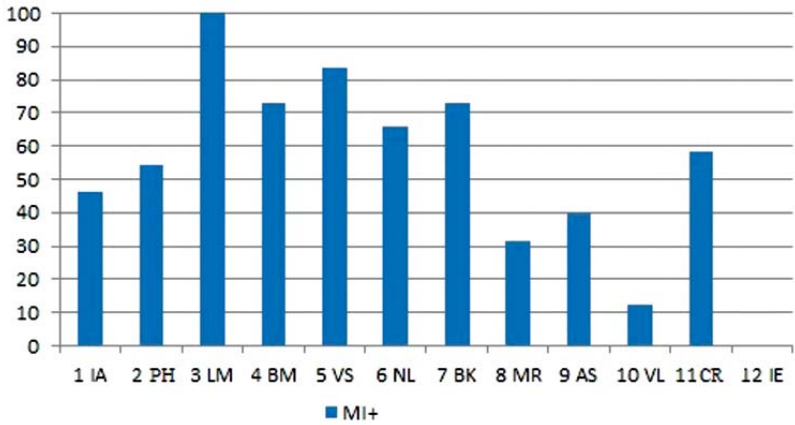

Fig. 2. Subject Sergey. Multiple intelligences profile

Abbreviations for Figures 2 and 4. IA — Intrapersonal, PH — Philosophical, LM — Logical-mathematical, BM — Business-mercenary, VS — Visual-spatial, NL — Naturalistic, BK — Bodily-kinesthetic, MR — Musical-rhythmic, AS — Ascetic-Sacrificial, VL — Verbal-linguistic, CR — Creative, IE — Interpersonal

Comparison of the results obtained with the profile of multiple intelligence is due to the need to localize the area of professional activity into which accentuated personality traits are projected. In Sergey's profile, the first and second places belong to the logical-mathematical (100%) and visual-spatial (84%) types of MI (Fig. 2). The third place in terms of severity is occupied by business-mercenary (73%) and bodily-kinesthetic (73%) MI. The recommended areas of specialization, according to the results of testing with VibraMI program, are as follows: information technologies and communication, engineering and construction, natural sciences, mathematics and statistics (Table 1).

Table 1

Test subject Sergey. The correspondence of the types of multiple intelligence to area of specialization (the names of the specializations are given according to ISCED), (ISCED fields of education and training, 2013).

№	%	MI profile (VibraMI)	Broad field (VibraMI)
1	100	Logical-mathematical (LM)	Information and Communication Technologies (ICTs)
2	84	Visual-spatial (VS)	Engineering, manufacturing and construction
3	73	Bodily-kinesthetic (BK)	Natural sciences, mathematics and statistics
4	73	Business-mercenary (BM)	Agriculture, forestry, fisheries and veterinary
5	66	Naturalistic (NL)	Service sector

The results are consistent with the subject's real biographical data: higher technical education, working in his field of study, running his own business. No imbalance of special abilities or readiness for their realization was detected for the testee at any level of mental organization. The process of an individual's personal development takes place in favorable conditions, characterized by a rational distribution of information, energy, and personal resources.

Let's consider another example of the professional formation of the individual from the standpoint of the irrational distribution of energy resources (Example 2):

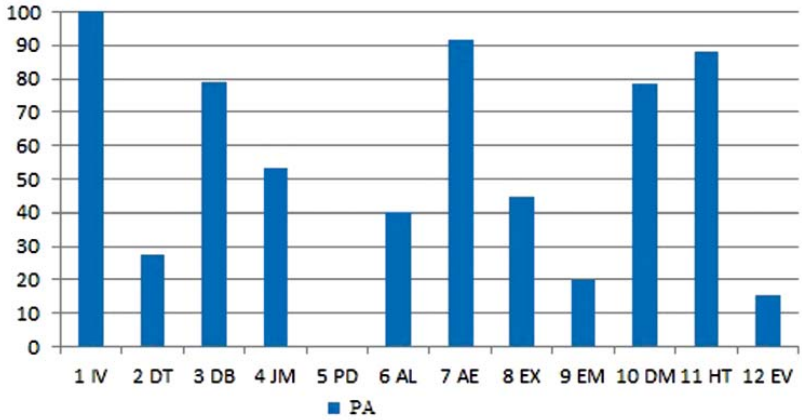

Fig. 3. Subject Konstantin. Personality accentuations profile

Example 2. Konstantin is 32 years old and also has a higher technical education. He works in his field of study and dreams of starting his own business. An analysis of his personality accentuations revealed the predominance of the introverted (100%) and affectively exalted (92%) type (Fig. 3). The high intensity of the rate of increase in the reactions of exalted personalities is a consequence of their hypersensitivity to environmental events. For introverted individuals, the opposite is typical, with a low significance of external events in relation to the inner world. Accordingly, the combination of introverted and affectively-exalted personality traits in one person (inherently opposite) can be considered as a category of intrapersonal conflict.

An analysis of conscious (YN) and unconscious (IE) attitudes also revealed a discrepancy between the results. At the conscious level, Konstantin considers himself a disturbed individual (100%). While at the unconscious level, the introverted (100%), affectively-exalted (84%) and demonstrative (72%) types of personality accentuation prevail. A comparative analysis of the main character traits inherent in each type of personality accentuation showed that the affectively-exalted type is much closer to demonstrative than introverted (Lichko, 2010). It can be assumed that the introverted type is not genuine, but rather unmasks the manifestations of the affective-exalted type. Thus, the results obtained during the comparison of conscious and unconscious attitudes confirm the presence of

intrapersonal conflict, which was mentioned earlier. Accordingly, the consumption of information and energy resources, ensuring the integrity of the functioning of the individual, is increased.

Let us compare the obtained data with the test results from VibraMI program:

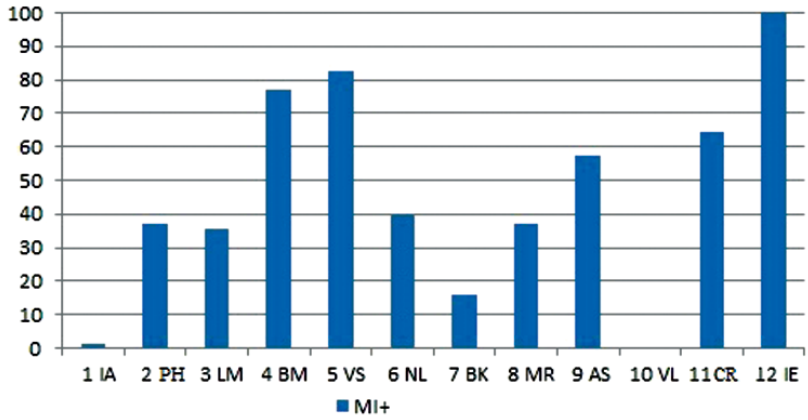

Fig. 4. Subject Konstantin. Multiple intelligences profile

Table 2

Subject Konstantin. Conformity types of multiple intelligence field of specialization.

№	%	MI Profile (VibraMI)	Broad field (VibraMI)
1	100	Interpersonal (IE)	Engineering, manufacturing and construction
2	82	Visual-spatial (VS)	Business, administration and law
3	77	Business-mercenary (BM)	Education
4	64	Arts-bohemian (AB)	Social sciences, journalism and information
5	57	Ascetic-sacrificial (AS)	Arts and humanities

The predominant types of multiple intelligence in Konstantin were interpersonal (100%) and visual-spatial (82%). The business-mercenary (77%) type comes in third place (Fig. 4). The recommended areas of specialization according to VibraMI test results: engineering and construction; business, administration and law (Table 2). He describes himself as a purposeful, sociable person, capable of doing business successfully.

Thus, Konstantin's self-assessment of his character traits and the level of aspirations are in conflict with the actual ones (obtained during the testing). For affectively exalted

personalities with traits of the hysterical type, it is quite difficult to conduct business. For this reason, at this stage of professional self-realization, one's own business remains the subject of dreams, and professional achievements in the technical field (engineering and construction) are associated with a high level of information and energy costs.

In particular, the affectively-exalted person spends an irrationally large amount of information and energy resources to maintain their introversion traits. As a result, a demonstrative type of behavior is formed: a demonstration of introverted personality traits by suppressing exalted forms of self-expression. The motivational aspect of the process of transforming and masking accentuated personality traits is beyond the scope of this study. My task was to show that the professional development of an individual takes place in unfavorable energy-intensive conditions, due to the imbalance of special abilities and personal readiness (intrapersonal conflict) to implement them.

Discussion

In the choosing of a profession, there are both personal and socio-cultural needs involved, dictated by the changing standards of modern society. The cumbersome, sometimes hours-long, procedure of conducting interviews for admission to work sometimes turns out to be ineffective. The right person is not in the right place i.e. not doing his job, and doesn't choose his future specialty correctly. A comprehensive, diversified approach to the assessment of personality has proven itself in the field of psychological diagnostics and recruiting in particular. There's a need to create a diagnostic tool that is accessible and comfortable to use both by a specialist and by any person interested in solving the problem of professional choice at any stage in life. However, this tool must meet all the requirements of a comprehensive psychological diagnosis. It combines the characteristics of a test of abilities and questionnaires of interests and attitudes, is short in time and correct in interpretation, and is protected from typical errors of observation and attitudes to the response from the respondent. This study has shown the range of possibilities of vibraimage technology (a combination of MI and PA techniques) in identifying the hidden tendencies covering the process of a person's professional development. If we assume that the different picture revealed between conscious and unconscious reactions reliably reflects hidden information, then this method can become the main one in the search for the optimal method of self-perfection. In this case, the risk of occupational deformities, professional burnout, and the pathological dynamics of accentuations (with a transition to a pathological level) will be minimized. In order to confirm or refute the results obtained, it is advisable to conduct more mass experiments using the proposed method (vibraimage technology), with the involvement of a larger number of subjects and the availability of more complete biographical data. There is a need for longitudinal studies of various social groups, monitoring the process of personal development at different life stages.

Conclusions

By analyzing a person's multiple intelligence profile, we were able to diagnose the presence of abilities for a particular type of professional activity at different levels of mental organization: conscious and unconscious. It turned out that professional human activity can equally occur both in prosperous conditions, accompanied by a rational distribution of energy resources, and in disadvantageous conditions, accompanied by an irrational distribution of energy resources (in the form of an imbalance of special abilities and personal readiness for their realization).

In a broad sense, the irrational distribution of energy resources was understood to be those types of professional activity that are associated with high energy costs for this particular individual. The main reason for the inefficient distribution of resources was the understanding that the ability to have one or another type of professional activity is not a guarantee of its successful implementation.

The diagnosis of the profile of personality accentuations and the profile of abilities was carried out using vibraimage technology and PsyAccent and VibraMI programs. Vibraimage technology makes it possible to identify multidimensional dependencies of the characteristics of psychophysiological state and to record the changes in energy and the direction of this change at different levels of mental organization in assessing the abilities and accentuations of a person as categories of a person's professional development.

Thus, we have confirmed the hypothesis that a person's professional development implies a balance between the presence of abilities in a particular sphere of professional self-realization and personal readiness.

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VIBRAIMAGE TECHNOLOGY APPLICATION IN PSYCHOLOGY

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Abstract: *The article discusses the possibilities of using vibraimage technology in various areas of psychology. Various aspects of the application of different types of software based on vibraimage technology in behavioral, cognitive, social, and existential-humanistic areas of psychology and psychoanalysis are analyzed.*

Keywords: *vibraimage technology, validity, behavioral, cognitive, social, existential-humanistic, directions of psychology, psychoanalysis*

Psychology studies the patterns of development and functioning of the human psyche. In turn, the psychometric approach in psychology ensures the objectivity of the data obtained and allows us to solve practical problems of diagnosing the states of a person within private areas of psychology. Therefore, it is important to choose the right instrument that meets the specifications of a particular area of psychology. Anna Anastasi, in her methodological approach to psychometric testing, says that tests should be selected and used taking into account their feasibility and existing limitations (Anastasi A., 1994; Standards for Educational and Psychological Testing, 2014).

To date, a detailed review of psychological testing tools, as well as the development of educational and psychological testing standards, is reflected in the activities of the following organizations: American Educational Research Association (AERA), American Psychological Association (APA) and the National Council on Educational Measurement (NCME), among others. On the basis of these organizations' activities, the Standards for Psychological Testing were developed (amended in 2014) (Bertram, 2011). The main problem lies in the fact that the developed criteria of reliability and the reliability of psychological methods are applicable only to the conscious sphere. The methodology of the unconscious does not fall under the main list of criteria for the validity of the Standards for Psychological Testing. This circumstance complicates the work of experts in the fields of Jungian analytical psychology, Szondi's fate-analysis, psychoanalysis, etc. Another problem is the reliability of test users. According to Dave Bertram, only 41% of users of psychological tests (out of 3,234,994 people surveyed from 36 countries) received a specialized education. Accordingly, most of the results should be considered indicative, but not descriptive.

Thus, there is a need to create a psychodiagnostic tool that is accessible and easy to use, both for specialists and for other "users of psychological tests". Vibraimage technology allows the user to obtain multidimensional dependencies of the characteristics of the psychophysiological state (PPS) and record the change in energy and the direction of this change. The change in energy released (consumed)

by a person from the initial state to another energy state is measured in kcal/min (Minkin & Nikolaenko, 2008; VibraMI, 2019). The analysis of motor activity (micro vibrations) of a human head and the transformation of movement parameters into the characteristics of the psychophysiological state (PPS) can be viewed as a category of the unconscious, and the answers to the questionnaire can be regarded as a category of the conscious. In the techniques created on the basis of vibraimage technology, both approaches are implemented.

1. The main directions in psychology

In this paper, we will consider five of the most popular areas in psychology, as well as the possibility of using vibraimage technology in each of them (see Figure 1).

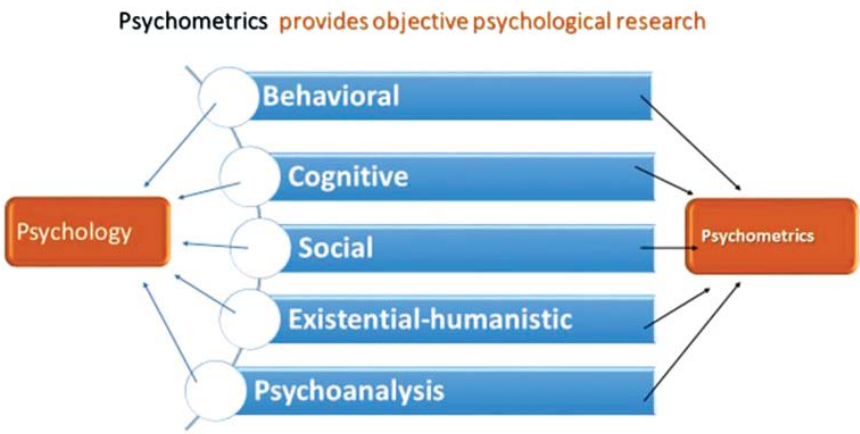


Fig. 1. Fields of psychology

1.1. Behavioral psychology

The field of behavioral psychology studies the behavior of a person as the main indicator of his personality. Regarding behavioral psychology, Skinner said that the science of human behavior is not fundamentally different from any other science based on facts. Its purpose is to predict and control the phenomenon under study (VibraPA, 2019). Accordingly, the psychodiagnostic tool should have high predictive accuracy, based on criteria that can be checked in real time. It is most convenient to do this using data on the psychophysiological state (PPS) of a person at the time of the survey. For this purpose, you can use the Excel_M file, based on VibraMed programs (or, depending on the initial orientation of the study, the Excel_M file, based on VibraMI or PsyAccent).

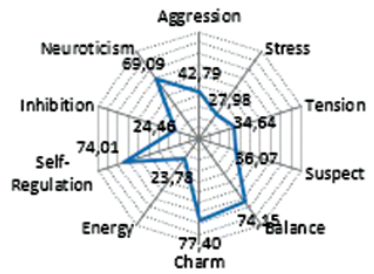
Testing Result for mental-functional state

Name	0	ID	
Gender		Date	04.04.19 10:45
Age		Σ Vi	23,9235

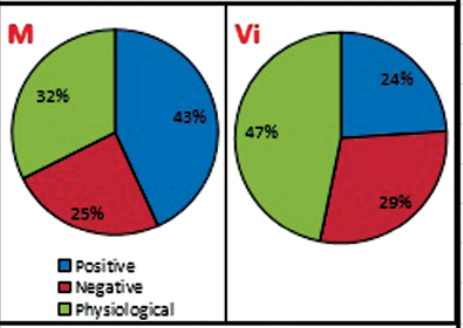
10 Parameter Results

Parameter	Min	Avg	Max	Vi	Parameter	Min	Avg	Max	Vi
Aggression (10 *10)	1,2	42,7922	64,6	20,3	Stress (10 *10)	10,3	27,9837	45,3	21,8
Tension (10 *10)	3,2	34,6448	51,6	34,9	Suspect (10 *10)	14,5	36,0707	44,2	14,3
Balance (10 *100)	46,5	74,1519	94,1	9,6	Charm (10 *100)	30,6	77,396	85,2	14,0
Energy (10 *10)	2,3	23,777	50,0	42,8	Self-Regulation (10 *100)	39,1	74,0125	86,1	8,4
Inhibition (10 *10)	10,8	24,4626	73,5	28,2	Neuroticism (10 *10)	0,0	69,0936	186,2	44,9

Parameter Chart

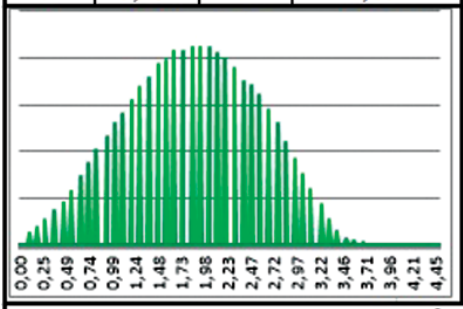


Emotion distribution Chart



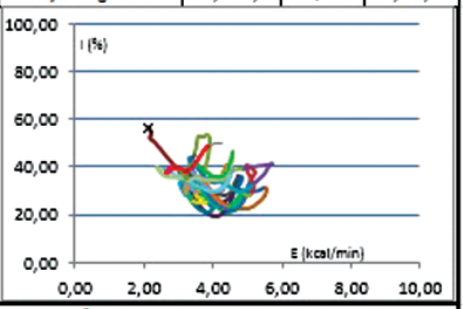
Frequency Histogram

Mf	1,808	S	0,718



Psy variability - Mental basal metabolism

Psy change rate	19,1-56,3	Kcal/min	2,1-5,7



Result [Quality 99%]

Extraversion	34,9176	Stability	50,6277

Your testing result for mental functional state is

☒ Normal

☐ To recommend a professional consultation

Comments

Fig. 2. File Excel_M, data of a person's PPS at the time of testing

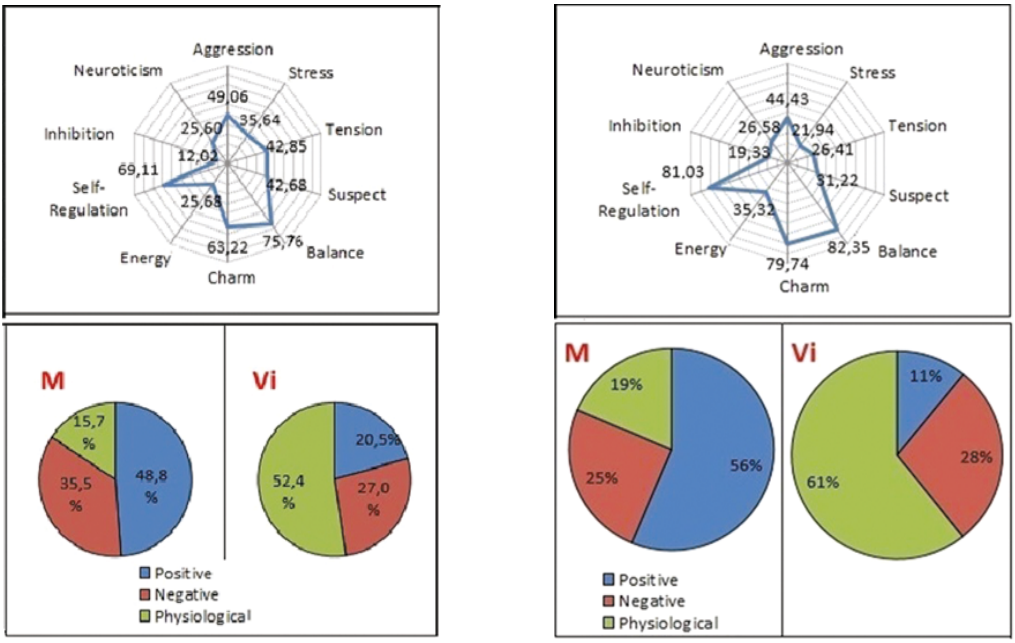
Express diagnostics of PPS and complex personality assessment have different goals. Express diagnostics (default test duration 60 seconds) allows you to predict the likelihood of destructive behavior in the next period (Figure 2). In what specific case can PSP rapid diagnostics be useful? For example, in differentiating between dangerous and safe situations: when a person's behavior on visual grounds can be interpreted by people nearby as aggressive, but it is not. No less interesting is the reverse situation, when in the absence of any information about a person, it is difficult to predict his behavior in the next few minutes. For example, the behavior of a fan during a football match.

In the case of a comprehensive assessment of the individual, in contrast to PPS, the goals are different. Consider the model of integrated assessment of personality on the example of operant learning. Skinner's operant conditioning or Thorndike's law of effect suggest that in the process of gaining a specific repetitive experience, the behavioral response model is reinforced (VibraPA, 2019). The authors themselves explore the incentives and reactions to them of man. But neither Skinner nor Thorndike could determine which people are more and which are less affected by this influence. However, this can be achieved with a comprehensive assessment of the individual. A good helper in solving the problems of operant learning will be PsyAccent program, based on vibraimage technology.

PsyAccent program allows for the diagnosis of personality accentuations. Accentuations of personality is traditionally understood to mean the extremes of the manifestation of character, in which certain features are strengthened while others are weakened (VibraStatMI, 2019). Such a person may be more susceptible to negative influence than other people without character accentuation. PsyAccent program includes three main questionnaires that are targeted at different ages and audiences. For adults we use L12, for older adolescents and young people — T12, and for psychological compatibility of the patient and the doctor — PA. The L12 questionnaire includes the following main tabs: a general profile of character accentuations, vulnerability for each type, a table of potential compatibility of carriers of various types of character accentuations in the process of interaction. The T12 questionnaire includes the following main tabs: a general profile of character accentuations, vulnerability for each type, and risk group (with indication of clinical diagnoses).

1.2. Cognitive psychology

Consider the cognitive and social model, in the aspect of the theory of social learning by Albert Bandura (Skinner, 1953). In general, the most susceptible and conforming personalities are most affected by social influence. At the same time, the tendency toward misdemeanors is mainly observed in people with epileptoid and unstable types of accentuation, as well as with different variants of their combinations (Leonhard, 1976; Lichko, 2010).



a) Epileptic accentuation *b*) Hyperthymic Accentuation

Fig. 3. The Excel_M file, a comparative analysis of PPS profiles for hyperthymic and epileptoid personality accentuations

Analysis of the PPS in individuals with epileptoid and hyperthymic accentuations revealed differences in the profile of the distribution of emotions (Figure 3). For individuals with epileptoid accentuation, a relatively high percentage of negative emotions is 35.5%, and, importantly, the level of self-control is weakened. Poorly expressed physiological reactions (inhibition and neuroticism) — 15.7%, positive emotions — 48.8%, i.e. less than 50% of the total emotional profile. There is considerable variability in both positive and negative emotions, which indicates a general emotional instability of such a person (Vi). On the contrary, with the hyperthymic personality type, positive emotions make up 56% and negative — 25%, while physiological reactions are expressed well — 19%. Low variability of emotions (Vi) indicates the persistence of positive emotions with hyperthymic accentuations.

1.3. Existential-Humanistic psychology

Another area that we will consider is the existential-humanistic psychology of Abraham Maslow (Maslow, 1954) and Carl Rogers (Rogers, 1951). This is one of the most positive trends in psychology. It recognizes that a person has infinite possibilities for self-improvement, including professional, where a person and a profession merge into a single whole. A properly chosen profession corresponds

to the abilities of the individual and brings them joy and pleasure. Accordingly, the approach to the abilities assessment should also reflect the basic principles of humanistic psychology. In this regard, the most acute question is the method of assessing human abilities. “Intellect” and “abilities” — are they parts of a whole or independent variables? The analysis of ability tests implies a certain relation to these concepts. Traditional tests of special abilities measure various aspects of intelligence that ensure effectiveness in specific narrow areas of activity. However, the intellect itself is understood as an indivisible whole — “general intelligence”, reflected by IQ points. On the contrary, according to Gardner’s theory of multiple intelligence, it is not about “aspects of intelligence”, but about independent, discrete forms of intelligence, i.e. multiple intelligence (MI) (Gardner, 1983). This model of intelligence allows you to effectively predict the focus of professional activity in the most comfortable (in terms of self-actualization) areas of study.

VibraMI program, based on the technology of vibraimage, presents a supplemented and expanded 12 types of classification for Gardner’s multiple intelligences, with an indication of the possibility of self-realization in a particular professional field. The profile of multiple intellects, obtained with the help of VibraMI, can be viewed from the perspective of an individual profile of abilities, sphere of interests, and preferences. At the end of the 6.5 minute test, VibraMI program instantly generates results in the form of 12 files with many tabs. The content of each tab carries the analysis of data that may be useful in drawing up a profile of the person being tested by specialists in various fields.

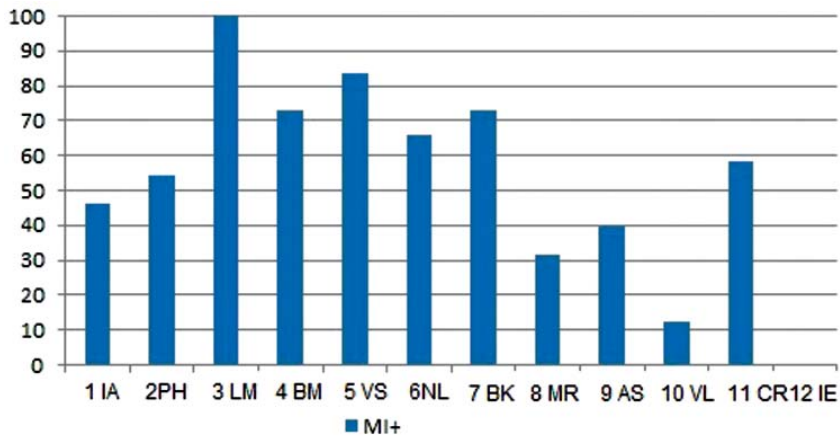
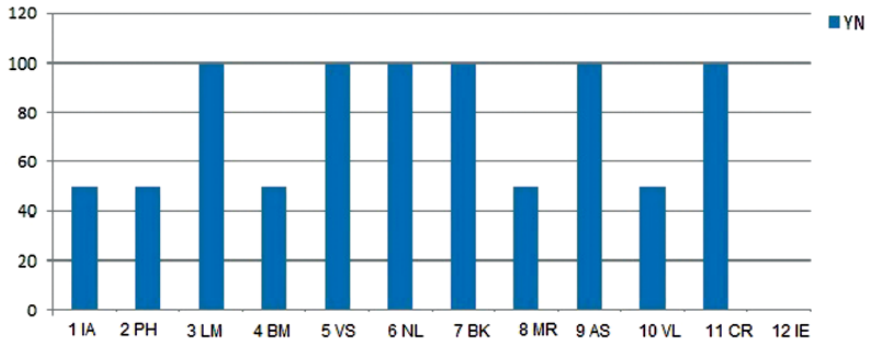


Fig. 4. File Excel_MI (tab MIStat), General Profile–Final

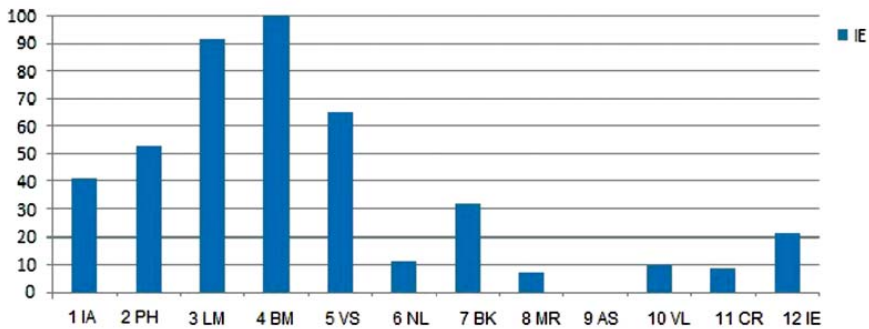
The general profile of multiple intelligences is presented on the Final graph (Figure 4), which is obtained by summing up conscious responses (YN) and unconscious responses (IE). Based on the multiple intelligence profile, data on the recommended specialty is automatically generated: a wide area, narrow area, and specialization.

1.4. Psychoanalysis

If one considers the answers of the subject to questions as a criterion of conscious attitudes, then there certainly is an unconscious answer — YN. What is important is that YN unconscious answers are more reliable, since they are not tied to the situational factor nor are they subject to the social desirability of the answers. This is why the analysis of unconscious reactions is so popular in psychoanalysis. The YN graph shows the conscious responses of the subject (in the YES/NO mode), and the IE graph shows the unconscious reaction (PPS) (Figure 5).



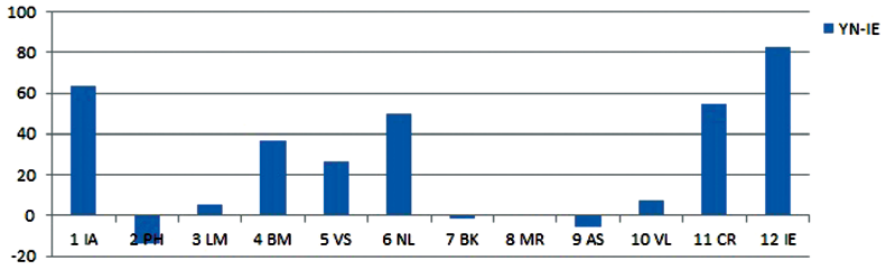
a) Conscious responses (YN)



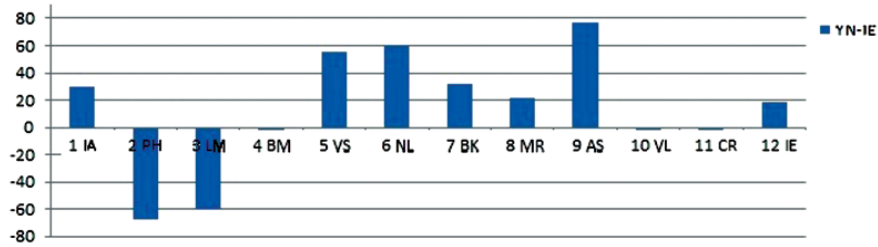
b) Unconscious responses (IE)

Fig. 5. Excel_MI file (MIStat tab), Conscious and Unconscious Reactions — YN & IE

Vibraimage technology allows for the real-time tracking of a person's PPS dynamics with a number of parameters, which is convenient for identifying intrapersonal conflicts and ulterior motives of behavior. A person's conscious answers reflect his self-esteem. At the same time, self-esteem is a complex mental education that is not limited to the conscious person's self-image. His unconscious sphere (fears, instincts, repressed desires) can influence conscious responses to varying degrees. The degree of this influence is determined by the depth of the conflict between the desired and the actual. The deeper this discrepancy, the greater the influence of the sphere of the unconscious on conscious responses.



a) Favorable profile



b) Unfavorable profile

Fig. 6. Excel_MI file (MIStat tab), Differential Graph (YN-IE)

The range from 20 to –20 is considered to be a match between the desired and the real, (Figure 6a). Negative values greater than –20 should be understood as the most significant parameters of the unconscious, while an excess of a positive value of 20 can be considered as significant parameters of the conscious sphere (Figure 6b). This is one of the possible interpretations of the subject's conscious and unconscious answers.

Conclusions

Along with other traditional method of psychological testing, vibraimage technology can also be a valid and reliable tool in various areas of psychology. The main advantage of vibraimage is the ability to process data obtained directly from two independent human sources — the conscious and the unconscious — in real time.

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DOI: 10.25696/ELSYS.VC2.EN.22

FEATURES OF CHILDREN'S (ADOLESCENTS') PSYCHODIAGNOSTICS USING THE VIBRA_MI SYSTEM

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Abstract: *The features of VibraMI system application in the psychodiagnostics of children (adolescents) are discussed. The possibilities of using vibraimage technology in the analysis of conscious and unconscious human responses to periodic stimuli are investigated. Recommendations on the use of VibraMI program for determining the abilities of children and adolescents are given.*

Keywords: *Vibraimage, VibraMI, psychodiagnostics, children, teenagers, psychophysiology, multiple intelligences.*

The term "psychodiagnostics" is one of the terms most frequently used by psychologists, especially when it comes to working with children and teenagers. There are many reference manuals that describe a variety of psychodiagnostic methods. Higher education institutions provide counseling in which professional duties include conducting psychodiagnostic studies (these include school psychologists, HR managers, and others). Let us make a risky statement: it's not that psychodiagnostics does not exist as a field of knowledge, but rather that it is a collective concept, since the modern level of psychological science does not allow a psychological diagnosis to be made or a person's behavior to be predicted based on the results obtained by performing a particular psychological test (psychometric intelligence test, personal questionnaire, projective methods, etc.).

It would be more correct, in our opinion, to talk about psychometrics, the object of which are the laws governing the development and use of means of measuring certain mental properties and characteristics (including tests), as well as procedures for interpreting the results obtained. In various areas of psychology and other related sciences, the results of psychometric measurements of the cognitive sphere are widely and successfully used, particularly when it comes to abilities. However, despite the progress that has been achieved, scientists continue to debate the very existence of the phenomenon of intelligence and the right to evaluate it according to a total quantitative indicator, for example, the intelligence quotient (IQ), and its connection with abilities in a certain sphere of professional activity.

There are a number of intelligence tests (tests for the identification of individual cognitive abilities and intellectual scales such as Wexler, Amthauer methods etc.). Each test task (system of tasks) fixes some psychological symptom as a measure of the severity of a certain property of intelligence, which manifests itself in a specially designed type of activity, on a specific and unified material, if there is some situational state of the subject (from the point of view of his current knowledge, emotional status, motivation, etc.). In fact, we are dealing with a performance indicator that assesses the accuracy and speed of response. Virtually every test is a measuring instrument, like a thermometer. However, having taken the temperature

of the patient (that is, identifying one of the symptoms of a possible disease), no doctor would make a diagnosis or try to predict the course of the disease. An attempt to make a diagnosis on the basis of a psychological symptom (to assess the level of real intellectual capabilities) and to build a prediction of the further intellectual development of a person cannot be called professional frivolity. A. Anastasi at one time made a fundamental observation: no test can explain the reasons for individual differences in its implementation (Anastasi, 1982).

The main problem is that most of the techniques are characterized by a clear lack of consideration of the emotionally personal factor in the realization of cognitive potential. That is, these systems and principles of testing do not take into account the subject's unconscious reaction to the test. In the case of testing an adult, this problem is solved by a more correct interaction of the conscious and unconscious parts of the human psyche due to the already acquired knowledge, skills, and experience. In the case of testing children and adolescents, the situation is different.

One of the most sensitive issues of psychological testing is the relatively low predictive validity, i.e. a measure of compliance with the methods and results of research of existing intelligence tests. Thus, according to modern studies, IQ indicators on average correlate with school performance at a value of r = 0.40 – 0.50 (i.e., only about 16–25% of variations in student learning achievements are explained). In this case, the distribution of the values of the correlation coefficients in different studies varies from –0.03 to 0.61 (Druzhinin, 1988). There is a significantly lower correlation of IQ indicators with the success of professional activity (Trost, 1999; Sternberg, 2002). For example, according to W. Schneider, the IQ of "experts" (highly qualified professionals), as a rule, does not exceed 120 (Schneider, 1993). Thus, indicators of the level of psychometric intelligence in childhood, adolescence, or the late teens are not always a guarantee of individual achievement in maturity, since other aspects of a child or adult's life (including the "random event factor") may be more significant in terms of their influence on the growth of individual intellectual resources.

It is impossible to ignore the fact that many psychometric tests of intelligence are built on the principle of "do as I do." An interesting consideration in this regard was expressed by Alexander Poddjakov. Any test is developed within the framework of the model of intellectual activity created by the author, which is built, among other things, under the influence of the specifics of his own thinking. For example, the founders of the test were strong mathematicians, and their mathematical mindset undoubtedly affected the test tasks they had created. This means that if we were among those who compiled the tests with people with different ideological attitudes, we would now have completely different tests (Poddiakov, 2003). The use of psychometric tests is based on the assumption that an intellectual property is a linear (unipolar) dimension that can be described in terms of "low rate — high rate". In fact, any mental property is a multidimensional entity with a complex composition. An individual intellectual resource ("intelligence level") is determined by a balanced combination of cognitive abilities of various types, the formation of components of metacognitive experience (including strategies for involuntary and arbitrary control of intellectual activity), the presence of individual cognitive preferences, intentions, etc.

In addition, many factors can influence the degree of expression of one or another intellectual property. Thus, a low result according to the methodology, for example, Wechsler's, besides insufficient development of relevant knowledge and skills, may be the result of a low level of socialization, a high level of anxiety, a low level of motivation, a high level of creative abilities, and so on. Moreover, not all possible "causes" of a low result operate separately, but in a system of interconnections. There are problems with the habit of interpreting a low psychological test result as "bad" and a high one as "good". Such an interpretation is not entirely correct. There are many individual variations in the nature of expressiveness of various intellectual properties that cannot be brought under the norms of traditional testing (for example, the presence of an individual cognitive style for each child changes the profile of his abilities, which manifests itself in varying the performance success in different types of intellectual activity). Accordingly, the deviation of the testing indicators towards decrease or increase cannot be considered as a deviation from the norm (therefore, in principle, we have no right to immediately set the task of "correcting" a particular feature of the child's cognitive sphere). It is curious that, in everyday life, we, as sober-minded people, fully agree with the fact that "our virtues are the continuation of our shortcomings, and our shortcomings are the continuation of our virtues."

Finally, when testing a child of preschool or school age, it is important to keep in mind that his real intellectual abilities are manifested only in the process of mental development. Consequently, any ascertaining one-time testing of the "intelligence level" is not informative, since the assessment of actual intellectual achievements involves taking into account the individual "zone of proximal development" (L. S. Vygotsky) associated with targeted learning and self-learning of a child with the help of an adult. In short, any (relatively reliable and valid) psychological method can be used. What, however, cannot be done is to diagnose a person (preschooler, schoolchild, adult) on the basis of the result, and make a prediction about his future. However, this is exactly what is being done under the influence of the term "psychodiagnostics" introduced in due time (unfortunately, in my opinion), which, by its semantics, sets the wrong psychology to practical psychologists.

In fact, psychological methods are designed to collect information about a particular person in the monitoring mode. So psychological examination must meet the requirements of complexity, duration, multiple, ecological validity (conducted in a situation of real life), subject orientation (to have a dialogical character with a mandatory reverse communication, include elements of emotional support, create conditions for independence in choosing the mode of behavior, etc.). As previously mentioned, the results of psychometric measurements of the cognitive sphere, particularly when it comes to the ability for mental perception and the processing of external information, have been widely and successfully used.

The study of individual differences and the development for this purpose of innovative diagnostic tools, which is the technology of analysis of vibraimage (Minkin, 2017; VibraMI, 2019), allows, in part, to clarify this situation, because it uses the differential-stress approach.

The differential-stress approach (Minkin & Nikolaenko, 2017) to the compilation of the questionnaire implies a forced choice situation. Testing in this mode is as close to classic lie detection as possible. This is an important condition for the validity of this questionnaire, since it is a question of the psychophysiological response of a person, and not the standard diagnosis of his area of interest (as is the case in traditional psychological tests and questionnaires). The "zonal" approach to the construction of questions puts the respondent in a situation of forced choice, a situation of emotional dilemma. Thus, the initial intentions and professional preferences are verified. Bright stimulus material in the form of 24 photographs (one photograph for each question) is the final stroke in an artificially modeled emotional state. Although in the case of the definition of a hobby (in VibraMI there are two blocks of questionnaires, one is for professional preferences, the other is for hobbies) a total-comfortable approach is used, which is as close as possible to the classical psychological approach that is implemented when compiling questionnaires.

It lacks a "forced choice" situation of two questions that carry the opposite informational and psychological burden, emphasizing the respondent's conscious preferences. With the emergence of the Howard Gardner theory (Gardner, 1983), many educators, teachers, and parents thought about the fact that the approaches to learning and developing should differ significantly for different children. Considering their intellectual profiles, which are formed as a result of the greater development of mini-intelligences of certain areas of the brain, parents, and later teachers, must take this into account, creating certain conditions for the development of these abilities. In this way, such a complex, but quite realistic individual approach to the upbringing and development of each unique child will be provided. With the emergence of Gardner's theory of multiple intelligences (MI), the psychological-pedagogical theory was completely shaken, when the only intellect could be unambiguously measured with the help of a simple IQ test. The upbringing and development of all children according to one strictly approved program is already considered to be irrational and incorrect. This disrupts the natural work processes of the brain of each individual child's unique personality.

There are several reasons why Gardner's multiple intelligence theory has been widely recognized in education. Among other things, this theory confirms what teachers face every day: people think and learn in many different ways. In his research, Gardner focuses on a person's individuality, the uniqueness of his personality and profile of intelligence, citing the example that even identical twins will have different abilities (Gardner, 2011). The advantage of Gardner's theory of multiple intelligence is in its flexibility and unlimited possibilities for a person's self-realization in the professional sphere. In this regard, Gardner speaks of the "infinity" of intelligences, of their integrity and ability to develop. In VibraMI program developed on the basis of the Multiple Intelligences theory and vibraimage technology, the classification of the structure of multiple intelligences is built upon and expanded to 12 types indicating the possibility for self-realization in a particular professional sphere (Minkin & Nikolaenko, 2017).

Children process information from the outside world in various ways, and these methods largely have a psychophysiological basis. In particular, the methods of processing information coming from the outside world in early childhood can also be referred to as general abilities. For example, the olfactory-tactile and tactile way of knowing the world is the norm for a one-year-old child. The one-year-old child who received a toy as a gift will not only examine and feel it from all sides, he will also willingly taste it. To deprive him of such a possibility means to make it impossible to become fully acquainted with it. Of course, the auditory way of getting to know the world also takes place, but it is not the leading method within this sensitive period. The behavior of a five-year-old child licking and groping unfamiliar objects, on the contrary, testifies to the underdevelopment of cognitive processes. It is logical to assume that there are individual periods, also confined to age sensitivity (increased individual sensitivity to external events and accompanied by anxiety before new incidents) of the development of specific intellectual abilities.

For example, parents of grown-up children often recall: "You were still very young, you were in kindergarten and couldn't draw, but you loved it so much. We bought you a Lego set so that you didn't make a mess everywhere." What happened? The child activated the visual-spatial type of intelligence (according to Gardner), but was suppressed by the economic dominant of the surrounding social environment. What would be the right thing to do in this case? Which algorithm of actions is correct?

– Diagnosis of the interests and abilities of the child ("the zone of current and proximal development," according to L. S. Vygotsky);

– Visually or with the help of professional programs (VibraMI, children's questionnaire);

– Purchase of special materials for artistic expression (pencils, paints, paper in sufficient quantities, a drawing tablet).

Thus, the timely diagnosis of abilities in children of preschool and primary school age allows them to coincide with their intellectual development in a certain sensory period, that is, to the maximum effective period of the formation and deployment of common abilities. The theory of multiple intelligences allows for the differentiation of these abilities, localizing them in relation to a single person (child), and with a certain zeal — a certain sensitive period or the period of the formation of special abilities in adulthood.

Differences between children are largely due to the percentage of ratios that they have developed types of intellects. Their future profession will depend on this, as well as inclinations and success in certain activities. The task of teachers and parents is to contribute to the maximum disclosure of the child's talent and develop it in the future precisely in the ways that are most suitable for that individual child, taking into account the peculiarities of his intellect according to Gardner. An individual training program and selected learning methods, taking into account a child's most developed ways of perceiving information, are the basis of Gardner's theory of multiple intelligences. When studying the types of intelligence that each individual child is endowed with, it is important to understand that each person has all nine or twelve varieties. They have a huge number of manifestations. You should never label a child on the principle that

he has only limited abilities. It is important, when providing an individual approach to the development and training of the child, to create such conditions in which he could manifest many of his sides and interests.

In order to understand the relationship of the profile of MI and the choice of profession, we need to consider the current international classification of education. One of the stages in the system of professional self-determination is the search for the relationship between the individual's professional qualities and his chosen profession. In the proposed methodology, the profile of MI and professions is linked to the international classification of education. The International Standard Classification of Education (ISCED) is a framework document that makes it possible to unify the presentation of a variety of educational statistics required for the development of a policy in accordance with an internationally agreed upon set of common definitions and concepts, which ensures the comparability of national indicators (UNESCO 2011/2013). ISCED is the main international document regulating the preparation of educational programs, including in the territory of the Russian Federation (GC 017-2013, All-Russian Classifier of Specialties of Higher Scientific Qualification, OKSVNK). Thus, the diagnosis of professional interests and abilities should be based on the existing classifier of specialties. Otherwise, diagnostics of abilities will be observed without reference to a specific sphere of their implementation. VibraMI program allows you to diagnose professional interests and abilities with reference to the international classifier of specialties.

ISCED 2013 covers 10 main educational areas, each of which includes 29 areas of education and a specific list of specialties. In our opinion, using official documents is quite correct and structured, but a clearly defined structure of the classification of education is each time "imposed" on the psyche of a teenager that is rather diverse and subject to age-related changes. Yes, this program allows you to identify the main directions and professional "affection" of a particular person, but the information received must also be correctly interpreted. For example, natural intelligence can indicate preferences when it comes to choosing a profession, and the fact that a person lives "in nature" (for example, in a cottage) or simply spends a lot of time there, visiting friends or relatives, etc. There is a question about the interpretation of the information received. This places serious demands on the tester. It turns out that this should be not just a psychologist who can interact correctly with a teenager and, possibly, his parents, but also to correctly provide the testee with the information.

We are aware that vibraimage technology (Minkin, 2017) is an innovative product, which can be supplemented and configured for the specific tasks of specific users. However, at the moment the program itself, in its current form, does not allow you to get such comprehensive information. In our opinion, it is of interest only for people who are sufficiently prepared to work with this program and have a suitable education. It is important to emphasize that a psychologist should "hold in his head" a preliminary assessment of the intellectual abilities of an individual in the form of some probabilistic judgment or general guidance on creating the conditions for the productive intellectual development of this particular child, taking into account his individual characteristics. A non-sociable child (if he wants it and if he really needs it)

can be taught to communicate, whereas one who is too talkative can be taught to pause and think about himself, etc. Thus, a psychological diagnosis (if you really use this term) is always the result of hard, time-consuming work.

I would like to add that even a correctly made psychological diagnosis or analysis should never, in our opinion, be passed on to a person (child first) in a direct formulation, due to the extremely dangerous effect of the "label" (as well as due to the high probability of inaccuracy of this diagnosis). So what do we do? Is there a way out of this situation? What should school psychologists do, whose professional activity has been and will be associated with the need for psychological examination of children in order to identify their intellectual abilities? Practicing psychologists have accumulated a wealth of experience in the use of psychological methods in the framework of the personality development paradigm, which changes the requirements for the goals of psychological testing and defines new forms of psychological work with children. We are listing some elements of this experience.

1. Repeated examination over a sufficiently long period using a variety of psychological methods, depending on the characteristics of the child's intellectual development and his personality as a whole.

2. The use of individual psychometric tests of intelligence in the framework of the procedure of psychological and pedagogical monitoring, that is, tracking the dynamics of the intellectual development of each individual student (or students with educational or personal problems) in order to individualize educational and extracurricular activities. Thus, the result of psychological testing should be the internal differentiation of training with the development for each student of the individual trajectory of his mental development by providing him with the necessary psychological and educational assistance.

3. The inclusion of psychological testing in the educational process and its conduct in connection with the educational activities of the child.

4. Conduct testing to assess the actual intellectual capabilities of the child in the subject area that corresponds to the aptitudes and interests of the student. Such testing provides the subject with autonomy in choosing a line of intellectual behavior in a psychological examination situation.

5. Using as a means of obtaining information about the student not only standardized methods (psychometric tests of intelligence, personal questionnaires), but also qualitative methods, including observation, conversation, questioning, analysis of activities, self-description (methods of unfinished sentences, verbal portrait, writing essays on a specific topic), games and training methods.

Thus, the use of psychometric tests of intelligence changes its vector: they are focused on creating the conditions for the development of the intellectual resources of the individual, thereby contributing to the building of an individual intellectual biography.

To conclude, psychology is not only the science of the general laws of the human psyche, but also the science of the principles of the protection of individual rights. Psychological testing, as an area of psychological knowledge, must fully meet these criteria.

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APPLICATION OF VIBRAIMAGE TECHNOLOGY FOR STUDIES OF VARIOUS STABLE PHYSIOLOGICAL STATES

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Annotation: *A comparison of people's psychophysiological states in different age groups using vibraimage technology, the control system of a person's psycho-emotional state (Vibraimage 8.1) and the program VibraStat2 developed by Elsys (St. Petersburg, Russia). The conducted study has revealed physical abnormalities between patient groups, which corresponds to the various stable states of the brain.*

Keywords: *Comparison, vibraimage technology, brain, steady state, psychophysiology.*

The human brain is in search of stable states, normal or pathological, which became such after a period of destabilization as a result of disease. It seems that the brain has the ability to remember a stable state and return to it. For a healthy brain this is a protective mechanism, but for a sick one, this is adaptive as well as protective, though in the latter case it is a stable pathological condition. The inertia forces the matter of the brain to maintain its previous state, and its inertia does not allow it to get out of this state, which makes the matter not the initiator of the changes, but rather their recipient. Since matter is controlled by forces, it is up to you to look for the manufacturer of consciousness. Immediately the question arises: what forces are these and what are they like? In particular, it can be constantly acting emotions. Can the brain itself leave this state? What can be done to get out of such states? In order to answer these questions, we need to learn how to measure these states and compare the measured parameters. We know that emotions cause changes in the brain and mobilize us to act on what caused our emotions, as well as changes in our autonomic nervous system, regulating heart rate, respiratory rate, sweating intensity and many other physiological changes and thus prepare us for different actions. As a result of this, facial expressions also change. Scientists knew about this already in the sixteenth century: "Mimicry is one of the most elementary manifestations of nervous activity … Like language, mimicry represents a wide variety of forms, but despite this, it is always a more common language … Mimics are the language of all people" (Mantegatstsa, 2011). Changing facial expressions can cause changes in the human autonomic nervous system and experience corresponding emotions.

Great scientists (Darwin, Sechenov, Lorenz) declared the inextricable link between movement and the life of biological objects, including the connection between motor activity and the psycho-physiological state. Sechenov's thesis that all external manifestations of brain activity can be reduced to muscular movement remains relevant today (Sechenov, 2001).

Based on this, it's possible to say that every emotional state is characterized by a certain energy expenditure, and the work carried out by the system is converted

into microvibrations if a person is standing or sitting without moving. Head vibration parameters (frequencies in the range of 0.1–10.0 Hz and amplitude in the range of 10–1000 μm) (Minkin, 2017) for a stable emotional state of a person are stable over time. Vibration parameters change only after a change in emotional state. It is known that the assessment of the work of the vestibular system is effectively used for the functional diagnosis of psycho-physiological parameters and human performance.

Vibraimage program is based on the functioning of the human vestibular and nervous systems. The vestibular system is responsible for maintaining a person's vertical balance and can be considered as a special case of motor activity, while the processes of sensory inhibition of the vestibular system determine the dynamics of muscle movement. Vibraimage method registers micromovements and spatial oscillations of an object by determining vibration parameters (frequency and amplitude) for each element (pixel) of the object under study (Minkin, 2017). Using this method, it was possible to establish that the parameters of vibraimage reflect the amount of movement, and therefore characterize the emotions and physiological state of the human body.

The brain provides mental activity with a system of rigid (obligatory) and flexible (variable) links, all external manifestations of which are reflected in muscle movement. This activity is characterized by a certain expenditure of energy and a certain facial expression. We assume that at different ages, the brain is in various stable states, which are characterized by the corresponding physiological states of the body. Bekhtereva believed (Bekhtereva, 2008) that, up to a certain age, the brain triggers a biological program to protect human life, and this is determined by the age associated with the ability to perform reproductive functions. "The most significant period in a person's life is healthy, full maturity, after puberty and before menopause or its equivalents. So what's next? Judging by how quickly diseases begin to occur, something happens in the program of life during this period. Something brings the brain to a new stable state when the biological life protection program ceases to operate." (Bekhtereva, 2008). Before us again are the following questions: can the brain get itself out of this state? What can be done to get out of such psychophysiological states?

Materials and Methods

To answer these questions, it was necessary to understand whether there are physiological and physical differences in a group of people 20–23 years old (8 women) and a group of people over the age of 52 (7 women). We investigated these two groups with the help of the individual's control system for their psychophysiological state (Vibraimage PRO) (Vibraimage PRO, 2019). The studies were conducted using the default settings of Mode M (Vibraimage PRO, 2019). The main purpose of this mode is to use vibraimage system for medical diagnostics and psychological research. Statistical processing of the obtained results was carried out by VibraStat program (VibraStat, 2019).

Results

Figures 1 to 4 show histograms of the frequency distribution of vibraimage. The frequency histogram shows the distribution of the frequency of head movement for all points of the image for a certain period (by default, this period is 20 seconds). According to these graphs, conclusions can be drawn about such composite temperaments as excitation force; braking force; balance of nervous processes; and their inertia. The rise in the graph shows the strength and speed of arousal, while the decline shows inhibition. The height of the graph indicates the strength of the nervous processes. The sharpness of the peak and the length of the top point indicate inertia.

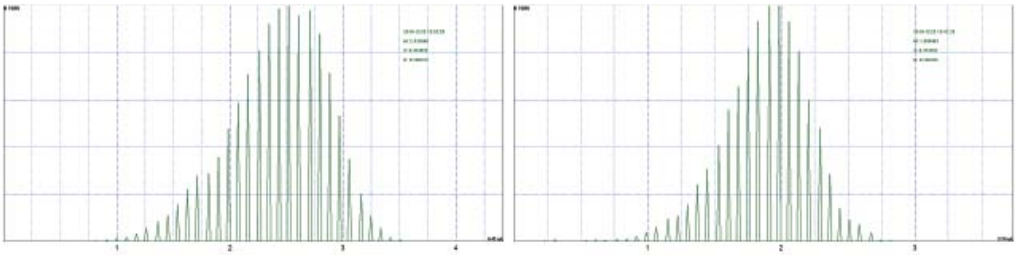

Fig. 1.

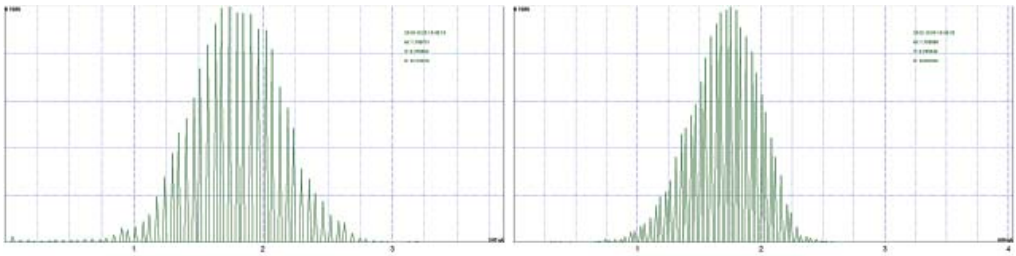

Fig. 2.

In the graphs shown in Figures 1 and 2, we see sharp peaks of greater height, greater force and speed of arousal and inhibition. These graphs reflect the psycho-physiological parameters of young people aged 20–23. In this case, the force of inhibition is equal to the force of excitation, which speaks to a balanced temperament with a short time course of nervous processes. This corresponds to more elastic work of all the facial muscles and more stable work of the entire vestibular apparatus.

In the graphs shown in Figures 3 and 4, the force and speed of inhibition exceeds the force and speed of excitation. The height of the top point indicates high inertia. These graphs reflect the psycho-physiological parameters of people over the age of 52. Since the force of excitation and inhibition is not equal, we can talk about imbalance. In this case, the excess of the braking force over the excitation force, inertia, and imbalance indicate a different steady state of the brain. In stressful situations, each person chooses different strategies of coping behavior that can lead to a loss of balance in nervous processes.

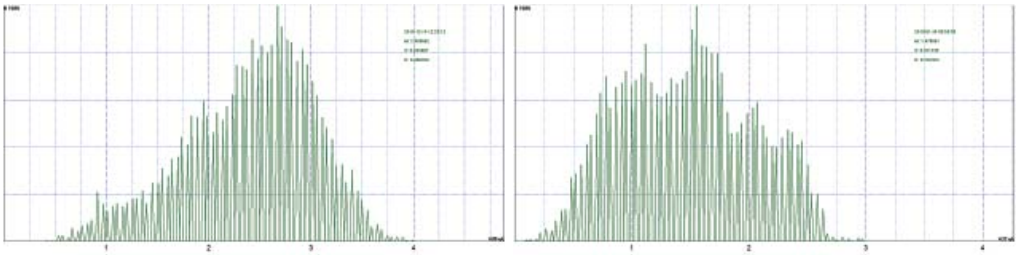

Fig. 3.

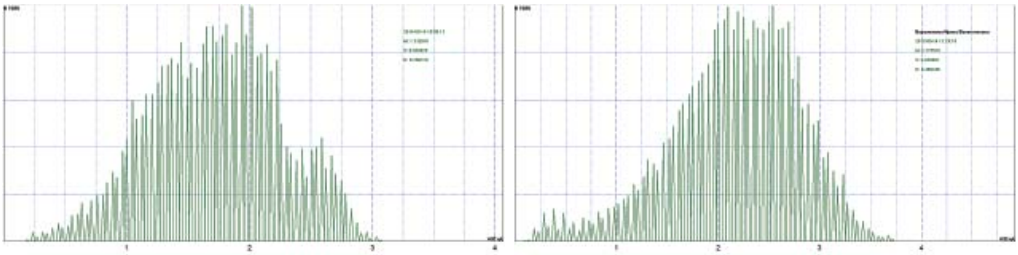

Fig. 4.

Discussion

Anger, Aggression, Asocial manifestations, Resentment — these emotional reactions are inappropriate for the situation:

– the emotion corresponds to the situation, but its intensity does not correspond;

– the emotion corresponds to the situation, but it manifests itself in an inappropriate way (for example, anger is justified, but a silent form of it is counterproductive);

– we experience an emotion not relevant to the situation.

The brain can go into an overexcited state, the extreme case of which will be a nervous breakdown. Emotion absorbs a person, taking possession of an increasing number of areas of his brain. The emotionalized brain "becomes larger, which literally blocks its ability to perform the mental tasks that allow a person to act appropriately in a situation. Ordinary little things in life, such as a flight delay or a quarrel with an employee become an important "attacking force". The equilibrium of the brain is lost, and with it the ability of the brain to think, especially creatively. Conversely, strategies of coping behavior such as avoidance, cautious actions, and manipulation lead to the fact that the defensive reaction becomes excessive and the constant potential falls below constant in all areas of the brain. It becomes harder and harder to experience joy or sadness, that is, ordinary emotions. The colors of the surrounding brain fade. Creativity also decreases. For this person it seems that now there are almost no frightening situations or, on the contrary, everything around is under pressure (although the search for strong emotions with all the negative consequences is very likely).

If such conditions last a while, the brain potential in most areas decreases and the person falls into a state of emotional stupor (dullness). Such "errors in the manifestation of emotions are constantly accumulating and can lead to new stable brain states that determine the physiological characteristics of people in older age" (Bekhtereva, 2008).

To improve the accuracy of determining the difference in the psycho-physiological state in groups of people of different ages, the program TPStat.exe was used, which is intended for the statistical processing of the results from Vibraimage program. The analysis uses the mathematical expectation M, the standard deviation S, and the variability V of the set of human psycho-physiological parameters T1–T10, measured in the M mode by Vibraimage PRO program.

At the same time, the name of each Ti parameter can characterize different psychophysiological characteristics depending on the use of vibraimage system. The results of statistical processing are presented in the graphs below.

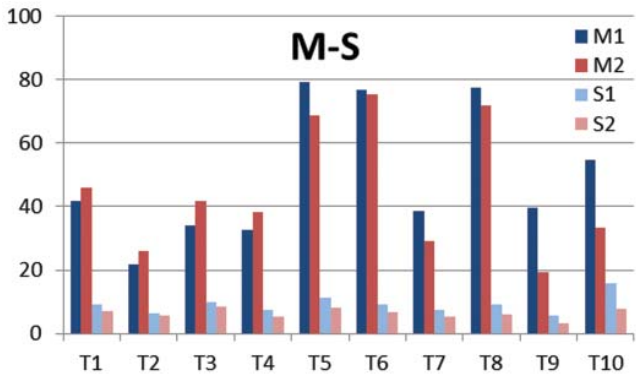

Fig. 5. Sheet M–S — histogram of the results of comparing the parameters of MO (the first pair of graphs) and the standard deviation (the second pair of graphs) for all parameters T1–T10. The data for "Group 1", ages 20–23, are displayed in blue, and in red for "Group 2", for subjects over 52.

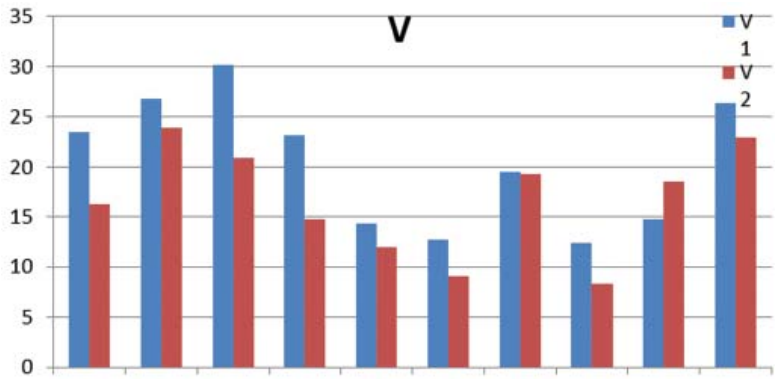

Fig. 6. Sheet V1–V2 — a histogram of the results of comparing the parameters V (variability) for all parameters T1–T10. Data on Group 1 is shown in blue, data on Group 2 in red.

The big differences in the graphs for the two groups in the following T1 parameters are the Aggression parameter (P7); T3 — Anxiety parameter (F5X); T4 — Danger parameter (P19); T9 — Inhibition parameter (F6); T10 — Neuroticism parameter (F9) indicates the occurring physical deviations between the patients of the groups.

Conclusions

The proposed method of dealing with any pathological condition consists in activity, physical and mental as well as spoken activity. This includes oral speech, communication, learning foreign languages, traveling, walking in the fresh air. The excitation energy must be redirected to an activity. Emotion must do the work in physical manifestation. So that the emotional energy does not burst forth uncontrollably, it is necessary to speak out as dissatisfaction accumulates, to enter into a dialogue with relatives and friends. If this does not help, and you feel that you are ready to explode or lash out, you need to interrupt the stressful situation.

You can break something or scream. You can run for 10–15 minutes or take a quick walk to relieve muscle tension. Breathing exercises work well: a few deep breaths and exhalations or a short inhale and a long exhalation. Repeat this until you feel calm. Praying can also help. Learn to separate the important from the unimportant things in life. Vibraimage technology programs allow you to objectively control the change in the psychophysiological state and are a simple and affordable means of self-control.

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MANIFESTATION OF ETHNIC IDENTITY IN MULTIPLE INTELLIGENCES PROFILES BASED ON COMPARATIVE RESEARCH IN JAPAN AND RUSSIA

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Abstract: *The purpose of this work is to analyze ethnic identity as a factor in differences in the profile of multiple intelligence among representatives of the Russian and Japanese ethnic communities. Some aspects of the emotional-axiological perception of the stimuli of the Gardner_12 questionnaire in the assessment of multiple intelligence are considered.*

Keywords: *ethnic identity, stimuli, multiple intelligence, vibraimage technology.*

Ethnic identity is increasingly understood to be not only the stable emotional-cognitive process of an individual conceiving that they belong to a certain ethnic group (Naumenko, 2003), but also as a kind of emotional-axiological attitude of their belonging to an ethnic community (Stefanenko, 2006). Emotional-axiological and emotional-cognitive components of ethnic identity are closely connected and can probably manifest themselves in a selective attitude to the same events/stimuli in people belonging to different ethnic communities. This factor should be taken into account when compiling and interpreting psychological tests or any other means of assessing and controlling personal achievements (Nikolaenko, 1983). Howard Gardner is an opponent of the theories of indivisible intelligence and the traditional test approach to diagnostics (Gardner, 2011; Minkin & Nikolaenko, 2017). Most intelligence tests reflect the level of awareness that is positioned within a particular subculture. They have a “learning/awareness” factor, not abilities parameters. Gardner’s multiple intelligences do not deny the social, emotional, and cognitive components of intellectual activity. Each of the intelligences are important, forming a unique profile of a single person. “A deep understanding should be our main goal; we must strive to understand what in a given cultural context is considered true or false, beautiful or ugly, good or bad” (Gardner, 2011). However, intelligence tests can also be influenced by ethnic identity at the emotional-axiological level of the perception of test stimuli (we intentionally use the term test stimuli, rather than test items, because these are the stimuli that form test items), even if we are talking about multiple intelligence.

Methods and Materials

The first part of the study was conducted from 2017 to 2019 in Russia. In total 1,158 people, all Russian citizens, were tested. The subjects were 14 years and older. 63% of the participants were adults and 37% were minors.

The group tested in the second part of the study consisted mainly of Elsys-Japan company employees (155 people including salespeople, technical staff, and office

workers) from Kyushu to Hokkaido, Japan (aged 20–71, male/female breakdown of 83%/17%) who answered questions from VibraMI programs with the Gardner12 questionnaire conducted from March to April 2019.

VibraMI program, based on vibraimage technology, presents a supplemented and expanded 12 types of classification for Gardner's multiple intelligences, indicating the possibility for self-realization in a particular professional sphere (Minkin & Nikolaenko, 2017; Minkin, 2018). The respondent needs to answer 12 pairs of questions, supplemented by stimulus images. The content of each of the 24 questions is directly related to the potential interests of the respondent, and their formulation allows you to assess the orientation of the installations. The orientation of installations can be traced in the change of the information and energy component of the psychophysiological responses to the question posed. Vibraimage technology allows one to obtain multidimensional dependences of the characteristics of the psychophysiological state (PPS) and record the change in energy and the direction of this change. The change in energy released (consumed) by a person from the initial state to another energy state is measured in kcal/min (VibraMI, 2019). Presumably, the emotional-axiological component of the ethnic identity of the representatives of the Russian and Japanese ethnic communities will manifest itself in individual differences in the perception of the stimuli on the Gardner_12 test (VibraMI). These differences may be manifested in the fact that representatives of the Russian and Japanese ethnic communities may have different profiles of multiple intelligence (MI).

Results

The differential Russian-Japanese MI profile is shown in Figure 1. Data was captured by VibraMI program (VibraMI, 2019) and processed by the VibraStatMI program (VibraStatMI, 2019).

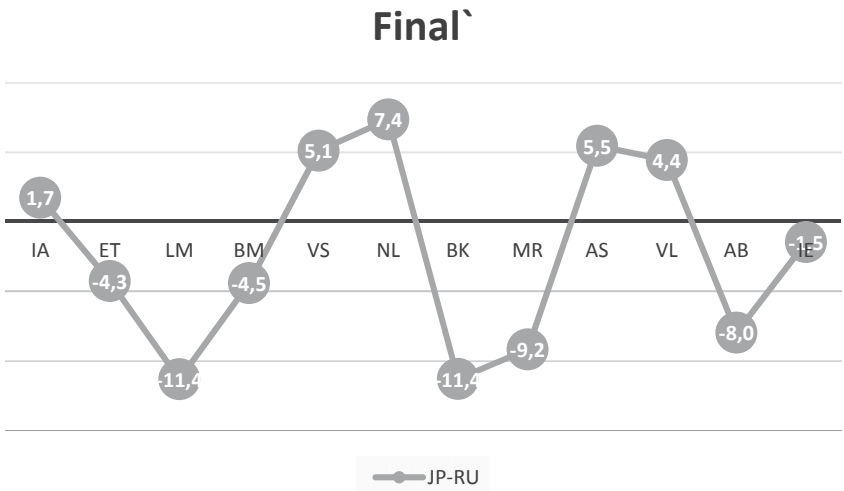

Fig. 1. MI Differential Profile (Final`_JP–Final`_RU) of 1,158 Russians and 155 Japanese

The maximum differences of the Japanese from the Russians appeared in relation to the logical-mathematical (LM), visual-spatial (VS), natural (NL), bodily-kinesthetic (BK) and musical-rhythmic (MR) types of MI, (Fig. 1). In the group of Russians, the highest values for the general MI profile were obtained for the ascetic (AS = 68.4%), interpersonal (IE = 65.6%) and bodily-kinesthetic (BK = 62.8) MI (in descending order) (Fig. 1). The minimum values were obtained for business-mercenary (BM = 43.8%), verbal-linguistic (VL = 48.4%) and philosophical (ET = 51.8%) MI. In the Japanese group, the highest values were obtained for the ascetic (AS = 73.9%), interpersonal (IE = 64.1%) and natural (NL = 64.1%), (in decreasing order). The minimum values are obtained in relation to business-mercenary (BM = 39.3%), logical-mathematical (LM = 40.7%) and philosophical (PH = 47.5%) MI types. Let's compare the obtained results with the profile of conscious (YN) and unconscious (IE) attitudes.

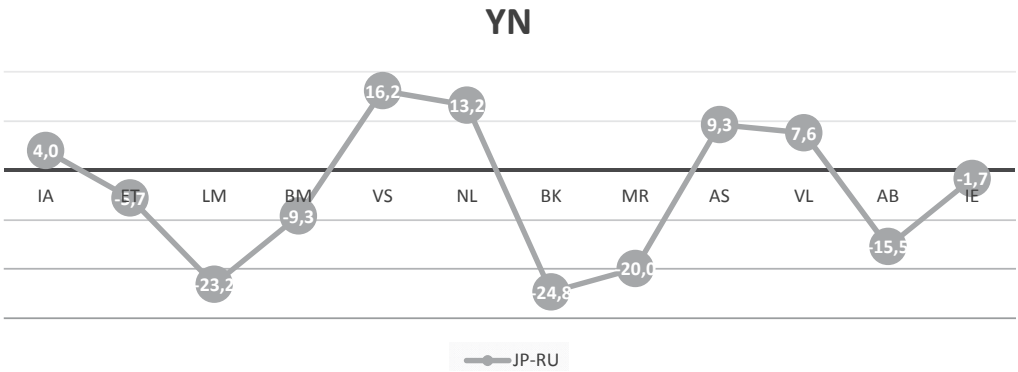

Fig. 2. Differential profile (YN_JP–YN_RU) of the conscious responses of 1,158 Russians and 155 Japanese MI testing

The maximum differences between the Japanese and the Russians (by analogy with the general profile of MI, Fig. 1) appeared in relation to logical-mathematical (LM), visual-spatial (VS), natural (NL), bodily-kinesthetics (BK) and musical-rhythmic (MR) MI types (Fig. 2). In the group of Russians, the highest values in the profile of the conscious reaction (YN) were obtained from the ascetic (AS = 85.6%), bodily-kinesthetics (BK = 74.4%) and natural (NL = 60.6%) MI (in descending order) (Fig. 1). The minimum values were obtained for business-mercenary (BM = 37.7%), verbal-linguistic (VL = 46.3) and philosophical (ET = 51.7%) MI, (Fig. 2). In the Japanese group, the highest values were obtained for the ascetic (AS = 94.8%), interpersonal (IE = 82.8%) and visual-spatial (VS = 76.7%) MI (in descending order). The minimum values were obtained in relation to the business-mercenary (BM = 28.4), logical-mathematical (LM = 30.5) and philosophical (ET = 46) MI type (see Fig. 2).

An analysis of the unconscious reaction revealed minimal differences. Russian and Japanese at the unconscious level significantly differ only in the visual-spatial (VS) type of MI, (Fig. 3). In Russians, the visual-spatial (VS) MI = 52.3%, among Japanese, VS MI = 46.3%.

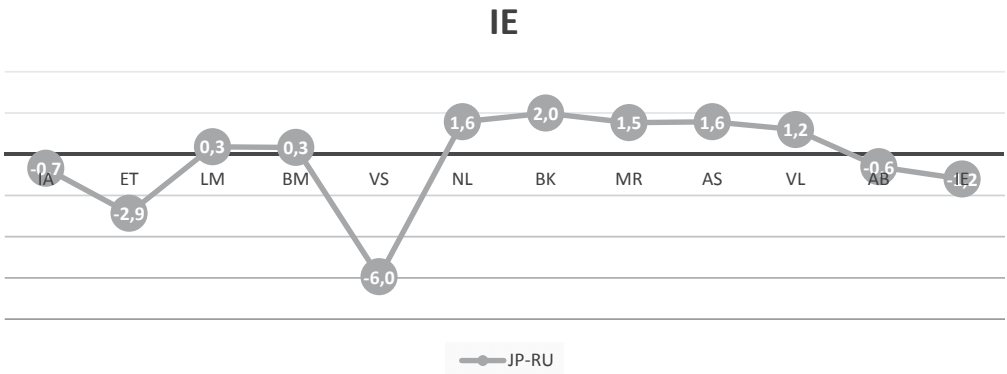

Fig. 3. Differential profile (IE_JP–IE_RU) of the unconscious responses of 1,158 Russians and 155 Japanese MI testing

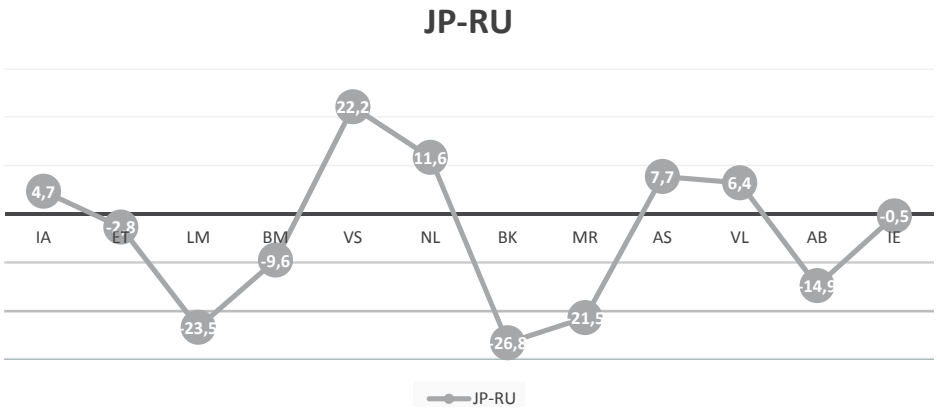

Fig. 4. Double differential profile (YN_JP-IE_JP)–(YN_RU-IE_RU) of 1,158 Russians and 155 Japanese MI testing

The maximum differences of the Japanese from the Russians (by analogy with the general and profile-conscious responses of MI, Figures 1 and 2) appeared in relation to logical-mathematical (LM), visual-spatial (VS), bodily-kinesthetics (BK) and musical-rhythmic (MR) MI types, (Fig. 4). The range of values on the differential profile of MI, within 40 units (from 20 to –20) is considered the coincidence of the desired (YN) and real (IE), (Fig. 2). There is an assumption that positive values on the differential profile of MI primarily reflect socially significant benchmarks for the use of abilities, and negative values are individually significant benchmarks for the use of abilities. The highest values for the differential profile, in the group of Russians, were obtained for interpersonal (IE = 37.7%), ascetic (AS = 34.3%), bodily-kinesthetic (BK = 23.2%) MI (in descending order), Fig. 1. The minimum values were obtained for business-mercenary (BM = –12.1%) and verbal-linguistic (VL = –4.2), Fig. 4. In the Japanese group, the highest values for the differential profile were obtained in relation to the ascetic (AS = 42%), interpersonal

(IE = 37.3%), and visual-spatial (VS = 30.4%) MI (in descending order). The minimum values were obtained in relation to business-mercenary (BM = –21.7%) and logical-mathematical (LM = –20.4) MI, Fig. 4. Thus, the maximum differences in the group of Japanese and Russians in the differential MI profile were obtained mainly in relation to the visual-spatial (VS) MI, Fig. 3.

Results and discussion

Russians are typical representatives of the multinational Slavic ethnos. In this regard, the results of this study may spread to other representatives of the Slavic ethnos (Ukrainians, Belarusians, etc.), not being a modal-specific feature of the Russian ethnic community. The Japanese, by contrast, are predominantly a mononational ethnos. Many authors, in the framework of interdisciplinary research, noted the high spirituality inherent in both the Slavic and Japanese ethnos. In this regard, high values of the ascetic (AS) type of MI in both groups are fairly predictable. On the contrary, the differences obtained in the general profile of MI among Russians and Japanese are quite debatable. For example, the ability to conduct business in both groups at an average level is significantly inferior to other types of MI. In fact, Japan is the undisputed leader in the field of high-tech integration, and Russia is a leader in the field of military-industrial (MIC) and fuel and energy (FEC) complexes. Therefore, it is impossible to judge the ability or inability to conduct business only by this indicator. Features of ethnic identity are manifested in the combination of ways of doing business.

Research activities in Japan are focused on advanced technology. Most innovations are brought in by improving the quality of life of the population and protecting the environment. A caring attitude to natural resources (NL) and the originality of the geographical location of Japan (an archipelago with limited land resources) determine the high importance of natural (NL) and bodily-kinesthetic (BK) types of MI, and specialization in advanced technologies (microelectronics, robotics, and others) are closely intertwined with the visual projection (VS) capabilities of the data. It is the combination of these types of MI that determines the specifics of the ethnic identity of the Japanese. The Russian economic model is also associated with technical advances, but in the fields of fuel, energy, and military-industrial complexes, where the combination of logical-mathematical (LM) and bodily-kinesthetic (BK) MI types are more pertinent.

Conclusions

The results show that modern Russians and Japanese are in many ways similar in their ethnic identity and are focused on achieving common socially significant goals. At the same time, the ways they achieve these goals are associated with the activation of various components of the MI profile: visual-spatial (VS) and bodily-kinesthetic (BK) MI types in Japan, and logical-mathematical (LM) and bodily-kinesthetic (BK) types of MI in Russian.

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DEVELOPMENT AND APROVAL OF THE METHOD FOR STIMULI PRESENTATION DURING TESTING OF MULTIPLE INTELLIGENCES BY VIBRAIMAGE TECHNOLOGY

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Abstract: *The purpose of this article is to develop and approve the method of presenting stimuli for testing multiple intelligences based on vibraimage technology. The possibilities of vibraimage technology in the implementation of tasks for HR, vocational guidance, recruiting, diagnostics of abilities and multiple intelligences profile measurement are explored.*

Keywords: *questionnaire structure, question content, stimulus material, multiple intelligences, abilities, vibraimage technology*

In 2018, for the first time, the results of stimuli selection used in VibraMI program (VibraMI, 2019) based on vibraimage technology (Nikolaenko, 2018; Minkin, 2017) were published. The very principles of stimuli selection were analyzed for question-stimuli and stimuli-images (factor of social desirability of answers, conflict of desires and possibilities, etc.). In the process of selecting stimuli, difficulties were identified in the dosing of the informational and emotional component, as well as a number of other problems that impede obtaining a statistically stable psychophysiological reaction. In this regard, it was decided to continue the study on the selection of incentives needed in working with software based on vibraimage technology. VibraMI program presents an augmented and expanded 12 types classification of Gardner's multiple intelligences (Gardner, 1983; 2011), indicating the possibility of self-realization in a specific professional sphere (Gardner, 2011; Minkin&Nikolaenko, 2017 a, b). A questionnaire was developed consisting of 24 questions, allowing a diagnosis of the strength of each of the multiple intelligences based on the current psycho-physiological state and the conscious responses of the subject. The resulting profile of multiple intelligence can be viewed from the perspective of an individual profile of abilities, sphere of interests and preferences (Minkin&Nikolaenko, 2017 a, b). Completing a test of 24 questions does not result in mental exhaustion for the subjects. Both the testing procedure itself and the interpretation of results are automated. Vibraimage technology allows one to obtain multidimensional dependences of the psychophysiological state (PPS) characteristics and record the change in energy and the direction of this change. The change in energy released (consumed) by a person from the initial state to another measures the energy state in kcal/min (Minkin & Nikolaenko, 2017b). The psychophysiological approach and availability of its implementation based on VibraMI program allows for testing without the involvement of third-party narrow-profile specialists (Minkin, 2019). This method used the classical principles of psychophysiology based on the latest computer technology.

Materials and Methods. Questionnaire type

Based on its content, the Gardner_12 questionnaire belongs to the category of special abilities tests. The substantive side of the Gardner_12 questionnaire incorporated in VibraMI program meets the main criteria of the questionnaires of interests and attitudes, on the one hand, and a test of special abilities on the other hand. The content of each of the 24 questions is directly related to the potential interests of the respondent, and their formulation allows you to assess the orientation of the installations. The orientation of installations can be traced in the change of the information and energy component of the psychophysiological response to the question posed. The Gardner_12 questionnaire has a line-opposite structure. Each MI pair has a forced choice of two mutually exclusive questions. The respondent needs to answer 12 such pairs of questions supplemented by stimulus images. The questions are structured in such a way that for each type of MI, a person with the developed relevant abilities answers YES to the first question and NO to the second. Accordingly, the linear opposition structure of the questionnaire implies an artificially modeled situation of choice from potentially mutually exclusive concepts.

The model in which each type of MI occupies its functional niche implies a sequence in writing followed by the location of pairs of MI. Therefore, first the wording of the questions is refined: to the first and twelfth pairs, then to the second and eleventh, and so on. Then, if all the necessary conditions are met, the stimulus material (photo) is selected. The use of visual stimulus material is due to the need to increase the emotional load of the questions. The difficulty in their selection is in the dosing of the emotional load, the degree of which can be determined only in the process of repeated testing.

Thus, the structure and algorithm for writing the Gardner_12 questionnaire are closely related. It is necessary to experimentally confirm or disprove the validity of the existing incentives used in the linear opposition structure of the Gardner_12 questionnaire. In total, 72 adolescents studying in secondary schools were tested in the age range of 14–16 years. The ethnic and sexual composition of the group is relatively homogeneous. The test results of students whose Russian language is not native are considered separately, and in the present study (due to the small sample size) they will not be analyzed. 40 boys and 32 girls were tested.

Results

A series of tests conducted during 2018 revealed some problems associated with the insufficiently correct selection of incentives in certain question pairs. Let's consider this in more detail. Based on the structure of the questionnaire, a pair of questions should negatively correlate with each other (the first pair of questions with the twelfth, the second with the eleventh, etc.). If this does not happen, then the incentives (the question and/or photo related to it) are chosen incorrectly. What does this look like?

Table 1

Correlation analysis of MI pairs, according to the Gardner_12 questionnaire

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	AB	IE
IA		-0,19	0,22	0,32		-0,61	-0,33	-0,51		-0,35	0,21	-0,26
ET	-0,19			-0,06	0,25	0,25		-0,35	0,28	0,26	0,12	-0,34
LM	0,22			0,73		-0,35	-0,38		-0,36	-0,62	0,31	-0,22
BM	0,32	-0,06	0,73		0,07	-0,33		-0,14	-0,48	-0,39	0,09	-0,35
VS		0,25		0,07		-0,17	-0,10		0,14	0,14	-0,12	0,20
NL	-0,61	0,25	-0,35	-0,33	-0,17		0,35	0,26	0,07	0,52	-0,25	
BK	-0,33		-0,38		-0,10	0,35			-0,05	0,43	-0,51	0,28
MR	-0,51	-0,35		-0,14		0,26			-0,25	0,06	-0,11	0,58
AS		0,28	-0,36	-0,48	0,14	0,07	-0,05	-0,25		0,36	0,11	0,32
VL	-0,35	0,26	-0,62	-0,39	0,14	0,52	0,43	0,06	0,36		-0,38	0,32
AB	0,21	0,12	0,31	0,09	-0,12	-0,25	-0,51	-0,11	0,11	-0,38		-0,27
IE	-0,26	-0,34	-0,22	-0,35	0,20		0,28	0,58	0,32	0,32	-0,27	

The principle of MI pair arrangement is that of opposition. The further in relation to the center (the sixth and seventh pairs form the center) the pairs are located, the stronger the correlation. What's important to note is that the correlation between question responses is negative, not positive since the location of the questions not only in the pair, but also the pairs themselves, are oppositional. Intrapersonal (IA) and interpersonal (IE) MI are located at the edges, forming a pair of 1 and 12. IA and IE pairs have a negative correlation dependence (–0.26), (Fig. 1). That is why the questionnaire begins and ends with these kinds of question pairs. The key in determining humanitarian or technical profiles are the Logical-Mathematical (LM) and Bohemian-Artistic (AB) MI pairs, (–0.62), which are no less opposite in nature. As you approach the center, there is a weakening of the correlation dependencies, their decay or even a transition to positive values: a pair of Visual-Spatial (VS) and Musical-Rhythmic (MR) MI (no correlation), Natural (NL) and Bodily-Kinesthetic (BK) MI, (0.35).

Thus, the Philosophical (PH) and Bohemian-Artistic (AB) pair of MI are the most alarming. For these pairs, a small positive correlation of 0.12 was obtained (the significance of differences with $p \leq 0.05$). It was initially decided to replace the stimuli within one pair, the Artistic-Bohemian (AB) MI, since it is in this pair of questions (AB MI) that a pair of affirmative answers (instead of oppositional ones) were most often encountered.

Table 2

Bohemian-Artistic/Creative MI types

Previous version Art-Bohemian (AB)	Current version Creative (CR)
21. I can easily adapt to any necessary situation	21. Your creative side never rests
22. I don't like to stand out from the crowd	22. Comprehension is more important than incarnation

The result of changing the wording of the questions was a shift in the content, from the artistic component of the personality to a wider channel — the creative component. Artistic (as well as bohemian) are the private manifestations of a creative person. In addition, opposition between ET-AB pairs was strengthened by shifting the focus to philosophical knowledge in question 22. Thus, double opposition was achieved — within the AB pair and between PH-AB pairs. Accordingly, the name was changed from Bohemian-Artistic (AB) to Creative (CR). The changes also affected the visual stimuli (photos).

The selection of visual stimuli is closely related to the content of the questions. Changing the content of the question inevitably leads to the replacement of the stimulus-photo, which was done. In our opinion, the unusual architecture of the house should have caused pleasant associations for a creatively gifted person, additionally provoking a positive answer to question 21 (Fig. 1). On the contrary, the existential choice between "comprehension" and "incarnation" was reflected in the form of the functional asymmetry of the brain (Fig. 2).

21. Previous version

21. Current version

Fig. 1. Artistic-Bohemian/Creative MI, photo for question 21

22. Previous version

22. Current version

Fig 2. Artistic-Bohemian/Creative MI types, photo for question 22

After replacing the stimuli questions and stimuli-photos in the Creative (CR) MI, the nature of correlation in the pairs themselves changed: Philosophical (PH)/ Creative (CR) MI. The expected negative correlation was obtained instead of the initial positive one, (Table 3). However, the obtained correlation (–0.07), despite its negative values, turned out to be statistically unreliable. As it turned out, the majority of respondents answered in the affirmative to question 3 of the Philosophical (PH) type, and to question 21 of the Creative (CR) MI type. Thus, the results obtained experimentally confirmed the need for further improvement of stimuli for the Creative (CR) MI, as well as the need to replace the stimuli for the Philosophical (PH) MI type.

Table 3

Correlation analysis of MI types, after changing stimuli in Gardner_12

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	CR	IE
IA		0,25		0,31	0,16	-0,13		-0,30	0,08	-0,23	-0,09	-0,39
ET	0,25		-0,38	0,20	0,20		-0,15	0,17		0,07	-0,07	-0,32
LM		-0,38		-0,35	-0,24	0,29	0,09	-0,25	0,32	-0,38	-0,08	0,23
BM	0,31	0,20	-0,35		0,12	-0,39	-0,34	-0,16	-0,43	-0,05	0,11	-0,40
VS	0,16	0,20	-0,24	0,12		-0,10				-0,12	0,21	
NL	-0,13		0,29	-0,39	-0,10		-0,12		0,49	-0,37	-0,54	
BK		-0,15	0,09	-0,34		-0,12		0,18	0,34	0,35		-0,16
MR	-0,30	0,17	-0,25	-0,16			0,18		0,11	-0,06	-0,12	
AS	0,08		0,32	-0,43		0,49	0,34	0,11		-0,29	-0,63	-0,16
VL	-0,23	0,07	-0,38	-0,05	-0,12	-0,37	0,35	-0,06	-0,29		0,32	0,18
CR	-0,09	-0,07	-0,08	0,11	0,21	-0,54		-0,12	-0,63	0,32		0,18
IE	-0,39	-0,32	0,23	-0,40			-0,16		-0,16	0,18	0,18	

We decided to strengthen the emphasis on the dynamic component of the issues: passive-creative philosophical and actively-applied creative (Table 4). The replacement of stimuli-photos creative (CR) occurred within 22 questions, which, in our opinion, should have been sufficient. All the stimulus-photos for the philosophical (PH) type were replaced due to significant changes in the content of the questions themselves. As a result, the control and relevant questions for CR and PH turned out to be strongly opposed to each other in a pair, as well as in relation to each other between MI pairs.

Table 4

Creative (CR) and Philosophical (PH) MI types, the result of changes in stimuli questions (final version)

MI type	Previous version	Current version
Creative (CR)	21. I can easily adapt to any necessary situation	21. Your creative side never rests
	22. I don't like to stand out from the crowd	22. Comprehension is more important than incarnation
Philosophical (PH)	3. Philosophy prepares you for twists of fate	3. Lying on the couch and thinking is more important than fussing around
	4. A person should act, not think	4. I have the ability to create something extraordinary

After replacing the stimuli photos and stimuli questions in PH and CR MI, a statistically significant negative correlation was obtained (–0.29), (Table 5) between the PH-CR pair. The obtained result shows that the current stimuli questions and stimuli photos between the ET-CR couple were chosen correctly for the line-opposite structure of the Gardner_12 questionnaire.

Table 5

Correlation matrix analysis of MI types, after changing stimuli in Gardner_12 (final version)

	IA	ET	LM	BM	VS	NL	BK	MR	AS	VL	CR	IE
IA		0,29	0,08	0,14	0,21	-0,13	-0,13			0,15		-0,19
ET	0,29		-0,19	0,14	0,08	-0,05	0,06				-0,29	
LM	0,08	-0,19		0,18	0,27	0,07		-0,18		-0,35	0,31	
BM	0,14	0,14	0,18				-0,14	-0,07	-0,35		0,22	-0,24
VS	0,21	0,08	0,27			-0,12	-0,36	0,22	0,16	-0,18		-0,09
NL	-0,13	-0,05	0,07		-0,12		0,25	-0,14	0,06		0,19	-0,13
BK	-0,13	0,06		-0,14	-0,36	0,25		0,20		0,13	-0,20	0,19
MR			-0,18	-0,07	0,22	-0,14	0,20		-0,14	0,24	0,10	0,08
AS				-0,35	0,16	0,06		-0,14		0,06	-0,28	0,11
VL	0,15		-0,35		-0,18		0,13	0,24	0,06			0,30
CR		-0,29	0,31	0,22		0,19	-0,20	0,10	-0,28			-0,05
IE	-0,19			-0,24	-0,09	-0,13	0,19	0,08	0,11	0,30	-0,05	

21. Previous version

21. Current version

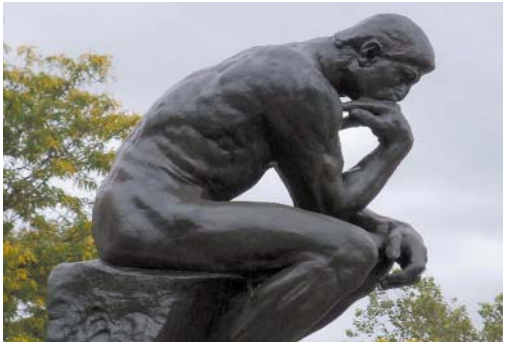
WITHOUT CHANGES

22. Previous version

22. Current version

Fig. 3. Creative MI type, the result of changes in stimulus photo (final version)

3. Previous version



3. Current version

4. Previous version

4. Current version

Fig. 4. Philosophical (PH) MI type, the result of changes in stimuli photos (final version)

Discussion

It is difficult to predict how stable the psychophysiological response of subjects will be with an increase in the sample size by an order of magnitude. This may require further adjustment of individual questions, stimuli, or photo stimuli. The probability of the influence of gender stereotypes of psycho-emotional evaluation of stimuli is also not excluded. These and many other nuances of human response to the questionnaire's stimuli are the subject of further research.

Conclusions

It is of course quite difficult to identify adequate stimuli for a statistically stable psychophysiological response of wide testee groups to certain types of multiple intelligence without repeated pilot studies. However, properly selected stimuli can achieve this goal. In the process of carrying out multiple tests, we were able to prove the validity of the existing stimuli used in the linear opposition structure of the Gardner_12 questionnaire. The compatibility of vibraimage technology with the mathematical apparatus of comparative testing of conscious and unconscious responses of the testee allows for the statistically reliably confirmation or rejection of the hypotheses and assumptions put forward.

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Part 3. VIBRAIMAGE APPLICATIONS

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REVIEW OF VIBRAIMAGE TECHNOLOGY APPLICATIONS

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Abstract: *A review of various vibraimage technology applications has been carried out. Variants of classification of Vibraimage system applications are proposed. The analysis of the literature on various vibraimage applications was done. The advantages and disadvantages of the main vibraimage applications are analyzed. The forecast for vibraimage updates and future developments is suggested.*

Keywords: *vibraimage, video, psychophysiology, security systems, applications.*

Since its inception, vibraimage technology (Minkin&Shtam, 2008; Minkin, 2017) has found application in various fields of science, technology and practical life. Vibraimage technology is video image processing method that identifies features of vibrations and movements of the objects explored. Vibraimage allows to open some hidden properties in studied objects, regardless of whether these objects are living or non-living physical objects. Relatively close analogues of vibraimage are thermal or X-ray images of objects. However, thermal and X-ray images require special photodetectors of a special spectral range, while vibraimage can be obtained from any video image, including black-and-white, color, thermal, or X-ray. The abundance of different vibraimage applications requires a certain systematization, at least to determine the limitations of the capabilities of this technology. In this review, I will focus on practical implementations of vibraimage technology, which have already found application in various fields.

1. Methods of classification for vibraimage technology applications

The basic principle of classification for vibraimage technology applications is the classification according to the type of object under study. It can be a live object (people, animals), a biological object (plants, seeds, blood, etc.) or a non-live physical object (cars, bridges, pipes, crystals, etc.). The next principle of classification for vibraimage technology applications is the classification according to the method of capturing information from a stationary camera connected to a computer or a standalone mobile device, for example, a mobile phone.

It is also possible to classify vibraimage technology applications based on the locality or globality of the system in use, such as a local computer, or a computer network that transmits the data and processes the results on the server. This study

is focused on the classification of vibraimage applications based on the object explored.

2. Review of vibraimage applications to live objects

The first vibraimages were obtained while observing various parts of the human body (Minkin&Shtam, 2008) and, of course, the human is the most interesting research object. The number of different applications of vibraimage technology devoted to studying people exceeds the number of all other vibraimage applications.

2.1. Human vibraimage

Security systems

The first practical task of vibraimage technology was to develop a system of contactless detection of suspicious and potentially dangerous people (Minkin, 2017). For more than 10 years of developments and deliveries, several thousands of such systems have been manufactured. They successfully accomplish their goals at airports, train stations and other protected areas (Anisimova, Biragov, 2008; Minkin, Tseluiko, 2014). The most significant event for this application was the Sochi Olympics, where vibraimage system was used to monitor all visitors and identify suspicious, potentially dangerous and aggressive people (Minkin, Tseluiko, 2014). Currently, vibraimage systems used 3 basic modes for the detection of suspicious and potentially dangerous people: Micro, Macro, and Mix (Vibraimage PRO, 2019). The Micro mode is focused on monitoring people standing in one place for at least 10 seconds and provides the highest accuracy (2% < FRR < 10%) (Vibraimage PRO, 2019) with proper control organization. The Mix mode is designed to control people standing in line or moving slowly, and ensures accuracy (8% < FRR < 15%) (Vibraimage PRO, 2019). The Macro mode is focused on the most rapid assessment of people's behavior in the crowd, and it is not as accurate as the Micro and Mix modes. It allows, however, to evaluate the behavior of a person who is in the frame for only 2–5 seconds with an accuracy (10% < FRR < 20%) (Vibraimage PRO, 2019).

Psychophysiological detection of deception

Vibraimage system that is focused on psychophysiological lie detection is essentially a contactless polygraph (Minkin, 2009; Vibraimage PRO, 2019; Choi, 2018). The main advantage of vibraimage systems in comparison with the polygraph is the possibility of contactless control. A relative disadvantage is the need to maintain a stable illumination of the testee. The accuracy of vibraimage systems during psychophysiological lie detection is comparable to a contact polygraph, however, the test time is reduced due to vibraimage's larger informativity (Choi, 2018; Minkin, 2018).

Interviews, HR, recruiting, loyalty detection, psychological surveys, determination of abilities, self-tests, vocational guidance, etc.

The informativity of vibraimage signals and the proven possibility of additivity of conscious and unconscious responses allow (Minkin, 2019) to determine in a short (3–7 minutes) test the multiple intelligences profile (Minkin&Nikolaenko; 2017), psychological personality accentuation (Blank et al., 2018), compatibility (Minkin, 2012) or many other characteristics of a person, the identification of which requires hours when conducting similar studies by the other methods.

Medical diagnostics

Studies have shown that vibraimage technology makes possible to diagnose a wide range of diseases at early stages of their development (Blank et al., 2012). The vestibular-emotional reflex (Minkin&Nikolaenko, 2008) creates a characteristic motor imprint for each pathology, similar to biochemical analysis. For the detection of said motor imprint it is necessary to conduct standard medical studies of control and patient groups. For medical applications, vibraimage technology should be considered as an express diagnostic, since the speed of obtaining results excels the majority of analogues currently in use.

Psychophysiological preshift testing

This application is increasingly important, as the development of technologies increase the role of the human factor as one of the most significant reasons of man-made disasters. One-minute pre-shift testing of operators at nuclear power plants (Bobrov, Shcheblanov, 2018), air traffic controllers and other specialists (Schelkanova, 2018) by Vibraimage system (VibraStaff, 2019) can significantly reduce the risk of inadequate actions of the personnel in critical situations, and prevent staff from working in inadequate condition.

Vibraimage sport applications

One of the main problems of modern sport is the lack of operational and contactless methods of controlling the overtraining of athletes. It is also known that the psychological attitude of an athlete before the game has a great importance for obtaining the ultimate result. For team sports, team compatibility, the optimal choice of starting staff, operational control over changes in the psychophysiological state during the game, and the right substitutions during the game are also very important. Vibraimage technology is used to solve the listed problems (Lutkova et al., 2019), and psychophysiological control in training of athletes will undoubtedly develop in the near future.

Vibraimage as a tool for the scientific study of personal characteristics

Recently, a number of studies aimed at studying various characteristics of personality have been carried out, in which vibraimage technology performs a key role (Minkin&Nikolaenko, 2017; Minkin&Myasnikova, 2018; Minkin&Blank, 2019). The unique capabilities of vibraimage technology, which allow to combine the simultaneous study of conscious and unconscious responses, reveal new properties of a personality and contribute to the development of new vibraimage applications. The obtained results are used in testing of multiple intelligences, psychological accentuations, medical diagnostics, lie detection, interviewing, and can be used with any technology of psychological and psychophysiological testing.

2.2. Vibraimage of animals

At present, these applications are only developing, although in the future, in terms of volume, they can seriously compete with applications based on human vibraimage. People can exchange verbal information, and vibraimage technology is used mainly to obtain hidden information about a person. But the animal cannot say anything to its owner, and vibraimage technology can simplify the communication between people and animals. Moreover, the sources of vibraimage technology were certainly established by Darwin (Darwin, 1873) and Lorentz (Lorenz, 1966), who first analyzed the behavior of animals, and then reapplied their findings to humans. Therefore, the use of vibraimage in veterinary medicine and animal behavior should be more developed in the near future.

2.3. Vibraimage of biological objects

Biological objects are organic objects that have their own mobility (living cells, blood, fluids), which can be observed with a microscope, and objects with little or no mobility (seeds, leaves, plant parts), the vibraimages of which is mostly determined by the mechanical features of the edge and the contrast of the object against the background. Even if the studies are seemingly low informative, their statistical results should not be disregarded if they show significant differences between different types of biological objects (Zanco, 2016; Venture at al., 2017). The internal biochemical composition has an impact on those physical characteristics (color, weight, contrast, shape of the edge), which vibraimage reveals. Therefore, vibraimage can be a rather technological way of detecting genetically modified products, due to the influence of aggregate physical features on vibraimage characteristics (Zanco, 2016).

2.4. Vibraimage of non-living objects

Since almost all the physical objects in our world have vibrations or movements, one can observe vibraimage of almost any object. The availability and quality of vibraimage depends primarily on the means of observation. Naturally, standard

television cameras should be used to observe objects with large vibrations, such as a running car engine or bridge vibrations, while a microscope can be used to record the vibrations of bridge supports. At the same time, for non-living objects (as well as for the living), vibraimage allows to calculate and use not only periodic movements, but also macro-movements, as in, for example, traffic control (NikeiBP, 2017). Another possible way to use vibraimage is to predict earthquakes and control seismic activity (VibraEarth, 2016). The possibility of informative using of vibraimage in astronomy and remote probing of the earth is not excluded, since the accumulation of information about remote macro objects may exceed by some qualities the traditional methods of their observation.

2.5. Mystical events observation

The fact that vibraimage is a purely technical and physical technology for measuring the characteristics of mechanical movements of an object allows to visualize phenomena that do not always have current scientific explanation. In this case, special attention should be paid to the conditions of the experiment (I repeat that any object has vibrations, their visualization depends only on the means of observation) and conclusions that are drawn on the basis of the data obtained. Vibraimage technology, by virtue of mathematical formulas embedded in it, with high sensitivity reveals periodic and stochastic vibrations in any movement. Changes in vibrations may indicate various changes in the state of the object, which may not always be as significant for other physical methods. It is precisely that high sensitivity to state changes that attracts researchers involved in the study of various unexplained phenomena (Debertolis, Gulla, 2017).

All results obtained by vibraimage system have a clear physical meaning, since the system registers only physical phenomena. Proper organization of the experiment and strict adherence to the instructions allow researchers to draw correct conclusions from the obtained results.

3. Discussion

This review is the second after the study (Minkin, 2007), which describes the various applications of vibraimage systems. Naturally, over the time since the first publication, the number of practically used applications has slightly increased. The work (Minkin, 2018) analyzed the reasons for slow development of vibraimage technology. Most of the new applications were proposed by the users of vibraimage systems, who had obtained new results that extend the capabilities of existing programs. Most likely, such a trend will continue in the future, if the existing business model of Elsys — Partners cooperation does not change. At the moment, the developers of vibraimage system (Elsys company) are mainly focused on the technical support of partners, the achievement of better technical results (increase in speed, reduction in processor load, increase in accuracy, development of new platforms, etc.), which requires significant resources (Minkin, 2018). However, the

rate of application development can be significantly increased with the emergence of a global business investor who can combine the development of all areas within one company.

Conclusions

Since the first patent has been filed (Minkin, Shtam, 2008), vibraimage technology is slowly but surely developing in different directions. Whether its development will be a breakthrough and mass apply will be clear in the next few years. Currently, vibraimage technical properties (contactless, informational content of the vestibular-emotional reflex, easy and friendly information processing) provide an advantage over other technologies of psychophysiological detection.

However, technical progress does not stand still. Most likely, if a breakthrough to mass applications does not happen in the next 10 years, powerful competitors will emerge. Perhaps this will be a technology of using reflected electromagnetic waves (Zhao et al., 2016), which are beginning to be used for psychophysiological detection, and perhaps something fundamentally new and unknown will appear. The Greek philosopher Protagoras claimed that "man is the measure of all things". Therefore, the study of people as an object will always be the main goal of science, and the technology of vibraimage is important step in its study.

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USING VIBRAIMAGE TECHNOLOGY WHEN ESTIMATING THE BEHAVIORAL REACTIONS OF A PERSON PERFORMING MODELED OPERATING ACTIVITY

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Abstract: *The paper presents the results of a comparative assessment of the parameters of the head and body vibraimage of persons performing simulated operator activity on a psychophysiological simulator. According to the parameters of amplitude, frequency, symmetry, spatial and temporal parameters of the mathematical processing of human body oscillations, new integral indicators for the assessment of behavioral reactions have been developed. Their changes are shown under different operating modes on the simulator, high correlation with the integrated parameters of the facial vibraimage. This allows an assessment of the current psychophysiological state using video recordings of a person's face and body.*

Keywords: *Simulated activity, behavioral reactions, parameters of facial vibraimage, parameters of vibraimage of the body, psychophysiological simulator, current psychophysiological state, vibraimage technology.*

There are many professions, in which a person is required to interact with technical and informational means, in which an employee's mistakes can lead to adverse consequences. The main reason is non-compliance of the current psychophysiological state of the employee with the requirements of the activities. The development of the state of monotony among operators of nuclear power plant control panels can reduce the functions of memory, attention, attention distribution, perception, etc. The same danger exists for civil and military air traffic controllers. Malfunctions in the work of technical and information systems can lead to a change in the psycho-emotional state of an employee, down to a level where they lose the ability to correctly perform the necessary actions and even stop performing them. Many professional activities are associated with a fairly stereotypical set of actions. If current psychophysiological state of an employee does not meet the requirements of the activity as a result of, for example, fatigue or increased psycho-emotional stress, stereotypic actions may be violated in terms of speed, order, etc. That is, the actions themselves (behavioral reactions) may be an indicator of inconsistency of the current psychophysiological state with the requirements of the activity. Therefore, the development of methods and criteria for monitoring the current psychophysiological state in the performance of professional activity is an important task of applied medical and psychophysiological research. The most promising for solving this problem, in our opinion, is vibraimage technology (Minkin, 2017).

This is evidenced not only by the numerous results of its effective use in profiling, but also by the research of the specialists of FSBU SSC FMTC named after A. I. Burnazyan when assessing the current psycho-physiological state of people

working on a psychophysiological simulator (Bobrov at al., 2016). It was found that the micro vibration parameters of a human head, recorded using a webcam, highly correlate with the parameters of electrophysiological signals and the quality of performance of the simulated activity. However, in real production conditions, placement of a webcam near the employee's face may not always be possible due to the nature of the workplace. In some cases, it may be more appropriate to install a video camera that captures the entire body of the worker, allowing to evaluate the change in the behavioral response.

The aim of this study was to develop criteria for assessing behavioral reactions of individuals performing simulated operator activity on a psychophysiological simulator by vibraimage technology.

Materials and Methods

The studies were carried out within the framework of the Russian-Norwegian Cooperation on the rehabilitation of radiation-hazardous facilities in North-West Russia (Contract No. M18–15/02 dated 02.02.2015). As a model of operator activity, a software and hardware complex (SHC) was used that implements interactive simulation training games with biological feedback in a virtual environment with simultaneous recording of the parameters of the modeled activity and electrophysiological indicators.

SHC was developed by the specialists of the FSBU SSC FMBTS named after A. I. Burnazyana together with employees of NIIMBB (Novosibirsk). The SHC is intended for training specialists using a psychophysiological simulator in the Center for Radioactive Waste Management (RAW) — Department of Andreeva Bay SSC "SevRAO" — a branch of FSUE "RosRAO" ("SevRAO") involved in spent fuel management operations. Psychophysiological training is aimed at developing spatial and temporal coordination, coordination and motor interaction, increasing stress tolerance, improving the characteristics of attention and memory. It is implemented on the basis of the performance of game tasks that simulate the work of personnel to overload substandard spent fuel assemblies (SSFA) of water-to-water reactors of utilized nuclear submarines using psychophysiological analogues of real-life conditions recreated using immersive virtual reality technology.

The SHC implements the usual and stress modes (time limit and external sound interference) of container disassembly. A webcam was used for video recording of the person in training/undergoing the test; body video was taken with a Panasonic HC-V770 video camera. Video recordings were processed using vibraimage technology implemented in VibraImage 8 PRO program (Vibraimage PRO, 2019). Video recordings of the face were processed in accordance with the program settings for the Micro mode. Optimal settings for the Macro mode were developed by Elsys specialists. The study involved 6 people who performed activities in the normal mode (BGROUND mode) and with the stress factor of a shortage of time and exposure to sound interference (LOAD mode). A total of 118 individual studies were conducted.

The results of the study were analyzed using the program STATISTICA v.8.0.

Research results

To assess the psychophysiological state of the person in training/undergoing the test according to the video of the face, the integrated vibration image parameters were used: stress level (Str), stability level (St), activation level (Act), self-regulation level (SR), calculated by the parameters of the human head vibraimage (Bobrov et al., 2016; Schelkanova, 2018).

Figure 1 shows the vibrogram of the body when being tested for various types of behavioral responses. Since the model is controlled using a joystick, the arm area is the most active.

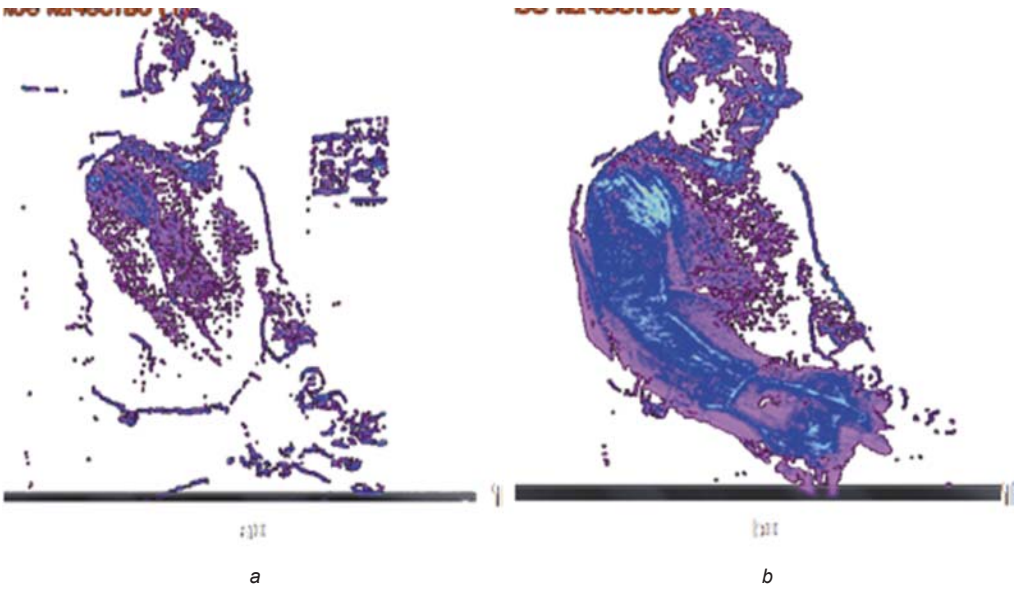

Fig. 1. Vibraimage of the testee during low (*a*) and high (*b*) movement activity

In total, vibraimage technology registers more than 40 parameters reflecting various types of movement and vibrations, and vibraimage parameters divided into 4 main groups: A — amplitude parameters; F — frequency parameters; S — symmetry parameters; P — spatial and temporal parameters of mathematical processing (Vibraimage PRO, 2019). To assess the behavioral reactions based on the video of the body of the testee in accordance with the parameters of the specified groups of vibraimage and using the factor analysis (Schelkanova, 2018), 4 new integrated parameters A, F, S and P were constructed. The factor analysis was carried out according to the primary parameters that reliably distinguish between the operating modes of the BGROUND and LOAD.

It has been established that there are 3 types of behavioral reactions when performing simulated activities performed in different modes: Type 1 — typically characteristic of the BGROUND mode, Type 2 — typical of the LOAD mode, Type 3 — encountered in both modes (fig. 2).

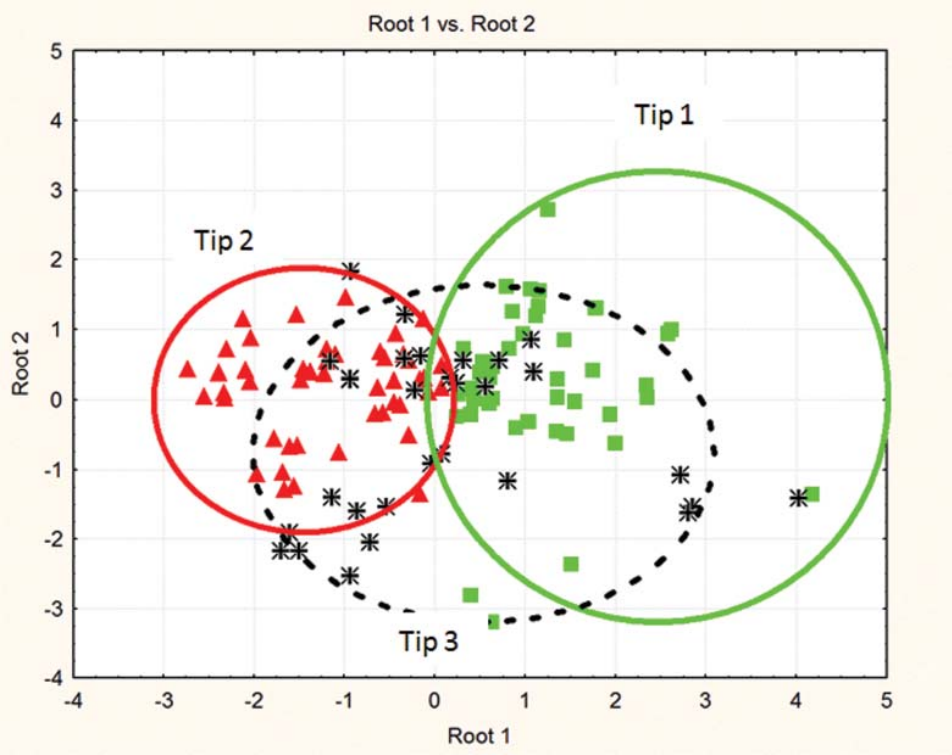

Fig. 2. Distribution of typical behavioral reactions along the axes of canonical discriminant functions

Figure 3 shows the average values of the integrated parameters A, F, S and P for different conditions of the simulated activity.

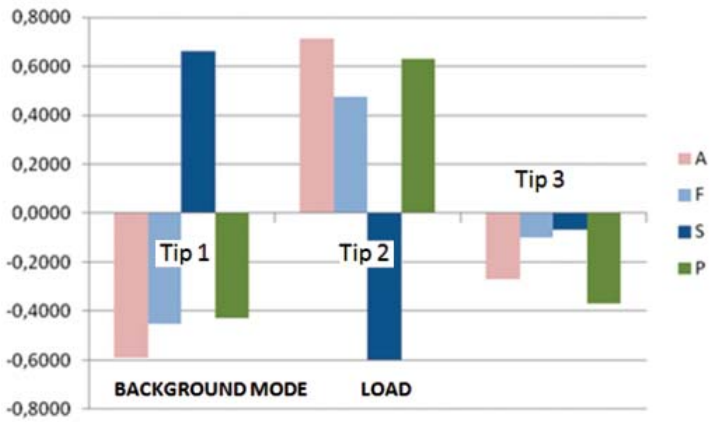

Fig. 3. The average values of the criteria for evaluating behavioral reactions in various modes of operation on the psychophysiological simulator

As follows from the above results, low values of amplitude (A), frequencies (F), dispersions (P) and high symmetries (S) in the body vibrations of the trainee/tested are characteristic of the background mode. The level of behavioral activity is low and corresponds to the tasks solved in the simulation model of activity. In the LOAD mode, the level of psycho-emotional stress of the trainee/person under test increases, which is reflected in the deterioration of the behavioral response parameters: an increase in the amplitude, frequency and uniformity of movements, and a decrease in their symmetry. However, in both modes of operation, behavioral reactions with an average intensity of movement parameters are encountered.

The interrelation of vibraimage parameters of face and body of the trained/tested individual was estimated using canonical correlation analysis (Kim et al., 1989). A high correlation of the compared parameters was established: the canonical correlation coefficient is high (R = 0.84) and reliable (Xi-square = 74.5, p = 0.0000001). The factor structure of the canonical variable Root 1 corresponding to this R is shown in table 1.

Table 1

Factor structure of the canonical variable parameters of vibraimage of the face and body performing the simulated activity

Facial vibraimage parameters	Root 1
Stress level, pu	0,70
Stability level, pu	–0,45
Activation level, pu	–0,49
Self-Regulation level, pu	–0,12
Body vibraimage parameters	Root 1
Integrated amplitude of movements, pu	0,77
Integrated frequency of movements, pu	0,43
Integrated symmetry of movements, pu	0,31
Integrated dispersion of movements, pu	0,31

It follows from the above data that the higher the level of stress of the trainee/test subject is (accompanied by a decrease in the stability of the psychophysiological state, a decrease in the levels of activation and self-regulation), the higher are the amplitude, frequency, dispersion and movement asymmetry. This allows, depending on the possibility of installing the equipment, to use the recording of the worker's face and body to assess the current psycho-physiological state.

Conclusions:

1. Vibraimage technology allows to effectively assess the current psychophysiological state of a person while performing a simulated activity. This provides the basis for its use in assessing the effectiveness of human interaction with technical and information systems in order to improve the reliability of the human factor.

2. The developed criteria for evaluating behavioral reactions allow to use both video recordings (face and body), depending on the possibility of placing video registration tools in order to assess the current psychophysiological state of the employees.

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CRITERIA FOR EARLY DETECTION OF PSYCHOSOMATIC DISORDERS BY VIBRAIMAGE PARAMETERS

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Abstract: *It is shown that vibraimage technology is a promising tool for the development of criteria for early diagnosis of psychosomatic disorders, in the tasks of improving the medical supply of workers in unfavorable conditions. The developed formalized criteria and decisive rules allow recognizing presence/absence of hypertensive disease, diseases of the gastrointestinal tract, musculoskeletal exchange processes. Increase of accuracy of formalized criteria and decisive rules of early diagnostics of psychosomatic disorders is connected with application of artificial neural networks.*

Keywords: *Vibraimage technology, psychosomatic disorders, early detection criteria, decisive rules, artificial neural networks, working in adverse conditions.*

Psychosomatics (Greek: “psyche” — soul, “soma” — body) is a branch of medicine and psychology that studies the influence of psychological (mainly psychogenic) factors on the occurrence and subsequent dynamics of somatic diseases (Malkina-Pykh, 2005). The basis of any psychosomatic illness is the body’s response to emotional experience, accompanied by functional changes and pathological changes in the body. Scientists have been interested in the problem of the relationship of psychological and somatic components for centuries since the time of Aristotle and Hippocrates. A sufficiently large number of models and theories of psychosomatic diseases have been developed. Medical statistics show that up to 70% of patients seeking medical care suffer from psychosomatic diseases. The most common diseases include hypertension, coronary heart disease, asthma, various types of dermatitis, diabetes mellitus, gastric ulcer and duodenal ulcer and cancer.

In total, scientists describe more than 40 psychosomatic diseases, and this number is constantly increasing due to environmental change (economic, social, environmental instability), deterioration of the psychophysiological and mental state of a person (fears, aggression, anxiety, low stress tolerance, exhaustion, etc), as well as hereditary diseases (Medvedev, 2013). Particular attention is paid to the early diagnosis of psychosomatic diseases with the medical support of workers whose work activities are associated with harmful and dangerous working conditions. In particular, in the medical care of nuclear workers. This is necessary for the timely implementation of rehabilitation and recreational activities aimed at preserving the health of personnel and ensuring the safety of the enterprise (Ivanov, Fedotov, 2016).

The development of express methods and criteria for the early detection of psychosomatic disorders is a topical scientific and practical task in assessing the health of workers at hazardous industries. A promising direction for solving this problem is the use of vibraimage technology (Minkin, 2017). The theoretical possibility of

its use for the medical diagnosis of various mental diseases, diseases of the nervous system and pathology of the vestibular apparatus is presented in (Blank et al., 2013). It is based on the assumption that micromovements of the human head should be informatively associated with certain pathological conditions. In the development of this area in the Russian Scientific Center of Radiology and Surgical Technologies, studies have been conducted to determine the parameters of patients vibraimage with a histologically verified diagnosis of prostate cancer (Blank et al., 2013).

Similar studies were conducted in a group of healthy people who underwent research for the presence of cancrophilia syndrome, which showed a negative result. As a result of studies, a significant difference was found between the experimental and control groups in a number of parameters of vibraimage. This makes it possible to conduct operational screening for the early detection of people with prostate cancer (Blank et al., 2013).

The purpose of this study was to develop criteria for the early detection of certain types of psychosomatic disorders in terms of vibraimage parameters.

Materials and Methods

The object of the research was the staff of one of the enterprises of the State Corporation Rosatom. During periodic medical examinations and psycho-physiological examinations, the health status of 282 employees of the enterprise was examined. Psychosomatic disorders were grouped into the following groups: the presence/absence of any type of disorder; the presence/absence of hypertension (GB); the presence/absence of diseases of the gastrointestinal tract; the presence/ absence of diseases of the musculoskeletal system; the presence/absence of diseases of metabolic processes. In the course of psychophysiological examinations using VibraMED program (Vibraimage PRO, 2019), the parameters of vibraimage were recorded. The results of the study were analyzed using the methods of multivariate statistical analysis (Kim et al., 1989), implemented in the program STATISTICA v.8.0.

Research results

In order to select the informative parameters of vibraimage that reliably differentiate the presence/absence of certain types of psychosomatic disorders, and to build the decisive rules for their formal identification, a stepwise discriminant analysis was used (Kim et al., 1989). The analysis is carried out using all parameters of vibraimage stored in VibraMED program database.

The table shows vibraimage parameters, ranked in order of information content for various types of psychosomatics. The ranking was carried out by the value of the Wilks' lambda criterion (Λ). The designations of indicators correspond to those stored in the database: X — mean values, Vi — variability, S — standard deviation of the indicator. Because currently there are no data on the psychophysiological interpretation of all recorded parameters of vibraimage, a meaningful analysis of the results obtained is very difficult. The table also shows the magnitude of the errors

of the 1st (probability of making a decision about the absence of a psychosomatic disturbance if there is one) and 2nd (the probability of making a decision about the presence of a psychosomatic disturbance if there is none) kind of developed formal decision rules. Error values of the 1st type do not exceed 10%, 2nd type — 20%.

It is important to emphasize that the constructed formalized decision rules for the identification of psychosomatic disorders have limitations, not acknowledging which leads to an increase in these errors. The result was generally as expected, since vibraimage parameters reflect the systemic response of the body to internal and external stimuli and factors (Bobrov et al., 2018) and it would be too optimistic to expect a high accuracy of identification of a specific type of psychosomatic disorder. One of the promising studies in this area is the use of artificial neural networks (ANN) for the identification of psychosomatic disorders, which, in contrast to the methods used for linear discriminant analysis, are nonlinear mathematical methods. In particular, the use of multilayer perceptron in information technologies of occupational medicine (Bobrov A. F., 2003).

Currently, various ANN learning algorithms have been developed for automatic selection of the neuron weights of all layers of a multilayer perceptron. Algorithms of learning implement the principle of learning with and without a teacher. The setting up of the ANN is carried out for each example from the training sample until the ANN begins to recognize all these examples with the required accuracy. Only after that, ANN is considered ready for use for the recognition of real objects shown. A tuned and trained ANN is able to effectively recognize the new objects presented to it, attributing them to one of the classes whose recognition it was able to train.

Table

The results of certain types of psychosomatic diseases recognition using formalized decision rules

№	Type of psychosomatic disease	Leading informative indicators			Recognition results using formalized decision rules		
		Parameter designation	Magnitude Wilks' criterion	p-level	Average % correct classification	Type 1st error, %	Type 2nd error, %
1	Psychosomatic diseases in general	Charm (P17)-X	0,55	0,000	87,6	7,5	17,3
		P1-X	0,47	0,001			
		Self-Regulation (P18)-Vi	0,46	0,005			
		Balance (P16)-Vi1	0,45	0,027			
		S1-Vi	0,45	0,063			
		Inhibition (F6)-X	0,45	0,068			

Table (*continued*)

№	Type of psychosomatic disease	Leading informative indicators			Recognition results using formalized decision rules		
		Parameter designation	Magnitude Wilks' criterion	p-level	Average % correct classification	Type 1st error, %	Type 2nd error, %
2	Hypertonic disease	P2-X	0,472	0,000	95,9	3,0	9,1
		F5 (fast)-Vi	0,449	0,000			
		F4-X	0,418	0,000			
		S5-X	0,411	0,000			
		S1-Vi	0,404	0,002			
		S5-Vi	0,404	0,002			
		A4-Vi	0,402	0,003			
		F4-Vi	0,398	0,009			
3	Diseases of the gastrointestinal tract	Charm (P17)-Vi	0,49	0,000	95,9	2,8	16,7
		P4-X	0,47	0,005			
		Balance (P16)-Vi	0,47	0,009			
		F1-X	0,47	0,030			
		A4 (fast)-X	0,46	0,048			
		A1-X	0,46	0,058			
		Self-Regulation (P18)-X	0,46	0,059			
		Energy (P8)-X	0,46	0,086			
4	Diseases of the musculoskeletal system	F5 (fast)-Vi	0,58	0,000	93,4	2,5	10,3
		Stress (P6)-Vi	0,54	0,000			
		F6-Vi	0,45	0,000			
		A3-Vi	0,44	0,001			
		F2-Vi	0,43	0,003			
		F7-X	0,43	0,006			
		Suspect (P19)-Vi	0,43	0,008			
		Suspect (P19)-X	0,41	0,103			

Table (*end*)

№	Type of psychosomatic disease	Leading informative indicators			Recognition results using formalized decision rules		
		Parameter designation	Magnitude Wilks' criterion	p-level	Average % correct classification	Type 1st error, %	Type 2nd error, %
5	Metabolic diseases	P1-X	0,41	0,000	95,8	4,3	4,0
		F4-X	0,41	0,000			
		S1-Vi	0,40	0,005			
		Aggression (P7)-X	0,39	0,011			
		Aggression (P7)-Vi	0,39	0,012			
		Balance (P16)-X	0,39	0,026			

Conclusions:

1. Vibraimage technology is a promising tool for developing criteria for the early diagnosis of psychosomatic disorders in the task of improving medical care for people working in hazardous conditions.

2. The developed formalized criteria and decision rules allow recognizing the presence/absence of hypertension, gastrointestinal tract disease, musculoskeletal system, and metabolic processes within the limits of the established limitations with an acceptable level of errors.

3. Improving the accuracy of formalized criteria and decisive rules for the early diagnostics of psychosomatic disorders is associated with the use of artificial neural networks.

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ASSESSMENT CRITERIA OF PROFESSIONAL STAFF ADAPTATION PARTICIPATING IN PROCESSING OPERATIONS ON HANDLING NUCLEAR FUEL AND RADIOACTIVE WASTE ACCORDING TO CHARACTERISTICS OF MULTIPLE INTELLIGENCES

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Abstract: *Formalized decision rules and assessment criteria of professional adaptation level of staff participating in processing operations on handling nuclear fuel and radioactive waste have been developed according to the comparison results of professional adaptation assessment by the multiple intelligences characteristics. Referral to the most dangerous and responsible work of staff with high level of professional adaptation allows to increase safety of work performance. The objective assessment of professional qualities of staff conduces to improve methods and means of enhancement by using deliberate training and staff recruitment.*

Keywords: *Vibraimage technology, multiple intelligences, scientific assessment, professional qualifications, professional success, professional adaptation, handling nuclear fuel and radioactive waste, temporary radioactive waste storage facilities.*

One of the main activities of the Center for RW Management,−Andreeva Bay SZTS SevRAO department of the FSUE "RosRAO" branch — is the management of spent nuclear fuel (SNF). Working with SNF consists in removing fuel assemblies of nuclear reactors decommissioned from nuclear submarines, and ransferring them in transport containers with subsequent removal for reprocessing. The danger of the work performed relates to the fact that during removing fuel assemblies, abnormal situations may occur that lead to radioactive contamination of industrial premises and the territory of a temporary storage facility. The working conditions of professional staff are described in (Rataeva, 2018). The safety of work on the management of SNF and radioactive waste (RAW) largely depends on the professional characteristics of the worker, the leading ones being professional preparedness and professional success. In accordance with the works (Scheblanov et al., 2012; Bobrov A. F., et al., 2017), the professional qualification (PQ) of an employee is understood as the correspondence of the level of knowledge and skills acquired in the process of special training and necessary for performing labor functions in a particular job to the requirements of professional standards (job description, qualification reference book). The professional success (PS) of an employee is proper and effective implementation of all work and the accomplishment of all tasks that determine the content of activities in a given position and (or) at a given workplace. In general, professional characteristics (PQ&PS) should be assessed using valid methods and techniques used in the educational units of Rosatom State Corporation, direct and indirect characteristics of the success of the prescribed professional duties of the employee.

Practice shows that vocational training in its modern sense is carried out only in training centers at nuclear power plants. There, operating personnel undergoes routine training/retraining on full-scale simulators, and their knowledge level is assessed. With regard to the success of professional activity, the heads of departments try not to advertise the mistakes of their employees if they do not lead to significant disruption of the work of technological processes. Therefore, when assessing the professional characteristics of PS and PS, which together characterize the level of professional adaptation (PA) of an employee, peer review is the most accessible tool. Since the conduct of an expert assessment is associated with the expert's subjectivity, it is of scientific interest to assess and predict the professional adaptation of an employee according to objective methods. In particular, using the methodology for assessing multiple intelligences (Minkin&Nikolaenko, 2017), which has proved its effectiveness in predicting student performance (Akimov et al., 2018).

The aim of this study is to develop the criteria for the professional adaptation of persons involved in the management of spent nuclear fuel and radioactive waste, according to the characteristics of multiple intelligences.

Materials and Methods

The object of the research was the personnel of the main (complex for storage and handling of waste (CSHW)) and ancillary production (radiation safety service (RSS)) PVC GB. Andreeva SZTS "SevRAO". In total, 16 employees from the former, and 28 of the latter were tested. Testing was carried out using VibraMI program in the framework of the Russian-Norwegian cooperation on the rehabilitation of radiation-hazardous facilities in the North-West of Russia (contract No. M18-15/02 dated 02/23/2015) and the agreement of the A. I. Burnazyan FSBI SRC FMBTS with SZTS "SevRAO". The expert assessment of professional adaptation was carried out using a questionnaire developed by specialists of the A. I. Burnazyan FSBI SRC FMBC. The results of the study were analyzed using the program STATISTICA v.8.0.

Results

The questionnaire for the expert assessment of professional adaptation included questions assessing: 1) the level of theoretical knowledge and competence; 2) the speed of mastering professional skills; 3) errors in the work; 4) level of adherence to the principles of safety culture and manufacturing instructions; 5) the desire to improve professional skills; 6) mental professional performance; 7) physical professional performance; 8) behavior in a difficult production environment; 9) prevailing mood background; 10) forms of manifestation of emotions in behavior in industrial situations; 11) temperament; 12) features of intelligence; 13) own self-assessment of the evaluated employee; 14) the level of communication (professional sociability); 15) the level of self-control behavior in a production environment; 16) the level of acceptance of industrial ethics, the ability to adhere to the instructions of their superior; 17) the ability to organize their work; 18) interoperability in group

production activities; 19) state of health; 20) the ability to fully rely on the employee in emergency situations. The directors of the testees acted as experts.

The method of automatic classification identified 3 groups of workers: individuals with high (BY), medium (CY) and low (HY) professional adaptation. Figure 1 shows the average «profiles» of the selected groups on the questionnaire. The average recognition accuracy of groups according to the results of discriminant analysis was 98.9%.

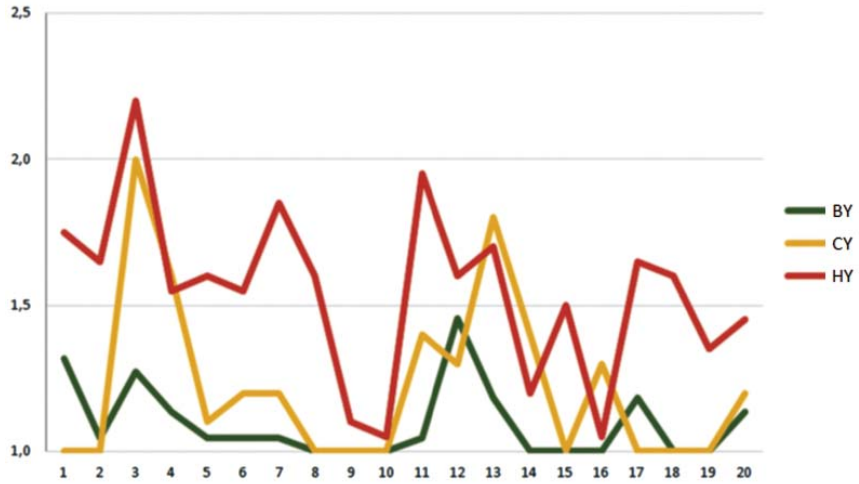


Fig. 1. Average profiles of workers with different levels of professional adaptation. The number of questions of the questionnaire plotted on the abscissa

As follows from the above data, workers with a low level differ from workers with a high level of professional adaptation, in that they have a lower level of theoretical knowledge and competence, a lower rate of mastering professional skills, a greater number of errors in work, a lower level of adherence to the principles of safety culture and production instructions. Additionally, they demonstrate less desire to improve professional skills, lower mental and physical performance, evasion of participation in the development decisions in a complex production environment, low ability to organize their work and interact with group production activities. Table 1 presents the profiles of the multiple intelligences of workers with high and low levels of professional adaptation.

As follows from the above data, the workers of the main production with a high level of PA reliably demonstrated the motor-motor type of intelligence, as well as the musical-rhythmic (pronounced tendency). This suggests that staff with a high level of PA is characterized by well-developed large motor and fine motor skills, allowing them to perform various actions with high-tech equipment. Well-developed coordination of movements, balance, agility, strength, flexibility are necessary to work successfully on the storage and management of spent nuclear fuel and radioactive waste. Moreover, personnel with a high level of PA are characterized by increased

sensitivity to sounds and phonemes, which is to a large extent characteristic of the presence of certain inclinations and abilities.

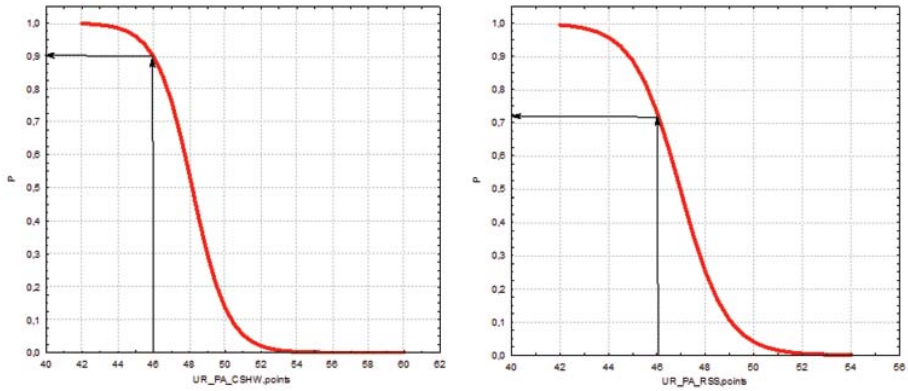
Table 1

Profiles of multiple intelligences of workers with high and low levels of professional adaptation and reliability (p) of their differences.

MI scale	SCHW			RSS		
	PA level			PA level		
	high	low	p	high	low	p
1 IA	43,8	45,9	0,93	49,8	66,1	0,282
2 PH	55,0	29,2	0,09	49,2	47,6	0,905
3 LM	42,6	30,8	0,42	40,0	65,9	0,077
4 BM	22,4	28,0	0,81	25,8	7,7	0,120
5 VS	43,6	56,1	0,45	67,1	48,0	0,08
6 NL	43,7	75,7	0,05	81,4	83,3	0,772
7 BK	77,8	43,0	0,01	76,1	58,1	0,05
8 MR	66,2	36,1	0,08	38,2	53,7	0,209
9 AS	76,2	74,9	0,93	80,6	76,4	0,753
10 VL	57,5	44,4	0,55	44,2	36,9	0,654
11 CR	35,5	38,8	0,84	30,3	42,7	0,336
12 IE	76,4	77,7	0,94	73,3	52,2	0,07

Workers with a high level of PA auxiliary production (RSS) are characterized by the predominance of motor, interpersonal and visual-spatial types of intelligence. For such workers, along with well-developed motor skills, such qualities as the ability to establish social contacts, work in a team, the ability to clearly define their position, taking into account the collective opinion already formed, the ability to perceive surrounding objects and phenomena in three-dimensional space, regardless of their initial position and dynamics. RSS personnel tend to work with constantly changing chemical shifts, monitor the current radiation situation, monitor compliance with the requirements of radiation safety rules, prevent personnel from overexposure, work with various radiation monitoring devices, which leads to the above qualities.

Using canonical discriminant analysis (Kim et al., 1989), formalized decisive rules were developed for assessing the level of professional adaptation of persons participating in SNF and RAW management operations (fig. 2).



a *b*

Fig. 2. Probability nomograms of identification of low-level professional adaptation for the CSHW (*a*) and RSS (*b*) workers

The abscissa axis shows the values of the integral indicators for assessing the level of professional adaptation for workers of the main and auxiliary production:

$$UR\_PA\_CSHW = 99.72 - 1.052 \times PR + 0.206 \times MR - 0.459 \times VI - 0.483 \times BA + 0.31 \times VP + 0.404 \times MD, \text{ points}$$

$$UR\_PA\_RSS = 56.1 + 0.09 \times BK + 0.6 \times MD + 0.41 \times VP - 0.28 \times PR - 0.31 \times LM - 0.19 \times MP - 0.25 \times VI - 0{,}33 \times BA, \text{ points}$$

On the ordinate axis — the probability of attributing an employee to persons with a low level of professional adaptation.

For example, if UR_PA_CSHW = 46 points, the probability (see fig. 2*a*) that an employee has a low level of professional adaptation is 0.9 (90%), with UR_PA_SRB = 46 points — 0.72 (72%) (see fig. 2*b*).

Conclusions

1. VibraMI program is an effective tool for assessing and predicting the professional adaptation of persons participating in operations with SNF and RAW.

2. Developed formalized decision rules and criteria allow, according to the assessment of multiple intelligences, to assess the level of professional adaptation of an employee in order to choose ways and means to improve it through the training focused on professionally significant qualities.

3. Referring people with a high level of professional adaptation to especially dangerous and responsible work will help increase the safety of work on the management of spent nuclear fuel and radioactive waste.

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PSYCHO-EMOTIONAL STATE MEASUREMENT FOR SENIOR THREE STUDENTS IN A HIGH SCHOOL IN CHINA — BASED ON VIBRAIMAGE TECHNOLOGY

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Abstract: *Human behavior and emotions have always been of interest to scientists. In order to investigate the grade three students' psycho-emotional state, vibraimage technology was used to collect data in the senior high school. The mean parameters of all students are within the reference range. 32 students' (89%) maximum in tension is higher than the reference maximum. Girls' stress level is significantly higher than that of the boys ($p < 0.05$).*

Keywords*: senior three students, psycho-emotional state, vibraimage technology*

Introduction

In recent years, there have been more than nine million high school graduates across China, but only 81.13% of these graduates would go to college, which means the students face tremendous competition in getting admission to tertiary education. The performance of college entrance examination is crucial for getting admission into one's preferred choice of college or university. Psychiatrists have expressed concern at the emergence of education as a serious source of stress for school-going children, causing high incidence of deaths by suicide (D'Mello, 1997). Accurate and prompt diagnosis of the students' psycho-emotional state has a profound meaning to these students.

Vibraimage provides information similar to the information obtained using point-by-point biomedical methods: EEG, GSR, ECG (Minkin&Nikolaenko, 2008). The main practical application of vibraimage technology is the representation of the reflex head movements through the psychophysiological parameters on the basis of the vestibular-emotional reflex (Minkin, 2018). The mental state of a person has a significant effect on vibraimage of a person, even minor change of a psycho-emotional state almost instantly leads to a change of energy of motion and vibraimage. And the normality of a psycho-emotional state also corresponds to the normal law of vibration distribution, similar to physiological condition. It was found that a quiet state is characterized by low-frequency vibrations, and the increase in mental energy leads to the increase in the observed frequency of a vibraimage.

Research on investigating academic stress and mental health of high school students are usually applied to the emotion measuring method of self-report (Xie Jing, Fang Ping, Jiang Yuan, 2011), a method using various emotion rating scales and other related questionnaires to fill in the subjects' emotional responses in the near future. It is the easiest and most feasible method. The premise of self-report method is that the subject is capable and willing to report their own emotions (Jiang Yuan, Lin Chongde, 2010).

This work intends to use vibraimage technology to detect the senior three students' psycho-emotional state. It could not only measure the students' emotional state quickly and precisely, but could also detect the underlying emotion.

1. Methods

1.1 Participants

The study was conducted in a class of grade three students from a senior school in China. All subjects gave full consent one day in advance. 40 people were tested, including 36 with valid data, 22 boys (61%) and 14 girls (39%) aged between 17 and 18 years.

1.2 Instruments

Video to vibraimage conversion provides real time determination of integral and local parameters of human head movement associated with functional state of the human body. Initial matrices for integral parameter calculation are represented by amplitude and frequency vibraimages calculated from equations. Vibraimage technology for testing vestibular functions determines real time trajectory of each point of student head in natural equilibrium with maximum accuracy. Virtually any movement of the human body is controlled by the sensory system. To obtain a clear vibraimage, the participant's face should be uniformly illuminated and located in front of the video camera. The software will calculate 10 different parameters to display participants' psycho-emotion state.

1.3 Data Analysis

In addition to the descriptive analysis of data, independent-sample t-test was applied to ascertain the deference of these parameters between boys and girls. All analyses were conducted using SPSS for Windows 22.0. Statistical tests used were two-tailed with a significance level of $\alpha = 0.05$.

2. Result

2.1 Sample's extremum of 10 parameters

Table 1

Sample's score of 10 parameters **(n = 36)**

	bMin	bMax	M (M)	cMin	cMax
Aggression	20	50	38.35	14.53	50.22
Stress	20	40	24.97	20.34	31.66

Table 1 (*end*)

	bMin	bMax	M (M)	cMin	cMax
Tension	15	40	30.79	13.48	45.13
Suspicion	20	50	30.73	20.81	37.72
Balance	50	100	66.86	50.8	81.97
Charm	40	100	79.02	71.15	84.37
Energy	10	50	25.03	10.91	30.71
Self-regulation	50	100	72.91	62.41	81.83
Inhibition	10	25	14.65	11.5	21.67
Neuroticism	10	50	21.85	0.88	27.53

Table 1 shows sample's score of 10 parameters used in the study. The mean values of the parameters are within the reference range. In terms of the negative part, the sample' maximum (also seen as cMax) of stress and suspicion are less than the reference maximum (also seen as bMax). In terms of the positive part, the sample's minimum values (also seen as cMin) of confidence and self-regulation parameters are much higher than the reference minimum values (also seen as bMin), but the cMax of energy is less than the bMax. In the physiological part, the cMin of neuroticism is much lower than bMin of reference norm, and cMax value of neuroticism is less than the bMax of reference range.

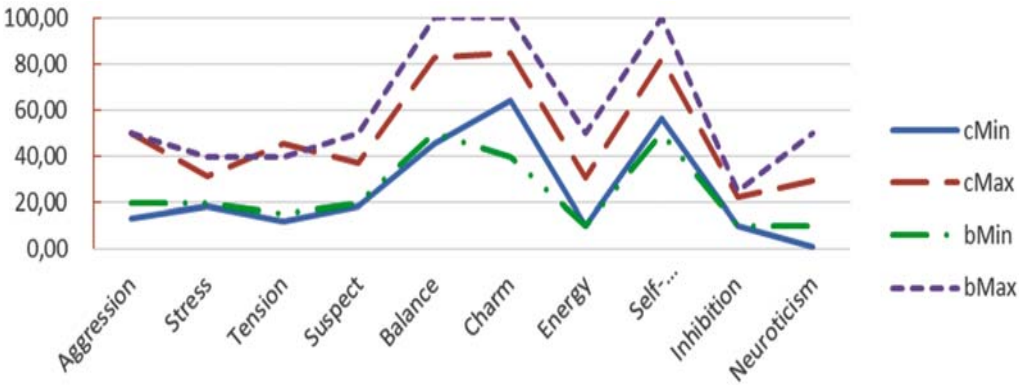

Fig. 2.1. Comparison between sample's extremum and reference range

As can be seen from figure 2.1, the cMin of confidence and self-regulation are much higher than the bMin, the cMin of aggression and neuroticism are much lower than bMin, and cMin of other parameters are basically consistent with bMin. Only the cMax of anxiety is far higher than bMax; the cMax of aggression and inhibition are basically consistent with bMax, and cMax of the other 7 parameters is lower than the bMax.

2.2 Sample' s means of 10 parameters

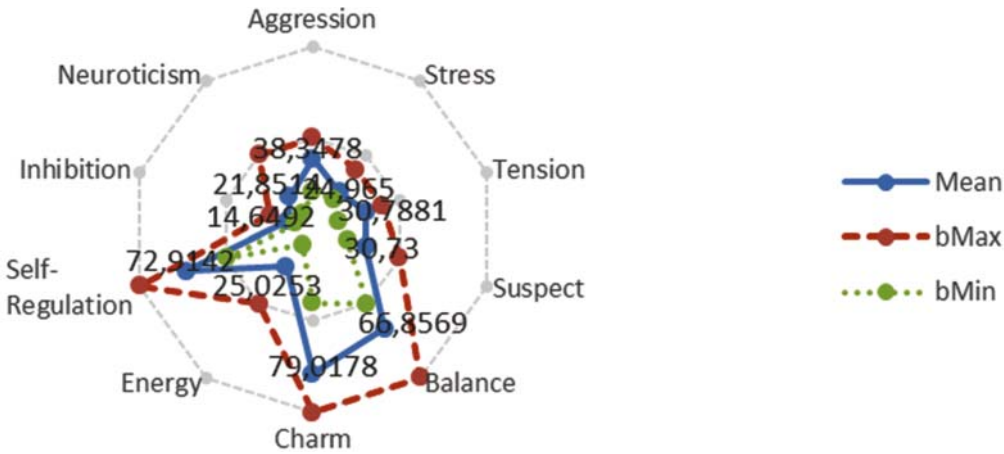

Fig. 2.2. 10 parameters' mean

From figure 2.2, it can be seen that the mean values of the 10 parameters of the sample are all within the range of the reference range.

2.3 Psycho-emotional state

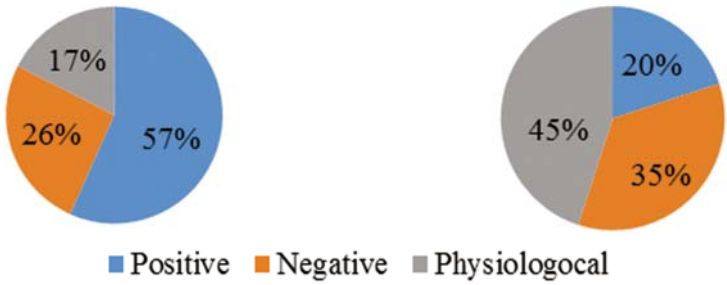

Fig. 2.3. Sample's psycho-emotional state

As can be seen from the figure 2.3, for the mean value of parameters, the students in this class have the largest proportion of positivity (55%), followed by negativity (28%), and the lowest proportion of physiology (17%). For the coefficient of parameter variation, physiological variation rate is the highest (45%), followed by negative variation rate (35%), and positive variation rate is the lowest (20%).

2.4 Personality tendency

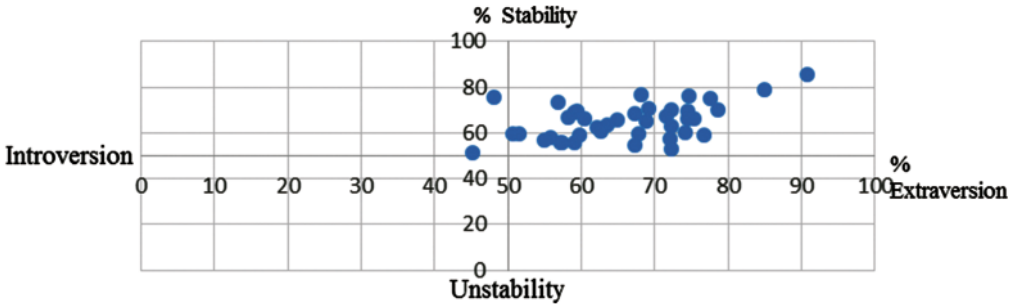

Fig. 2.4. Individual personality tendency

It can be seen from figure 2.4 that almost all students are extroverted and stable.

2.5 t test between different gender

Table 2

t test between different gender

	gender	M	SD	t	p
Aggression	boy	37.88	5.18	–0.67	0.06
	girl	39.09	5.39		
Stress	boy	23.29	4.89	–2.69	0.01*
	girl	27.59	4.31		
Tension	boy	30.76	6.8	–0.03	0.98
	girl	30.83	4.12		
Suspect	boy	30.01	4.31	–1.32	0.2
	girl	31.86	3.74		
Balance	boy	66.18	7.43	–0.67	0.51
	girl	67.92	7.73		

Table 2 (*end*)

	gender	M	SD	t	p
Charm	boy	80.39	6.44	1.84	0.08
	girl	76.86	3.99		
Energy	boy	24.46	5.86	–0.81	0.42
	girl	25.91	3.99		
Self-Regulation	boy	73.23	4.97	0.46	0.65
	girl	72.42	5.35		
Inhibition	boy	14.77	2.02	0.5	0.62
	girl	14.46	1.45		
Neuroticism	boy	22.36	9.79	0.41	0.68
	girl	21.06	8.08		
Positive	boy	61.07	4.67	0.19	0.85
	girl	60.78	4.04		
Negative	boy	30.49	4.09	–1.38	0.18
	girl	32.34	3.64		
Physical	boy	18.56	5.62	0.45	0.66
	girl	17.76	4.65		

As can be seen from table 2, there is a difference in pressure parameters between boys and girls, and the pressure level of girl is significantly higher than that of boys ($t = -2.69$, $p = 0.01$). On the parameters of aggression and confidence, boys and girls have a marginal significant difference. ($t = -0.67$, $p = 0.06$; $t = 1.84$, $p = 0.08$).

3. Discussion

It is found that the mean value of every parameter is within the reference range, indicating that the average level of all parameters of this class is at the normal level.

By comparing the maximum value of parameters and the maximum value of reference norm, the measured range of parameters and the range of reference norm, we find that, firstly, the maximum value of anxiety is larger than the maximum value of reference norm, and the change range of tension is slightly larger than the reference

norm, indicating that students' anxiety level is relatively high. It may be because the students in this class are in the state of coping with the college entrance examination. In China, the examination has long been valued by students, teachers and parents, and the heavy study tasks have triggered high levels of anxiety among students. Secondly, the minimum value of neuroticism is less than the minimum of reference norm, indicating that the neuroticism level of students is low.

Psycho-emotional states are divided into positive, negative and physiological states. Positivity includes balance, charm, energy and self-regulation, passivity includes aggression, stress, tension and suspect, and physiology includes inhibition and neuroticism. In this study, the average value of the students' positivity is the highest, but the variation rate of their positivity is the lowest. The low variation rate indicates that the intervention in their positive aspect would get little achievements. The mean value of negativity and variation rate of it were in the middle level. The physiological mean value of the students in this class is the smallest, but the physiological variation rate is the largest, so the intervention on the physiological aspect of this class may achieve a significant effect.

Introversion or extroversion of one's personality and emotional stability are direct factors that affect students' mental health. The data shows most students tend to be extroverted and stable. Students with high extroversion are active, proactively participate in and integrate into the group. They are good at expressing themselves in the group and achieving harmonious interpersonal relationship. Moreover, the school education is becoming more flexible and focuses on teaching students in accordance with their aptitude. Finally, parents' liberal parenting style also makes students' personality appear stable in the emotional dimension, which is conducive to the smooth growth of students.

The independent t-test of the parameters between genders shows that the stress of girls is significantly higher than that of boys. In terms of aggressiveness and confidence, the differences between boys and girls are marginally significant. The boys and girls experience similar score in the other parameters. The students in this class have excellent academic performance, and the intense learning competition and academic stress make the students face different degrees of pressure. Studies have shown that women tend to respond more emotionally to stressful situations. In terms of aggression and confidence, gender differences are marginally significant, which may be related to the small sample size, and their relationship can be further clarified by expanding the sample size.

4. Conclusion

The results show that all the psychological parameters of grade three students in a school in China are well distributed. Even though some students have a higher tension, it is acceptable in the face of such competitive examination. From the perspective of emotional state, physiological variation rate is the 45%, followed by negative variation rate 35%, and positive variation rate is 20%. Almost all students tend to be extroverted and stable.

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THE EFFECTS OF DRUM-CLUB ACTIVITIES PROGRAM ON MENTAL HEALTH OF SOLDIERS IN KOREA

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Abstract: **Purpose.** *The purpose of this study was to develop a drum-club activities program for soldiers and to explore the effects of the program on the mental health of the soldiers using vibraimage technology.*

Methods. *This study is focused on one group (pretest-posttest design). A drum-club activities program for soldiers was offered weekly for 12 weeks with each session being 2-hour-long. A total of 33 soldiers were recruited, but 16 soldiers were dropped out of the program because they did not participate more than 3 times during the 12 sessions. Finally, data from 17 soldiers were analyzed using the SPSS 22.0 program. Mental health status was measured by Vibraimage fixation standard systems (Mindin®), and the variables were aggression, stress, tension & anxiety, suspect, balance, energy, charm, self-regulation, neuroticism, concentration, and vitality index.*

Results. *There were statistically significant differences in anxiety (p = .001).*

Conclusion. *The results indicate that the drum-club activities program was effective in decreasing aggression, suspect, and anxiety in soldiers. The drum-club activities program can be considered as one of the possible intervention strategies for soldiers. In addition, vibraimage technology proved to be very convenient and useful measurement method in psychophysiological field.*

Keywords*: Vibraimage technology, Mindin®, Drumming, Anxiety, Psychophysiology*

Introduction

Vibraimage technology utilizes head micromovements in order to diagnose the overall mental health state of the patient objectively, accurately, quickly and quantitatively (Minkin&Nikolaenko, 2008). The technology: a) measures human biological variables in a non-invasive and contactless manner; b) performs statistical analysis on the collected information and; c) provides a diagnosis of the patients based on the statistics (Minkin, Nikolaenko, 2007).

Vestibular system is related to all other functional systems (Minkin, Gladyshev and Libb Thims) of human body, and effectively reacts to all mechanic, nociceptive or emotional changes. The Vestibular-emotional reflex demonstrates how micromovements of the head depend on emotions, particularly, through the constriction of muscles supporting the neck. Vestibular reflex in reaction to partial changes in the state is identical in standard situations. The informative nature of vestibular system in diagnosing various forms of pathological changes of the body enables a characteristic analysis of human psychological state through the processing of information about vestibular-emotional reflex (Minkin and Nikolaenko, 2008). Using Vibraimage in actual diagnosis requires an establishment of criteria for the parameters. Vibraimage reads out the signal changes of the human organ systems.

Not only the human but also all organisms have the differentiated periodic processes according to individual frequency characteristics. This periodicity affects a variety of physiological processes that ensure the normal activity of the body organs, including heart rate, body temperature, arterial pressure, cell respiration, and mitosis of various cells (Vayepsky and others, 2001; Cullen Kathleen and Roy Jefferson, 2004).

The progress of these physiological processes is related to the state of the body organ. The asynchronous cycle process is represented by two key indicators: frequency and amplitude. It is possible to inform the psychophysiological state of a specific time zone with a dynamic image that characterizes the frequency and amplitude of the point representing movement. This method is possible because all major physiological processes in humans have some correlation with each other.

In Korea, men must serve in the military for two years. Most Korean participants experience certain difficulties in the army, as they are normally in their late teens and early twenties. TFor this reason, the Nonsan Training Center organizes “drum club activities” to stimulate people’s positive emotion and improve the effectiveness of healing using percussion instruments (drum). It takes place for 2 hours every Friday. Using vibraimage technology, changes in the emotional state of the participants were measured and the effects were compared.

In this study, we analyzed the effectiveness of the drumming education and training (Drum Club activities) by evaluating it through vibraimage technology measuring machine that uses head micromovement reflex reaction. The human state assessment includes the arithmetic expectation (average value) of micromovement parameters, concentration, vitality and the various parameters provided by Vibraimage technology.

In the past, biometric variability was usually used to identify cardiovascular pathological aspects and study the reserved capabilities of body organ in the analysis of heart rate variability (Vayepsky and others, 2001). The integrated diagnosis information of heart rate variability parameter differs significantly from the vestibular system measurement information made by biorhythm and vestibular activity. The heart rate variability is the main body rhythm of the human organ, while the vestibular system is an important rhythm of psychophysiology, and its function is mainly determined by the activities of other functional systems.

Vibraimage technology physical models include the articles by Viktor Minkin and Nikolai. Nikolaenko (Minkin&Nikolaenko, 2007; Minkin&Nikolaenko, 2008), and the physical and thermodynamic model in Vibraimage technology was based on research by Viktor Minkin and Libb Thims (2008) (Minkin, Gladyshev and Libb Thims).

Vibraimage method has a minimum correlation and records as many as 9 independent psychophysiological parameters, characterized by 3D motion movements of human head. By the arithmetical processing for these 9 parameters, a single coefficient that characterizes the human function state is determined, and the micromovement parameter measurement is made up of Vibraimage technology. It consists of a standard camera with low temporary noise and Laptop installed with Vibraimage technology Application.

2. Objective and Measurement method

2.1 Objective

For each subject, the psychophysiological parameter values measured by vibraimage technology were obtained from two measurement testing groups according to the two conditions of the pre- and post-training state:

Condition 1 — pre-training state;

Condition 2 — post-training state.

The goal of this study is to compare the effectiveness by finding differences in meaningful psychophysiological parameters measured by vibraimage technology.

In the measurement stage, we detected the visual differences in vibraimage generated by vibraimage technology and acquired the detailed measurement data in the psychophysiological state using the digital image processing technique in vibraimage.

2.2 Experiment and Analysis method

The method used in Vibraimage technology testing equipment is non-contact, non-exploratory, and does not apply any external radiation. There is no high/low frequency electromagnetic field around the participant. The spatial distribution of micromovement was measured on the surface of living objects (human) associated with changes in the nervous muscle tremors in amplitude/frequency spectrum and psychological emotional state. The measurement results are based on the psychophysiological parameters provided by Vibraimage technology and the analysis of measurement results using statistical processing to obtain numerical values of the characteristics of the psychological emotional state of a person.

From the statistically reliable independence and by obtaining the results of the study, it is possible to find the changes in the functional state between two groups.

The statistically recorded differences in Vibraimage parameters demonstrate the functional, physiological, or emotional changes that are characteristic of the target group.

In the analysis, human psychophysiological parameter average value M, mean square deviation S, brain fatigue, concentration and vitality parameter were used on the basis of the following parameters.

T1: Aggression parameter, T2: Stress parameter, T3: Anxiety parameter, T4: Suspect parameter, T5: Balance parameter, T6: Charisma (Charm) parameter, T7: Energy parameter, T8: Self-Regulation parameter, T9: Neuroticism parameter.

The above parameters have been given the conditional names that conform to the various emotional human state. It is not necessary to accept these names literally because individual parameters reflect the physiological aspects of the space.

The individual parameter calculation formula from T1 to T9 is made according to the micromovement characteristics, so that the characteristics of the functional

process, the motion energy, and all other characteristics generated in the body organs can be reflected up to 100%.

The T1 to T9 parameters were selected to record all micromovement of the head. The name of an individual Ti parameter represents the various psychophysiological characteristics according to Vibraimage application. The priority characteristic of all individual parameters is the parameter determination formula, not the name.

2.3 Detailed Measurement

This healing program is conducting the drumming's education and training and the healing service through the healing effect program using percussions. It is organized by the SEROTONIN Institute. The participants were 33 military soldiers (all male) recruited in Nonsan Training Center. The average age of military soldiers was 23.8 years (standard deviation 0.74). For 12 weeks, the group of military participants had a training session every week the Nonsan Training Center in Nonsan, with each session lasting 2 hours. The measurements were performed twice, at the stage of 'before-training' and 'after-training' during the 12th week' of the drumming course. The measurement environment was installed so that Vibraimage technology was placed and operated between tester and participant sitting across from one another. The room was illuminated by the light on the ceiling providing enough light for the experiment. The camera on vibraimage technology was focused on the participant's face, and the tester was sitting facing the participant so that the laptop screen was not visible to the participant. At the adjustment stage, the optimum amplification factor for the electrical channel was set and was constant during the measurement period. The video at the time of measurement was captured from a camera with 30 frames, and the measurement was performed continuously for each participant. The measurement time was 1 minute for each participant.

The participant was in a stationary state and sitting in a chair in front of the laptop (1.6 GHz, RAM 8GB). Vibraimage technology was equipped with a camera (30 FPS). In Vibraimage technology record, the background was monotone and placed on the back side of the participant to reduce background noise, and the participant's head was displayed on the screen as a whole.

3. Measurement Result

For 33 participants, the status of the pre-training and post-training was obtained using Vibraimage technology measuring system. The results of Vibraimage technology were able to obtain data on the average value (M) for ten psychophysiological parameter values (T1–T9), concentration, and vitality.

The results of the statistical analysis of the data measured before and after drumming's education and training are shown on table 1 and figure 1.

Table 1

The Effect of Drum-club Activities Program (*N* = 17)

Variables	Pre-test	Post-test	Difference (pre-post)	z	*p*
	M±SD	M±SD	M±SD		
Aggression	34.62 ± 8.82	33.82 ± 7.06	0.79 ± 8.23	–0.49	.619
Stress	26.76 ± 4.73	30.26 ± 6.95	–3.50 ± 7.28	–1.72	.084
Anxiety	37.29 ± 3.90	29.13 ± 5.33	8.15 ± 7.04	–3.38	<.001
Suspect	32.86 ± 3.00	31.06 ± 2.79	1.79 ± 4.03	–1.63	.102
Balance	68.64 ± 3.81	64.61 ± 4.79	4.02 ± 7.62	–2.15	.031
Energy	18.04 ± 7.07	17.39 ± 6.71	0.64 ± 7.75	–0.21	.831
Charm	71.34 ± 11.60	68.08 ± 14.62	3.25 ± 19.44	–0.49	.619
Self-regulation	69.74 ± 6.13	66.16 ± 7.80	3.58 ± 11.20	–1.15	.246
Neuroticism	24.06 ± 10.06	26.56 ± 6.87	–2.50 ± 13.80	–1.30	.192
Concentration	51.87 ± 27.33	53.59 ± 16.56	–1.72 ±	–0.40	.687
Vitality	1.34 ± 0.46	1.31 ± 0.39	0.03 ± 0.45	–0.11	.905

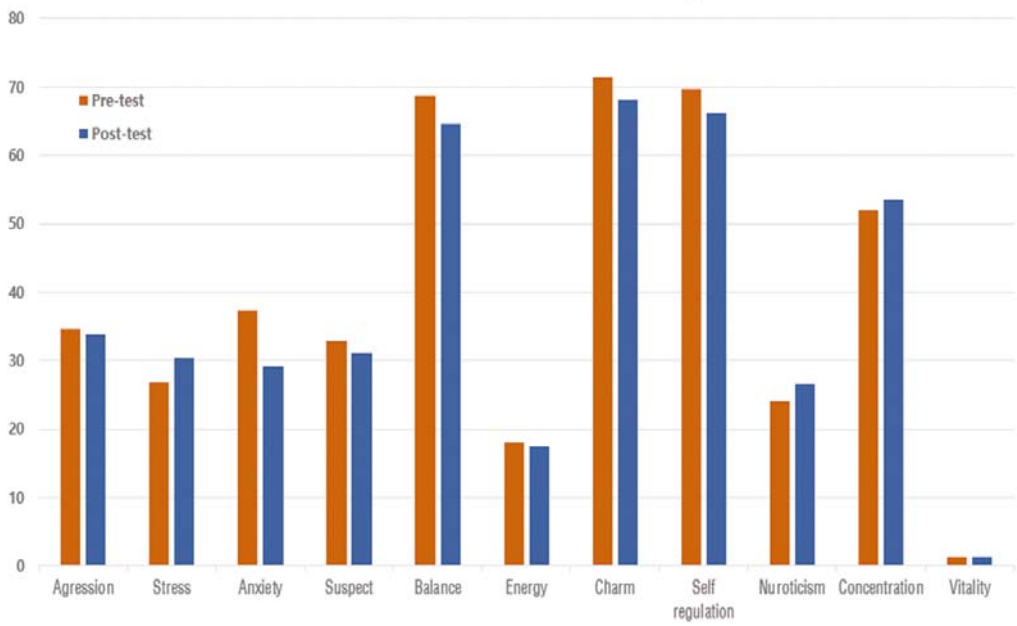

Fig. 1.

During the drumming training, it was not easy to adjust to percussion sounds as a group activity, so stress and neuroticism were slightly worsened before proficiency, but those were within a normal range. By the 12th week, there was statistically significant improvement in anxiety. Other parameters of aggression, suspect, and concentration were improved.

As a result, it was found that there was a important psychophysiological change between the pre and post-training status of drumming's education and training.

In addition, the study was able to clearly and objectively identify changes in some functional states apart from the physiological, psychological, or emotional causes, although the effects of drumming education and training vary slightly depending on the characteristics of each individual soldier or the military life with special hard training. At 12th week, we found there was a long march just before drumming session.

4. Conclusions

By using vibraimage technology, we were able to easily and quickly measure the psychological emotional state of a person, and we were able to record changes in the state of the person after the course of drumming education and training as well as the normal and quiet psychological emotional state of the person.

In the conducted study, the effectiveness of drumming education and training was positive in various psychophysiological conditions and the result proved to be effective.

The differences between the two conditions are relatively marked by psychophysiological parameters. The significant differences were remarkable in Anxiety.

The degree of concentration increased and then was improved as well. The distribution of the negative emotion variation was decreased.

In addition, since the measuring device of vibraimage technology is measured by non-contacting method, it has been proven that it can be easily and conveniently measured for the effectiveness analysis of drumming education and training.

At the same time, this study was able to objectively and efficiently identify changes in all functional conditions apart from the physiological, mental, or emotional causes, although the effects of drumming education and training differ slightly depending on the characteristic of each soldier or military life.

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DIAGNOSTICS OF GAME AGGRESSION OF THE QUALIFIED ATHLETES BY VIBRAIMAGE TECHNOLOGY

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Annotation: *The purpose of this article is to develop and test a method of presentation of stimulant material in sport when testing game aggression, on the basis of vibraimage technology. Possibilities of vibraimage technology in realization of diagnostic problem of game aggression and degree of expressiveness of each criterion of game aggression are investigated.*

Keywords: *game aggression, the qualified athletes, structure of the questionnaire, the maintenance of questions, vibraimage, VibraSport.*

Game aggression is defined as legitimate aggressive behavior of athletes, aimed at achieving strategic superiority over the opponent in individual martial arts, at certain intervals of the match, in the competition as a whole (Makarov, 2016). The definition of the concept of "play aggression" reflects the most essential features inherent exclusively to the conditions in which it is applied. Such features are the legitimacy of aggressive behavior; strategic superiority in the obtaining of a local advantage using aggressive actions allowed by the rules of the game.

Successful game action is unthinkable without aggression, which includes such personality traits as demonstrativeness, the desire for self-affirmation and rivalry, assertiveness, rigidity, and constant pressure on the opponent to deprive them of their psycho-emotional stability, trying to dominate, keeping martial arts on the verge of breaking the rules. The type of aggressive behavior and its degree depend on the type of sports game. Each game offers its own conditions for the manifestation of sports aggression, based on the competitive ability of the opposing sides, tactics, physical readiness and taking into account the strict limitations of the rules.

To assess aggressiveness, as a manifestation of personal mental traits, and aggression, as a manifestation of a mental state, psychologists most often recommend traditional psychological techniques: the Buss-Durkee method; Spielberger Express Method Aggression-Aggression Scale; interviews with athletes. These techniques require a lot of time to organize, conduct, process the results and obtain the necessary information. Therefore, their use (when working with athletes in the process of training and competitive activity) is carried out only in the course of specially organized scientific research conducted, as a rule, by psychologists.

The methods of operational contactless psychophysiological diagnostics, among which the most promising is vibraimage technology, allow to quickly receive contactless information about the parameters of current psychophysiological state (PPS) and promptly interpret it.

In this regard, the purpose of this study is to develop and test a method for presenting stimulus material in sports when testing game aggression based on vibraimage technology. The study suggested that the development of a method for presenting stimulus material in sports when testing game aggression allows the qualified game athletes to determine the detailed criteria for game aggression.

Materials and Methods

The object of the research was qualified athletes: young men aged 19–20 years who have a qualification of at least First-Class Sportsman; 20 people representing different types of sports (handball, volleyball), studying at the department of theory and methodology of sports games of the NSU.P. F. Lesgaft, St. Petersburg, Russia. VibraSport program detected the criteria for game aggression.

Research results and discussion

VibraSport, adapted from PsyAccent (VibraPA, 2019), is a program presenting stimulus material in sports for testing game aggression. It is based on vibraimage technology (Minkin, 2017; Minkin&Nikolaenko, 2008). For the development of the program, the following criteria for game aggression were defined: legal, physical, game, adaptive, strategic, and tactical.

Taking into account the selected criteria for game aggression, a questionnaire of 12 questions was developed, allowing to measure the degree of expression of each criterion of game aggression based on the current psychophysiological state and the subject's conscious answers. This includes stimulus images shown to the subjects on the screen along with questions.

The content of questions for each selected criterion:

LEGAL:

1. I am consciously breaking the rules of the game in order to achieve the goal.
2. I will not break the rules of the game, even if necessary.

PHYSICAL:

1. I like to press and physically influence the opponent during the match.
2. I prefer to avoid situations with power techniques "on the verge of what is permitted."

GAME:

1. In the struggle for the initiative, all means are good.
2. I will not break the rules of the game, even for the sake of superiority.

ADAPTIVE:

1. "In a foreign field" I play no worse than in the home arena.
2. Sometimes, I feel insecure in a changing environment.

STRATEGIC

1. For the sake of victory, I am ready for “rough play” and “unsportsmanlike behavior.”
2. I adhere to the position of “fair play” in any alignment of forces.

TACTICAL

1. If necessary, I resort to various tips and tricks.
2. It is better to accept the defeat with dignity than to break the rules.

The resulting characteristics of the game of aggression can be viewed from the position of the individual characteristics of the athlete during the game activity (Minkin&Nikolaenko, 2017).

The structure of the questionnaire has a differential stress approach, which implies a forced choice situation. The respondent is asked to answer 6 pairs of questions supplemented with stimulus images. The questions are structured so that for each criterion of play aggression the athlete answers YES to the first question of the pair, and NO to the second.

Testing in the differential stress approach is similar to the classical lie detection but is not its counterpart. This linear oppositional form of testing is less comfortable for the respondent than standard psychological testing, since it implies an artificially modeled situation of choice from potentially mutually exclusive concepts. Testing by the criteria of game aggression in this mode gives a more accurate result than direct questioning of aggression by traditional psychological methods (Minkin&Nikolaenko, 2017; Nikolayenko, 2018).

Passing the test of 12 questions does not lead to mental exhaustion of the subjects. Both the test procedure itself, and interpretation are automated. Vibraimage technology allows obtaining multidimensional dependencies of the characteristics of the PPS and recording the change in energy and the direction of this change. The change of energy released (consumed) by a person from the initial PPS to another energy state is measured in kcal/min (Minkin, 2018).

The psychophysiological approach and accessibility in its implementation on the basis of the VibraSport program allows for testing without the involvement of third-party narrowly specialized experts. The method is based on the classical principles of psychophysiology and the latest computer technology.

Testing the method of presenting stimulus material in sports when testing game aggression based on vibraimage technology was carried out during a pilot survey of qualified game athletes.

Figure 1 shows a graphical representation of the results of testing game athletes by VibraSport program.

Analysis of the indicators allows us to conclude that the leading criteria for game aggression among qualified game athletes in the group examined are (in order of ranking): adaptive, tactical, strategic, legal, game, and physical criteria. The first three criteria characterize the willingness of survey participants

to display game aggression in the implementation of strategic plans and tactical interactions, and to a lesser extent, due to physical aggression and violations of the rules of the game.

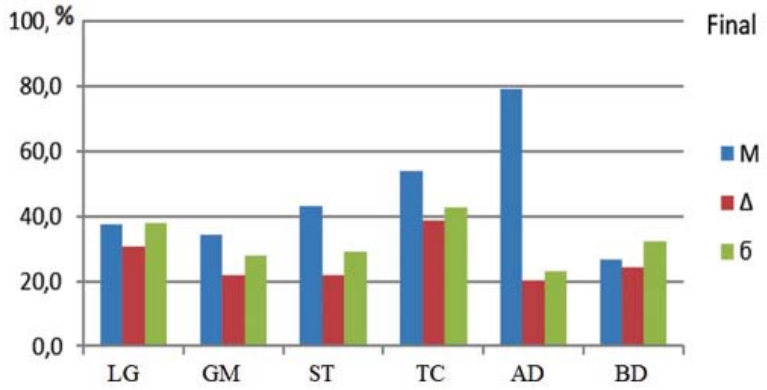

Fig. 1. Indicators of game aggression among qualified game athletes

Figure 2 shows the conscious reactions of qualified game athletes upon the presentation of stimulus material in sports when testing game aggression.

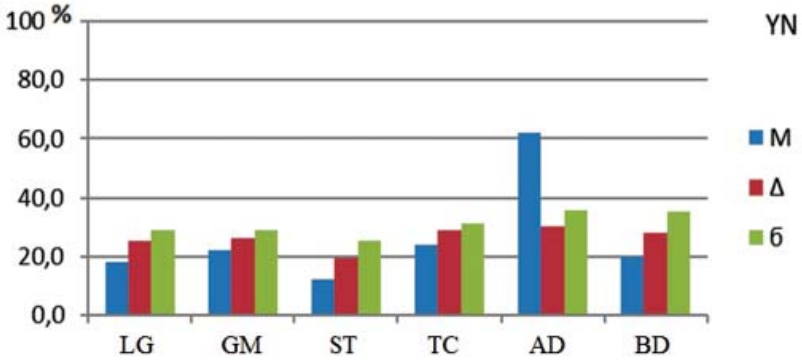

Fig. 2. Conscious responses profile of qualified game athletes during game aggression testing

Analysis of conscious responses results of qualified game athletes when testing game aggression allows to conclude that the survey participants have a high appreciation of the conscious positive perception of their adaptation to situations of game activity. The adaptive criterion has the highest rate of 60%.

Significant changes of the results obtained take place during the analysis of psychophysiological responses to the presented stimuli in the testing process, which are shown on figure 3.

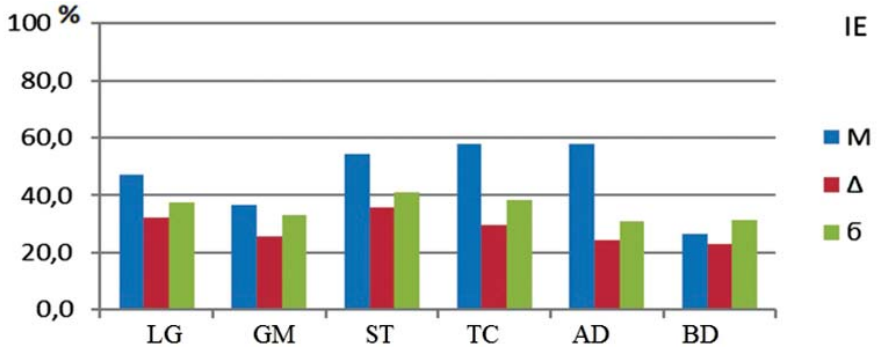

Fig. 3. Psychophysiological responses profile of qualified game athletes in game aggression testing

Analysis of the indicators of the psychophysiological responses of athletes in the surveyed group leads to the conclusion that they are most affected by the adaptive criterion (58%), the tactical criterion (57.9%), the strategic criterion (54.4%) and the legal criterion (47.2%). The obtained indicators at the level of psychophysiological responses characterize the changes in the states of the participants according to the strategic, tactical and legal criteria that determine their behavior, justified in terms of the conditions of the competition.

For joint processing of conscious and psychophysiological responses of survey participants, the obtained indicators were analyzed based on the determination of their percentage ratio, presented in figure 4.

Analysis of the indicators allows us to conclude that the calculated responses to most of the stimuli-questions coincide in direction, except for the strategic and tactical criteria, which correspond to the following negative values: 42.4% and 33.9%. The legal criterion also has a negative value (29.2%).

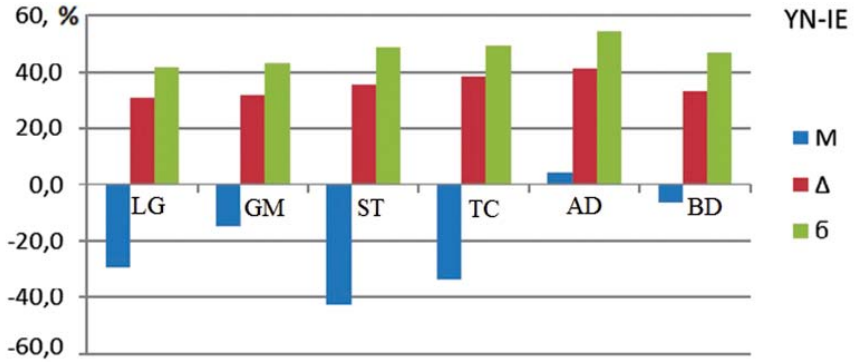

Fig. 4. The difference profile between conscious and unconscious responses of qualified game athletes during the game aggression testing

The obtained indicators show that survey participants consciously overestimate the possibilities of their actions in strategic, tactical confrontations and in compliance with all established rules of the game, experiencing a negative psychophysiological reaction on these criteria.

Conclusions

The obtained results allow us to conclude that the method of presenting stimulus material in sport by testing game aggression based on vibraimage technology (VibraSport program) allows measuring the rank of each criterion of game aggression based on the current psychophysiological state and the subject's conscious responses.

The results of the operational assessment of play aggression indicates the systemic reaction of game athletes to mental, psychophysiological, physiological levels, — taking into account their individuality. Using the method of presenting stimulus material in sports when testing game aggression allows the coach not only to obtain urgent information on individual criteria, but also to have a complete picture of the psychophysiological responses to these criteria.

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PERSONAL SECURITY AND POLITICAL LOYALTY ANALYZED WITH THE WelcomEU SYSTEM BASED ON VIBRAIMAGE TECHNOLOGY

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Abstract: *This article discusses the main problems of profiling as a mean of behavior detection, loyalty detection and suspicious persons detection. Technical profiling systems are contrasted with visual profiling. The modern means of technical profiling, their advantages and disadvantages in comparison to each other are analyzed in detail. A novel approach for profiling based on vibraimage technology is presented.*

Keywords: *profiling, technical profiling, political loyalty, questionnaires, vibraimage technology, psychophysiological detection of deception, PDD*

Loyalty relates to the dominant set of rules, values and norms of behavior in society. Accordingly, disloyalty manifests itself in the potential to violate the rules, values and norms of behavior, including criminal acts (Zhurin, 2013), established in a particular society. Profilers determine the state and intentions of a person, visually or during a survey. A selective inspection of passengers during pre-flight inspection is carried out in order to identify non-standard reactions to neutral questions. This kind of activity requires special training, which allows analyzing at one time a colossal amount of information received from the interlocutor: their appearance and clothing features, posture and characteristic gestures, speech characteristics and vocabulary used, characteristic reactions and much more (Privacy Impact Assessment…, 2011). Today, one of the main functions of various security services is the prevention of crime and the identification and monitoring of suspicious individuals. Modern security systems include various means of identifying the state and intentions of a person in order to predict their behavior. Usually such inspections are confined to profiling. Profiling is understood as a set of psychological methods for assessing and predicting human behavior, carried out by analyzing the most informative particular signs, like appearance and verbal and nonverbal behavior (Kulik, Mostovyuk, 2014). There are visual online profiling and technical profiling, which uses technical means of monitoring human behavior. Visual online profiling requires special training, which in a short period of time allows analyzing a colossal amount of information received from the interlocutor. Profiling of passengers at US airports is carried out through a system of behavioral analyses of passengers, called SPOT — Screening of Passengers by Observation Techniques. SPOT uses integral behavioral indicators characterizing levels of stress, fear and lies to characterize a person's emotional state. The main force in the SPOT project is the behavioral analysis by BDO (Behavior Detection Officers), visually analyzing the psycho-emotional state and human intentions, identifying individuals in passenger traffic whose behavior stands out from the general level (Privacy Impact Assessment…, 2011; Minkin, Tseluiko, 2014). SPOT is targeted to identify potentially dangerous individuals.

Other similarly focused behavioral risk assessment programs for prevention of criminal acts are: BASS (Behavior Assessment Screening System), BPRP (Behavioral Pattern Recognition Program), BASC-2 (Behavioral and Emotional Screening System), TARR (Terrorist Activity Recognition and Reaction) et al. (Demkin, 2019). Any visual profiling technique is related to a lot of stress; a specialist profiler cannot work more than one hour without a break. Accordingly, developments in the field of technical profiling are becoming increasingly popular. Automation of the profiling system will minimize the number of errors induced through the involvement of human resources.

1. Vibraimage system as a tool for technical profiling

Vibraimage technology (Minkin, 2017), when applied to a person, analyzes the motor activity (micro vibration) of a human head and converts in real time the light video image into an image formed by accumulated frame difference. Vibraimage reflects the average rate of change of the video image at each point calculated for a certain time. The obtained parameters of micro movements are transformed into the characteristics of the psychophysiological state (PPS), (Minkin&Nikolaenko, 2008; Minkin, 2017) by vestibule-emotional reflex. Vibraimage technology combines the capabilities of biometrics and psychology, allowing to jointly process the parameters of conscious responses and unconscious responses to questionnaire stimuli and characterizing this joint processing with uniform mathematical parameters reflecting the human PPS. The obtained parameters of vibraimage, in the form of integral profiles, make it possible to foresee human behavior in the near and distant future (Minkin&Nikolaenko, 2017; Minkin&Myasnikova, 2018)

WelcomEU (WelcomEU, 2019) is a system of psychophysiological testing of a person based on vibraimage technology. The system contains three different questionnaires (Id_leu, Id_leu2, Id_leu3), each of which includes 13 simple questions to be answered either Yes or No. Each question is supplemented with a stimulus photo. The questionnaire contains seven neutral (I), three control (C) and three relevant (R) questions. The test period is about 3.5 minutes. This time is sufficient to determine the trustworthiness / unreliability of a person.

2. Questionnaire structure

Unlike the classic detection of deception, where the control or comparative (C) and the relevant (R) questions form a pair (WelcomEU, 2019), in the WelcomEU system (Minkin&Myasnikova&Nikolaenko, 2019) they are separated by a neutral question (I), leading to the following sequence: I*-CIRI-CIRI-CIRI (Baur, D. J., 2006). The first neutral question (I*) of the questionnaire is the “zero” question. In the subsequent data processing, the I* is not considered. Data processing is carried out by two independent ways.

Method 1: It is based on the traditional comparison of the responses to control and relevant questions within the adjacent pair (comparison of the conscious and unconscious reactions). Naturally, both the control and the relevant questions provoke

a rather strong emotional reaction (in comparison with the reaction to a neutral question). However, in the absence of sympathy or involvement with persons having an evil intention, the control question exhibits an increased individual significant psychophysiological response compared with a relevant question. After all, a relevant question, in addition to a stimulus photo related to it, can be interpreted directly as pertaining to the potential activities of suspicious individuals. The uncontrollable psychophysiological reactions of an individual subjected to the WelcomEU profiling system to control questions will be more intense and hence detectable than on relevant questions.

Method 2: Comparison, within a pair, of the psychophysiological response (PPR) for control, relevant and neutral questions. This method was proven to be successful in cases where a person is trying hard to hide the truth. Hiding, imitating or over-controlling the expression of emotions during testing leads to an imbalance in the degree of intensity of psychophysiological reactions to control and relevant questions. Simplified, this process can be compared to the attempt of running through an obstacle; attempting to imitate a conditionally correct reaction to the obstacle (represented by a control or relevant question), leads to a general deterioration of health, an increase in energy consumption, which can be detected by WelcomEU systems. Because of this reason, the reaction to any neutral question is also quite intense. By analogy with the jump: the higher one had to jump (the degree of hostility caused by the control or relevant question), the greater the height to fall from will be (reaction to a neutral question).

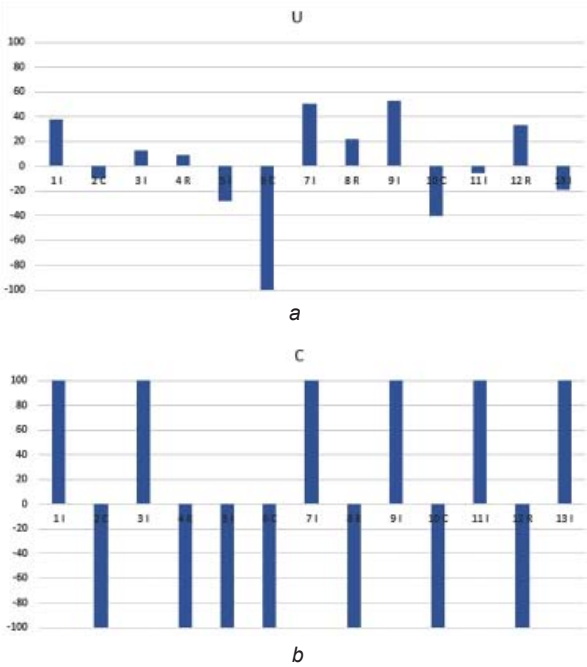

Fig. 1. *a* and *b*. Profiles of components of political credibility (U — unconscious reaction, C — conscious reaction, answers YES/NO) (Minkin&Nikolaenko, 2017)

Analysis of the conscious reaction (fig. 1B) shows that the screened person consistently gave negative answers to all control and relevant questions (Minkin, 2019a). At the same time, the analysis of the unconscious reaction (fig. 1A) shows that not all control and relevant questions received negative PPR, but only the control questions. The most unpleasant was 2, the control question under serial number 6C. The intensity of the reaction to the 2nd control question is 3 times higher than the intensity of the reaction to any of the relevant (R) questions. When C > R it can be said that the person quite sincerely answered control questions and their conscious reaction coincides in meaning with the psychophysiological (unconscious) reaction.

In the analysis of conscious and unconscious responses to the questionnaire one sees that the unconscious human responses are the fastest, spontaneous and most decisive reactions when reacting on fast stimuli. The conscious responses are decisive for making decisions on non-spontaneous stimuli in time. Both of these psychophysiological reactions determine a person's personality; the analysis of only one component cannot characterize a person (Minkin, 2019b).

	U1	C1	U2	C2	U3	C3	Σ|U|	Σ|C|	Σ|UI|	Σ|CI|	ΣU	Σui	Res	Res'
C	-10	-100	-100	-100	-40	-100	50	100	73	200	50	73	NDI	NDI
R	9	-100	22	-100	33	-100	21	100	55	200	21	55		
Ic	12	100	50	100	-5	100	23	100					NDI	
Ir	-28	-100	53	100	-19	100	33	100						

Fig. 2. CRI tab, analysis of PPR for control (C), relevant (R), neutral or Irrelevant (I) — questions (WelcomEU, 2019).

Fig. 2 Caption: U (1, 2, 3) — PPR for 1,2,3 control (C) or relevant (R) questions; C (1, 2, 3) — conscious answer YES/NO to 1, 2, 3 control (C) or relevant (R) questions; Ic — Irrelevant after the control; Ir — Irrelevant after the Relevant; Res is the averaged result of PPR comparison to the control (C) and relevant (R) questions; Res' is the averaged result of PPR comparison for control and neutral (Ic), for relevant and neutral (Ir).

This information is presented in more detail in the digital equivalent of histograms, in the CRI tab, fig.2. Consider it in more details:

Method 1. Traditional comparison of the PPR to the control (C) and relevant (R) questions within the pair. The average PPR for control questions have values (50%), and the average PPR for relevant questions matters (21%). Therefore, the PPR for control questions is more than relevant, the result (Res) indicates that the person is telling the truth (NDI) and is politically loyal, not inclined to extremism in the extreme forms of its manifestation i.e. terrorism.

Method 2. Comparison, between couples, the first couple PPR for control (C) and neutral (Ic), the second couple the relevant (R) and neutral (Ir) questions. In method 2, the PPR is added between control question and the neutral question following it, then the second PPR is added between relevant question and the neutral question that follows it. After that, a comparison of the couples amounts received. In the given example, the sum of the PPR control with neutral is 73%, and the sum of the relevant

with neutral is 55%, hence the second assessment of the control question is also greater than the relevant (Res').

Thus, a double check of political loyalty was carried out: the traditional way of comparing the PPR to the control (C) and relevant (R) questions, within the pair (method 1), and the comparison of PPR to the control (C) and neutral (I), relevant (R) and neutral (I) questions (method 2). The results coincide. Upon completion of testing with the help of WelcomEU, a database is formed of 11 files containing detailed information on the dynamics of the PPS throughout the test (Excel_M file) — information that is undoubtedly useful for profilers in solving controversial issues. You can estimate the ratio of negative (aggression, stress, anxiety), positive, and physiological reactions (inhibition and neuroticism), as well as the degree of their variability/resistance.

Conclusions

Modern security systems include various means of identifying the emotional state and intentions of a person in order to potentially predict his behavior. WelcomEU, based on vibraimage technology, can be considered as the most modern technical profiling tool, with conscious and unconscious control of political loyalty. Currently, the WelcomEU system is being tested in Russia and in EU (Cyprus). The profiling system contains a reference to the European Union (EU), and it can, after successful implementation of the technical and specific requirements, be implemented as the most powerful biometric tool for monitoring migrants and passengers at border or immigration controls worldwide.

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SPECIAL CHARACTERISTICS OF TESTING CHILDREN BY THE PSYCHOPHYSIOLOGICAL PROFILING SYSTEM USING VIBRA_MI PROGRAM

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Annotation: *A group of children aged 6 to 9 years underwent a test that was performed using VibraMI (a program produced by Elsys Corp., St. Petersburg, Russia). The results of psychophysiological profiling revealed some features of children's answers to the questions of the questionnaire Gardner12S5, which affect the reliability of the test results.*

Keywords: *Testing, vibraimage technology, children, profiling, psychophysiology.*

VibraMI program is implemented on the basis of Howard Gardner's multiple intelligences theory (Gardner, 1983). The author of the concept of multiple intelligences offers an alternative approach to the general intelligence, as measured by classical IQ tests. Gardner's multiple intelligences are equal and independent of each other. Each of the basic intelligences represents its own special way of interacting with the surrounding reality, a person's ability to solve problems or pose new problems valuable within a given or several cultures.

In recent decades, the authority of intelligence tests, which measure total IQ, has been steadily decreasing. Studies in various fields show that IQ points reflect only the "zone of actual development" — that is, what a person knows at a given time, and not "the zone of proximal development" (Vygotsky, 1982) — the ability to learn, acquire knowledge in a certain area (Ganin, Nikitina, 2009; Anastasi, Urbina, 2009).

VibraMI (Minkin&Nikolaenko, 2017) is a human psychophysiological testing program (PPT) based on vibraimage technology (Minkin&Nikolaenko, 2008; Minkin, 2017), which is based on the real-time conversion of the object's video light image into the image formed by accumulated frame difference.

The analysis conducted by VibraMI (VibraMI, 2019) program is based on the comparison and processing of a conscious reaction to the questions and presented stimuli (Yes/No testable answers) together with the subconscious human psychophysiological response determined by vibraimage technology. The questions and stimuli presented are sequentially grouped by personality type, according to the interpersonal intelligence model (MI):

1. Intrapersonal (IA)
2. Philosophical (PH)
3. Logical-mathematical (LM)
4. Business-mercenary (BM)
5. Visual-spatial (VS)
6. Naturalistic (NL)
7. Bodily-kinesthetic (BK)

8. Musical-rhythmic (MR)
9. Ascetic-Sacrificial (AS)
10. Verbal-linguistic (VL)
11. Creative (CR)
12. Interpersonal (IE)

Materials and Methods

Testing was conducted with children aged 6 to 9 years using VibraMI program manufactured by Elsys (St. Petersburg, Russia). The questionnaire used was Gardner12S5, which is designed to test children using the psychophysiological profiling system.

In the process of testing, it was required to answer 24 questions.

The test results are presented in the form of various text and graphic files showing the leading types of intelligences and types of professions in which these types of intelligences will develop in the most comfortable conditions. VibraMI program uses the principle of dichotomy, as a logical division of a class into subclasses, where the dividend concept is completely divided into two mutually exclusive ones. According to this concept, each type of intellect must have an opposition:

1. Intrapersonal (IA) — Interpersonal (IE);
1. Philosophical (PH) — Creative (CR);
3. Logical-mathematical (LM) — Verbal-linguistic (VL);
4. Business-mercenary (BM) — Ascetic-sacrificial (AS);
5. Visual-spatial (VS) — Musical-rhythmic (MR);
6. Naturalistic (NL) — Bodily-kinesthetic (BK).

The questions are structured accordingly: from 1 to 12, they characterize the first 6 types of intelligences, and questions 13 to 24 characterize oppositional types of intellect. It is assumed that these are mutually exclusive types of intelligences and the answers to the questions should correspond to this.

For example, if to a couple of questions:

5 I think well. I love numbers;

6 I like to solve problems and examples;

a child answers YES, which corresponds to the Logical-mathematical type of intelligence, then to the questions:

19 I'd rather say something than count;

20 I can talk about everything in the world;

the child should not respond affirmatively, since these questions are related to the Verbal-linguistic type of intelligence, which is oppositional to the Logical-mathematical type of intelligence, and therefore they are mutually exclusive.

However, as the test results showed, the answers of children at this age most often correspond not to personal preferences, but to what adults expect from them. The development of a personal or collective form of responsibility is very important. Of great importance for children of this age is praise; this is in every way developing and encouraging pre-school and school education based on a system of rewards

for achievements — letters, grades, gifts. On the basis of the developed reaction of receiving pleasure from encouragement, children respond positively to those questions that correspond to the activities in which they have success. Consider a few examples:

Julia, 7 years old, is engaged in dancing, music, painting. The resulting profile generally reflects all of these directions, see figure 1 and table 1.

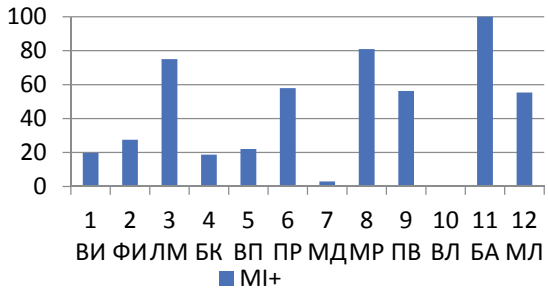

Fig. 1. The results of the diagnostics MI profile by questionnaire Gardner_12S5

Table 1

Julia's maximally developed MI intelligences

n	%	MI abb	MI type
1	100	CR	Creative
2	81	MR	Musical-rhythmic
3	75	LM	Logical-mathematical

Marina, 8 years old, is engaged in dancing, music, painting. The resulting most developed MI types (table 2) also generally reflect all of these areas.

Table 2

Marina's maximally developed MI intelligences

n	%	MI abb	MI type
1	100	CR	Creative
2	97	LM	Logical-mathematical
3	89	MR	Musical-rhythmic

Elena, 6 years old, is engaged in gymnastics, music (see table 3).

Table 3

Elena's maximally developed MI intelligences

n	%	MI abb	MI type
1	100	LM	Logical-mathematical
2	91	MR	Musical-rhythmic
3	87	CR	Creative

All three profiles, in general, are similar in areas of interest and types of intelligence. These are Creative, Musical-rhythmic and Logical-mathematical types. All these three types of intelligence are presented in the profiles of girls, only changing places. However, we were interested in the presence of Logical-mathematical type of intelligence in all profiles. If the creative and Musical-rhythmic types of intelligences belong to the arts (social) profile, then the Logical-mathematical type of intelligences belongs to the technical (natural) profile.

Let us look into the last example in more detail. According to the results of testing, the recommended «broad scope» are purely technical areas: information technology and communications, natural sciences, mathematics and statistics, management, business and law.

VibraMI program gives us the opportunity to compare the results of the conscious and unconscious responses of children when answering the questions of the Gardner_12S5 questionnaire.

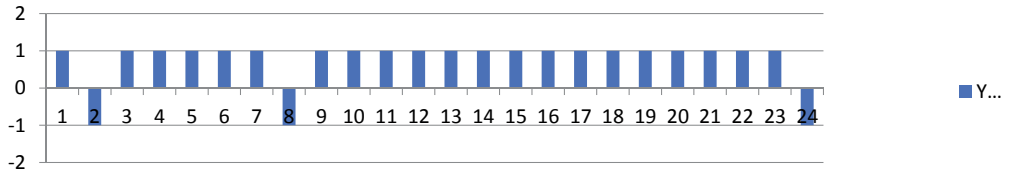

Fig. 2. The results of Elena's conscious responses when answering 24 questions of the questionnaire Gardner_12S5

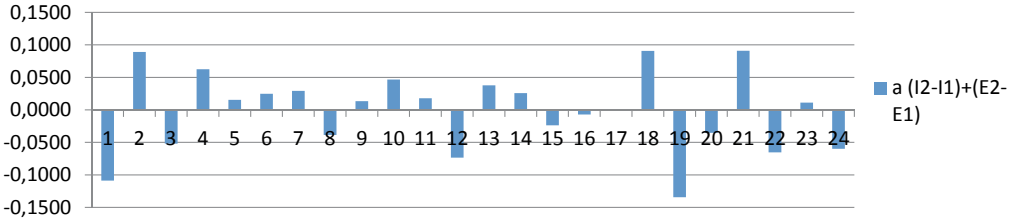

Fig. 3. Quantitative assessment of Elena's unconscious responses when answering the 24 questions of the Gardner_12S5 questionnaire

An analysis of the results of a conscious reaction confirms the above findings about the motivation of children in answering the questions of the questionnaire and give us little information. Since practically all the questions have been answered positively, with the exception of the answers to the following questions:

2. Parents' advice annoys me;
8. It is better to just take things from friends, — my own will be safer;
24. I can pose a question to a stranger.

These answers completely fit into the picture of "proper upbringing": parents must be obeyed, taking things from others is bad, and approaching strangers is forbidden.

Evaluation of the results of the psychophysiological reaction of children when answering questionnaire questions allows to partially avoid imposed labels. However, here the role of the one who directly evaluates the test results is very important. In this example, we evaluate the results of the answers to questions 5 and 6 in figure 3.

5. I can count well. I love numbers;
6. I like to solve problems and examples.

The answers are both positive, but we can evaluate their qualitative and quantitative degree (which is a huge advantage of VibraMI program). Both answers show a low degree of emotional response. Dad knows mathematics well and tutors his daughter day and night, and they have already begun to solve examples for 9-years-old children. Accordingly, the girl has already accumulated fatigue from these activities, but she is currently better in math than her peers, for which she is constantly praised at home. Apparently, for her good results the girl gets presents. Therefore, in this case, we are dealing with a technical profile imposed by parents, and not a natural one.

Conclusions

Testing of children aged 6 to 9 years (Sentsov, 2018) showed that direct diagnosis of abilities in the examination mode is unacceptable for children of preschool and primary school age. Due to the lack of life experience and the strong influence of external factors, the child, as much as they would like to, cannot demonstrate the available palette of abilities and their depth. Therefore, it is initially necessary to diagnose the sphere of interests of the child based on their psycho-physiological state using VibraMI program produced by Elsys (St. Petersburg, Russia). This approach will help avoid the imposed labels.

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FORECASTING STUDENTS' PROGRESS AT UNIVERSITY EDUCATION BY TESTING MULTIPLE INTELLIGENCES USING VIBRAIMAGE TECHNOLOGY VIBRA_MI PROGRAM

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Annotation: *A practically oriented model for solving the problem of students abilities matching the profile of an educational institution using vibraimage technology is suggested. The results of testing the profile of multiple intelligences for 84 first-year students of ETU LETI, St. Petersburg, Russia are given. The criteria for assessing the success of education in a technical university for students based on a profile of multiple intelligences are developed.*

Keywords: *human resource (HR), abilities, vibraimage technology, multiple intelligences, hidden motivation.*

In our previous study, the problem of conformity between abilities and chosen specialty was considered (Minkin, 2017; Akimov et al., 2018). 161 first-year students of Saint Petersburg Electrotechnical University (LETI), Russia were tested in 2017 year for this research. The profile of multiple intelligence (MI) (Gardner, 1983) was analyzed by vibraimage technology to forecast the progress of first-year students. That testing illustrated the perspectives of estimating student's academic progress by VibraMI program (Akimov et al., 2018). The prevalence of technical profile over humanities and of Logical-mathematical MI over all other MI types were found. At the same time, it remained unclear whether the results obtained were merely a tendency typical of a technical university, or they could be explained by a situational factor. More extensive research is required to confirm or deny the hypothesis of connecting several types of MI with certain profession (specialty). On the one hand, 2018's research is the continuation of the project from 2017. On the other hand, it was expanded by researching the factor of testing person's hidden motivation to miss University's classes. Manipulative behavior (in Odintsova's version — "rental behavior") is a wide-spread external stimulus, which could give unclear or perverted interpretation of test's results. Manipulative behavior always involves hidden motivation to get some advantages and profits without any purpose (Odintsova, 2010).

The aim of 2018 student's research was to check how manipulative behavior with hidden motivation to miss classes could influence the results of MI testing.

Methods and Participants

Students were tested by VibraMI program (VibraMI, 2017). This program for psychophysiological testing (PPT) of a person is based on vibraimage technology — transformation of the light video imaging to the image that was formed by frame

difference accumulation in real-time. Vibraimage technology and multiple intelligences theory are combined by dynamic approach to human's parameters research. In context of human research, vibraimage technology analyzing the motion activity (micromotions) of human head and transform the motion's parameters to the psychophysiological state's (PPS) characteristic. Using in material of (Minkin&Nikonaenko, 2017), linearly opposed system of questionnaire, permit to transform conscious answers and recorded changes of PPS to multiple intelligence profile. Thus, the practical task to determine accordance of student's abilities to changed specialty's profile is realized.

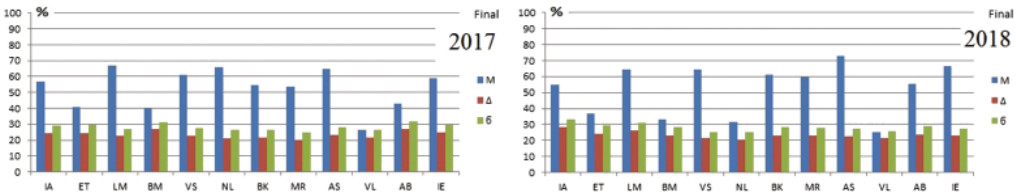
For the period from 11.20.18 to 10.12.18, 84 first-year students of the Faculty of Physics and Technology LETI were tested, sall in the age range 17–20 years, 29 women and men. The ethnic composition is homogeneous: 100% Russians.

1. Materials

In 2017 all students of Faculty of Computer Science and Technology (FCST) LETI were suggested to pass a test. Students were informed about time and place to do it. In 2018 experimental conditions had some changes. Standard pre-test briefing was expanded by information that pass the test could "person, who wants". Therefore, the concept "all students" was replaced by "students work who wanted" to miss institution lessons.

2. Comparative analysis of first-year student's multiple intelligences profile for 2017–2018 year.

On figure 1 is given comparative MI profile of 2017 and 2018 years testing



a *b*

Fig. 1. MI profiles of FCST LETI first-year student's multiple intelligence in 2017 and 2018 years

Matching of common MI profiles in 2017 and 2018 demonstrated differences in the rating of leading MI's type. Logical-mathematical type in 2017 was the first (67%) over the Natural (65.5%) and Ascetic-Sacrificial (64.6%) MI types (fig. 1a). But in 2018 Logical-Mathematical MI type is only on the third place (66.9%). At the same time, Ascetic-Sacrificial (72.6%) and Interpersonal (66.5%) types are on the first and second places (fig. 1b). There are two same values in the percentage of Logical-Mathematical MI types in two independent selections for two years, but there are

differences in the profile structure. This fact correlates with the hypotheses about impossibility to make a conclusion about abilities to technical sciences or humanities only based on high percentage of one MI type. It is also impossible to talk about abilities to master some specialty basing it on raw data of percentage of one or another MI types.

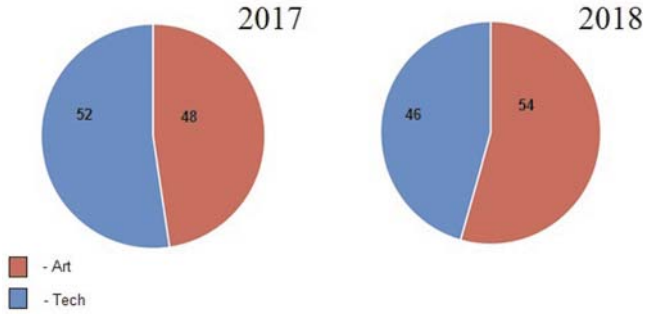


Fig. 2. Arts and technical profiles ratio for testing students in 2017–2018 years

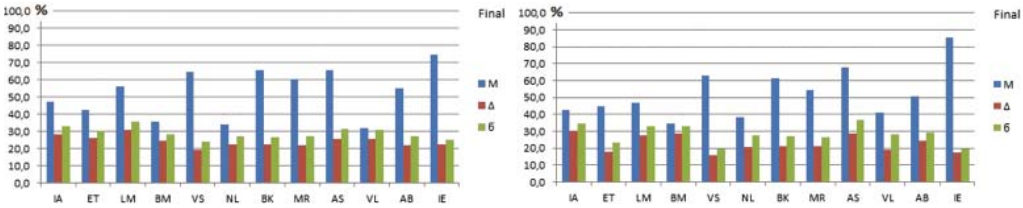
In VibraMI MI types disposition suggested that types with numbers from 1 to 6 refer to the technical profile and with numbers from 7 to 12 — to the humanitarian. Matching results of tests in 2017 and 2018 illustrated an increase of humanitarian profile over technical ones (from 48% to 54%), (fig. 2). Therefore, this confirms a theory that it is impossible to draw any conclusions about the presence of the abilities for technical subjects or humanities based on the "raw" data on the Logical-Mathematical MI type percentage.

Test results illustrated that students with weaker technical abilities had hidden motivation to miss classes. At the same time, mathematically gifted student with high level on Logical-Mathematical MI type preferred studying to testing.

3. MI profile's comparative analysis based on Unifed State Exam (USE) results and first exams in different groups

84 students, who have been tested by VibraMI, were divided into 3 groups, based on the USE and first exam results, same as in 2017. Summary results of the USE were the measurement of progress's estimation. Students were divided into 3 groups. In addition, based on first exam results students were divided into 3 more groups, depending on passing 4 exams and having has the permission to take them. The first group (1) contained students with the least progress — average rating less 3 of the first exams. The prohibition to exam estimated by zero. The second group (2) contained students with average rating from 3.01 to 3.99. Student with average rating over 4 were in the third group (3).

It was observed, that 3 groups based on the USE results are much different to the groups, based on first exams results (1C). Let us match results of the USE and 1C in group 1.

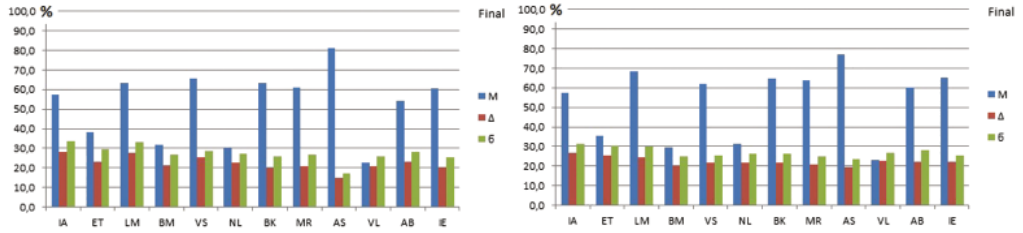


a *b*

Fig. 3. MI profile in group 1, based on USE (*a*) and 1C (*b*).

Description of said MI types placed in the monograph (Minkin&Nikolaenko, 2017). Analysis of the USE results in group 1 (students with least progress) illustrated the dominance of interpersonal MI type (74.7%). Second and following places are (in descending order): Bodily-Kinesthetic (65.9%), Ascetic-Sacrificial (65.4%) and Visual-Spatial (64.6%) types (fig. 3a). Logical-Mathematical MI type is on the 6th place in the group of the lowest USE results (56.1%). Matching USE results with first exam results, another disposition of MI types was found: Interpersonal (85.3%), Ascetic-Sacrificial (68%) and Visual-Spatial (63%) (fig. 3b). Logical-Mathematical MI type is on the 7th place (47%) (in 2017 it was on the 5th place — 58.4%). On the one hand, Logical-Mathematical goes from 6-th to 7-th place in the MI types hierarchy, but on the other hand, the difference in its rating is rather large — 56.1% and 47%. Thus, vibraimage technology is a more sensitive instrument to find mathematically gifted students than the USE (general USE results of some mathematically gifted students were very low).

The comparison of the data from group 1 in 2017 and 2018 demonstrates that Logical-Mathematical MI type dropped from 58.4% (2017) to 47% (2018). These results confirm the fact that tested persons had hidden motivation to miss the classes, and the weakest students were tested. Let us consider results in group 2 (middle rating):



a *b*

Fig. 4. Group 2 profile of multiple intelligences, based on the USE (*a*) and 1C (*b*)

According to the results of group 2, Logical-mathematical MI type is on the third place (63.2%), whereas Ascetic-Sacrificial (81%) is the first and Bodily-Kinesthetic (63.3%) is the second (fig. 4a). These results are in correlation with the first exam results. Logical-Mathematical MI type of student from group 2 goes to

the second place (fig. 4b). Ascetic-Sacrificial (77.1%) is traditionally on the first place, while the third position is occupied by Interpersonal type (65%). In.general, group 2 is significantly more successful than group 1. This trend is independent on combination of initial data (fig. 4 a, b). It seems, that student with a medium progress is a person, who had some external life circumstances, which were the reason for them not to become the most successful, despite their good potential. The same trend is in 2017 tests: Logical-Mathematical MI type is the second (66.1%) by the USE results and on the first place by 1C results. Thus, students with medium progress had not hidden motivation to miss classes (as opposed group 1).

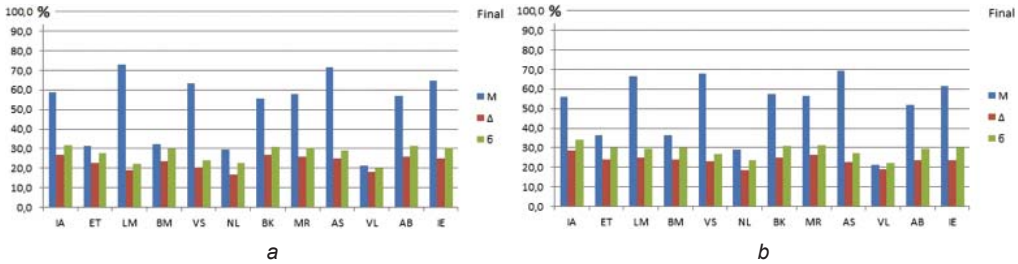


Fig. 5. Group's 3 profile of multiple intelligences, based on USE (*a*) and 1C (*b*)

On the first place of MI types in group 3 (highest progress students) is Logical-Mathematical (73.1%), the second is Ascetic-Sacrificial (71.5%), then Interpersonal (64.9%), (fig. 5a). After first exams, MI types disposition changed: the first became Ascetic-Sacrificial (69.3%), the second — Visual-Spatial (67.9%), then Logical-Mathematical (66.5%), (fig. 5b). In 2017 Logical-Mathematical MI type was the third and by the USE results, and by the results of first exams. This result gives a possibility to suggest that group 3 (student with highest progress) in 2018 are weaker by their potential that students from group 3 in 2017. The most obvious suggestion is that the most successful students had not tested, because they prefer to visit classes.

Conclusions

The test illustrated yet again the potential of student's progress estimation by VibraMI program. In 2018 research, it was decided to verify if rental behavior can affect the results of the testing of multiple intelligences. It shows that hidden motivation could influence test results, but to a different extent. Students with least progress (group 1) are the most sensitive to the hidden motivation to miss classes in comparison with the students from group 2 (medium progress). However, the results from group 3 (students with the highest progress) could not be compared with the results from group 1 and 2, because the most gifted students had not been tested.

To sum up, the developed VibraMI method can be successfully used to choose a University, that is suitable to individual's abilities of each person and its MI profile.

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CUSTOMER SATISFACTION LEVEL MONITORING BY VIBRAIMAGE TECHNOLOGY

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Abstract: *Experimental studies of changes in the parameters of the psychophysiological state (PPS) of a person using vibraimage technology have been carried out. An equation for assessing the satisfaction level of a person's PPS as the difference between the next and previous PPS is proposed. A psychophysiological explanation of the research results is given. A cybernetic model for assessing the current level of happiness is proposed.*

Keywords**:** *vibraimage, satisfaction level, level of happiness, psychophysiological state, cybernetic model of emotions*

Currently, quite often, there are tasks that require an objective assessment of changes in the psychophysiological state of a person. For security systems, it is necessary to be able to assess the negative characteristics of a person, such as the level of aggression, anxiety, stress, as well as the general level of danger that this person represents to others at a given moment (Minkin, Tseluiko, 2014). However, there are more tasks that require an assessment of the positive characteristics of a person than those requiring the assessment of negative qualities, especially that each emotion or psycho-physiological characteristic can be only conditionally divided into positive and negative. Charles Darwin claimed that all emotional states were of evolutionary origin (Darwin, 2001), and the Nobel laureate Konrad Lorenz (Lorenz, 1966) believed that aggression is the most necessary characteristic of any biological species for its survival. Since the development of cybernetics, as "the scientific study of control and communication in the animal and the machine" (Wiener, 1946; Bernstein, 1967), it has been proposed to use physical and informational parameters to assess the psychophysiological state (PPS) of a person. Before the advent of vibraimage technology (Minkin, 2000, 2007, 2018), such a cybernetic approach focused on the human was more theoretical, although many researchers of the 20th century came close enough to the possibilities of its practical application (Wiener, 1946; Anokhin, 1966; Simonov, 1986; Polonnikov, 2013). The task of determining the level of happiness is quite popular in the east, and it was not by chance, for example, that a Ministry of Happiness was appointed in the UAE in 2016. As is customary in classical psychology, an attempt was initially made to estimate the level of happiness using questionnaires (Lambert L., Pasha-Zaidi N., 2015). However, psychological questionnaires assess only conscious responses of a person to the stimuli presented, and a conscious reaction is not always objective. The development of the second generation of vibraimage systems with synchronous control of conscious and unconscious responses of a testee (Minkin&Nikolaenko, 2017) created prerequisites for developing psychophysiological systems capable of solving the problems of measuring parameters for any psychophysiological state, conditionally positive and conditionally negative.

The aim of this work was to study changes in the PPS and to determine the level of a person's satisfaction, depending on the known stimuli or in the absence of acting stimuli.

Materials and methods

In order to study the changes in the PPS in a quasi-stationary state, we consider the results of 200 tests, registering the responses of 5 programmers at work to asynchronously generated stimuli (40 tests per person). Programmers were monitored by VibraMed10 program (VibraMed10, 2019), the age of the operators was 21–25 years old, and the testing was conducted in 2019 using computers with an IntelCore I7 processor, and a Microsoft LifeCam Studio webcam with image format of 640×480. The illuminance of the testees was within 500–700 lux, the head of the testee horizontally was at least 200 elements, and the image quality indicator in VibraMed10 software exceeded 60%. The duration of each test was approximately 380 seconds.

To study PPS changes under the influence of external stimuli, let us examine the results of testing a group of 200 first-year students of the St. Petersburg Electrotechnical University, LETI (age 17–23 years old, M: G-80; 20) to questions from VibraMI programs with the Gardner12T questionnaire (Minkin&Nikolaenko, 2017; VibraMI, 2019). Testing was conducted on a computer with an IntelCore I7 processor, with a Microsoft LifeCam Studio webcam with an image format of 640×480. The illuminance of the test subjects was within 500–700 lux, the head of the testee horizontally was at least 200 elements, and the image quality indicator in VibraMI and PsyAccent programs exceeded 80%. The duration of each test was approximately 380 seconds.

The main measured parameters of a person are information efficiency of physiological systems and energy consumption, the calculation formulas of which were proposed earlier (Minkin, 2018; VibraMed10, 2019, Minkin et al., 2019). The parameter of the PPS changing (dP = P2–P1) is considered to be the parameter of a person's satisfaction level. A positive value of said parameter indicates positive changes in the PPS, and a negative value of said parameter indicates negative changes.

Results

Typical results of changes in the PPS, measured by vibraimage technology when testing subjects without the influence of external stimuli, are shown in figure 1.

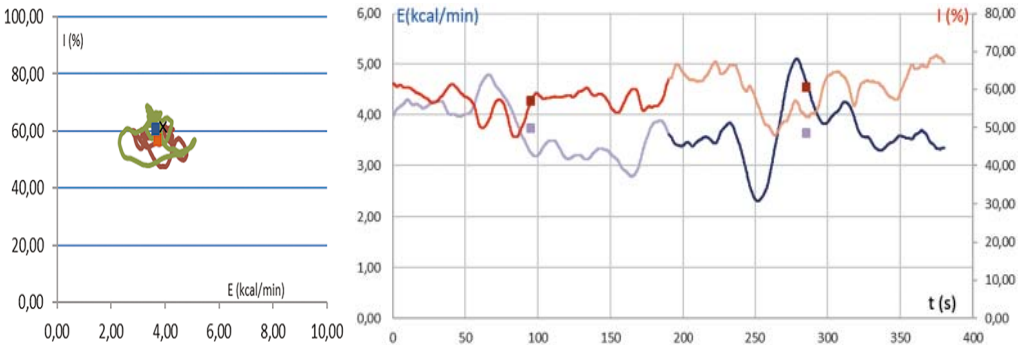

Fig. 1. Typical free changes of information and energy parameters without external stimuli

Typical results of changes in the PPS, measured by vibraimage technology and a line-opposite questionnaire presented to the testee, are shown in figure 2.

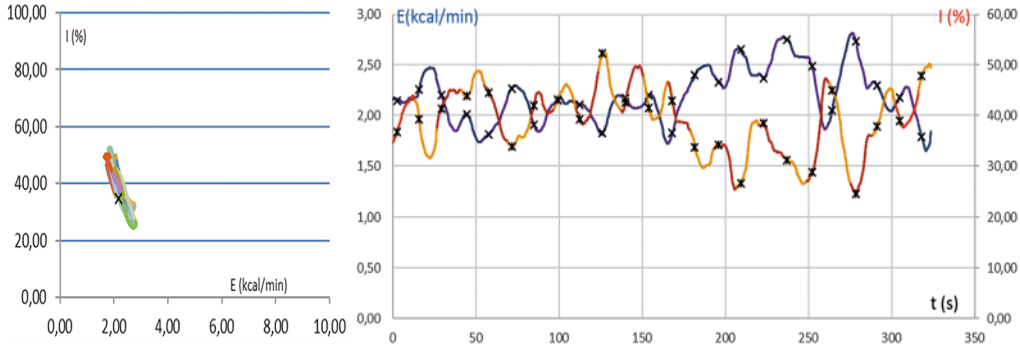

Fig. 2. Typical changes of information and energy parameters during presentation of line-opposite questionnaire to the testee

VibraStat (VibraStat, 2019) program calculated the average level of PPS changes during the testing for the first and second groups of testees. For the first group of tested individuals, $dP_1 = 0.000\%$. For the second group $dP_2 = +6.12\%$

Results discussion

The studies presented are of a comparative nature. They were carried out with the same equipment and identical software on testees of approximately the same age and identical sample size data. At the same time, the results of the first sample showed a zero change in state between the first and second halves of the testing time, and the results of the second group showed a significant positive change in the psychophysiological state. It is logical to assume that there is an objective reason explaining the difference in the results obtained. The fact that the averaged state of programmers does not change during the testing time is quite understandable, since, despite the constantly emerging external stimuli and reactions to them, on average and statistically they should be differently directed, therefore, a significant change in the PPS is observed on a significant sample. A similar result was obtained with less testing time for the free state of a person (Minkin, 2019).

With regard to testing the multiple intelligences of students, then most likely, students were apprehensive about the testing being conducted; this is the same natural fear of any new ordeal. At the same time, in the process of testing, students began to understand that, in fact, nothing terrible was happening, the questions are of a general nature, and their mood and the PPS began to improve in the process of this realization. Thus, the second half of the test (again, on average), took place in a better mood and psychophysiological state, which showed a positive change in the PPS by 6.12%.

It can be said that the students left satisfied with the test results, therefore, the proposed method can be considered applicable to various tasks, for example, determining customer satisfaction during short conversations. At the same time, the following factors should be taken into account. Firstly, the evaluation of the PPS should not be less than 3 minutes, otherwise the natural mechanism of regulation of brain activity will affect the result (Fleishman, 1999; Minkin, 2019). With considerable testing time (more than 10 minutes), other factors (fatigue, loss of concentration, and others) may influence the process of determining the result; therefore, the proposed method should be recommended for testing in the range of 3–10 minutes. In the work (Minkin, 2019) it was shown that during hour-long studies of the subject, the drift of individual psycho-physiological parameters could reach 10%. The used evaluation of the PPS according to the level of information efficiency and energy expenditure of the subject allows to evaluate not only the relative change in the parameters of PPS in percent, but also the absolute values of the measured parameters in conventional or physical units of measurement. From the point of view of Darwin's evolutionary theory, any organism tends to spend less energy, while maintaining maximum information efficiency. Therefore, the measured informational efficiency of the physiological systems of a person and the energy consumed by a person are the main indicators of a person's current level of happiness at the time of the study.

Conclusions

The results of this study show the ability to control changes in the PPS and the measurement of the human satisfaction level using vibraimage technology.

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Part 4. VIBRAIMAGE TECHNICAL ISSUES

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TYPICAL ERRORS OF VIBRAIMAGE TECHNOLOGY USERS

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Abstract: *This study outlines the basic principles and knowledge necessary for users to correctly and accurately operate systems based on vibraimage technology. The importance of such factors as the necessity of the initial verification of the hardware, its compliance with the necessary requirements, configuration and installation, as well as the competence of the installer and operator is demonstrated. Recommendations are given for the situations when the system is operated under various conditions. The reasons for the possible decrease in the accuracy of the measurement results, or their complete unreliability are described. It is recommended to avoid typical errors that can affect the accuracy of the result and regularly check the state of the hardware and software for compliance with the specified parameters.*

Keywords: *vibraimage, causes of errors, accuracy of results, settings.*

Vibraimage developers always get feedback from the users and system customers, and have compiled statistics about frequent user errors. Typical errors, the reasons of their occurrence and methods of elimination are presented in this report. This information will be useful for partners, customers and resellers of VibraImage Systems, as well as for operators and technical support specialists. Vibraimage system (Vibraimage) is based on vibraimage technology (Minkin&Nikolaenko, 2008; Minkin, 2017) and is designed for recording, analyzing and researching the psychophysiological state (PPS) of a person, quantifying emotion levels, lie detection, psychophysiological diagnostics and remote detection of potentially dangerous people. The first step is acquisition of input data. The system uses a video fragment, which can either come directly from a video camera or from a videofile. The amount of input information, the duration of the video and its quality are very important to calculate accurate results. The next step is video analysis using special algorithms, in accordance with the settings made by the operator. Finally, the system displays the results of the analysis for operator to observe, creates a text document with the report, or starts some action (alarm, etc.). In practice, errors can appear at any of these steps, and it is extremely important to avoid them during system operation.

1. The hardware errors

Already at the step of choosing the hardware, it is necessary to pay attention to the requirements specified in the system user manual (VibraImage10, 2019). To work with each specific vibraimage system, descriptions dedicated to a specific

system (VibraMA, 2019; VibraMed, 2019; VibraMI, 2019; VibraMid, 2019; VibraPA, 2019; Vibraimage PRO, 2019; VibraStat, 2019) should be used. It is required to correctly select a video camera, as well as correctly choose a place and method of its installation, to exclude negative factors as much as possible. Errors may occur during the camera installation process. For example, installing the camera on a vibrating or oscillating surface, mounting it on top of the laptop screen, or placing it on the table. The movements of the test subject or operator can reach the camera through the table. In some cases, cameras can be installed in public places. In such situations, they can be affected by vibrations transmitted through buildings, for example, vibrations from trains at stations, or from elevators and escalators in shopping malls. The cameras should be mounted on a solid base or a tripod that provides sufficient stability (figs. 1, 2).

In some cases, low-quality video may be coming directly from the camera. This can occur for various reasons: poor quality of the camera, low image quality settings, using codecs that significantly reduce the quality. The same applies to the errors in video files obtained from unknown sources or stored independently by third-party programs (fig. 3, 4). Therefore, the quality of the incoming video should be carefully monitored visually and using special tools included into the system and described in the manual (VibraImage10, 2019).

In addition, it is necessary to remember that modern video cameras have automatic functions. These functions can provide a good image for domestic purposes, but not always compatible with vibraimage system. For example, parameters such as autofocus, auto exposure or auto noise reduction (meaning the suppression of digital noise in the image) can adversely affect the results.

Fig. 1. Laptop vibration is transmitted to the camera

Fig. 2. Heavy tripod is better that laptop for camera installation

Fig. 3. Low quality video

Fig. 4. Quality normal for the system

Therefore, users should disable all automatic functions of the camera (depending on the specific situations, the installer partially enables the auto functions system), while monitoring the relevance of the camera settings before starting the experiment or after restarting the system (fig. 5).

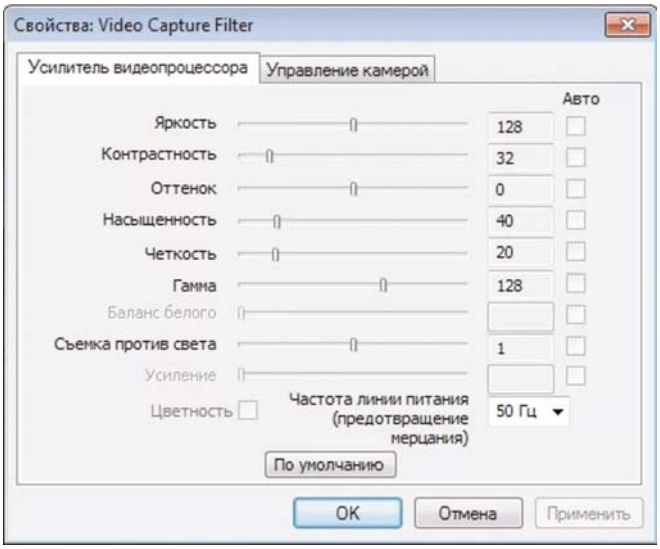

Fig. 5. All automatic parameters are disable

Vibraimage users should also pay attention to the relevance of these settings. In some cases, these settings can be reset when you reconnect the camera or restart the computer, depending on the manufacturer or type of camera. It is also a common mistake to use a computer with low performance. In this case, there may be a situation when a high CPU load occurs, which can significantly distort the measurement results. In this case, some of the video input frames may be lost, along with important information for correct analysis. Therefore, it is necessary to choose a system with

good performance. Consulting the requirements specified in the user manual and ensuring that the processor load does not exceed 70% (fig. 6) will help avoid such problems.

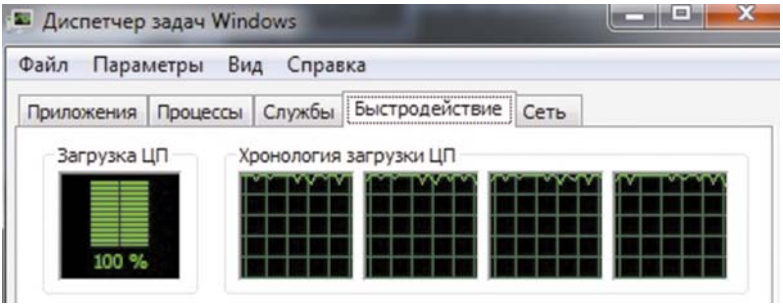

Fig. 6. High CPU loading

The frame skipping or low input frame speed failures may also occur because of certain hardware features. For example, in case of using network cameras, it is possible that the infrastructure is not capable for transmitting a video stream. To avoid this error, it is recommended to control the number of input frames with built-in tools, and, if necessary, optimize the network infrastructure or upgrade the hardware. Another problem is the erroneous removal of the protection key during system operation. In this case, if the system worked, it stops working and does not start until the key is returned. Therefore, it is necessary to instruct the operators and explain the purpose of the key. Additionally, it is possible to integrate the key into the body of the device to prevent any interference.

2. Operator's error

In order for It is necessary to install all the necessary components in accordance with the user manual for a particular software product to start the system and work with it successfully. Otherwise, the system will not start or can work incorrectly. Details on eliminating installation errors can be found in the user manual (VibraImage10, 2019) or additional articles (VibraMA, 2019). This error is purely technical. Operators often allow a situation when a person or persons are located in the frame incorrectly. To get correct results, it is necessary to carefully monitor that the person or persons in the frame are located in accordance with the requirements detailed in the description for the system. To avoid this error, it is recommended to use the automatic quality control function (fig. 7), monitor the correctness of the position of the object, and provide training, allowing the operator to independently detect errors of this kind. Operator should be able to understand influence of the error on the result and stop the experiment if it is necessary. For example, if during a video recording for lie detection someone distracts a person in the frame, if the frequency of input frames drops critically, or in case another person passes in the background. It is possible

that the automatic error control function signals a low video quality, but the research continues. Of course, in this situation, it is unlikely to get accurate results, and it is necessary to restart the experiment.

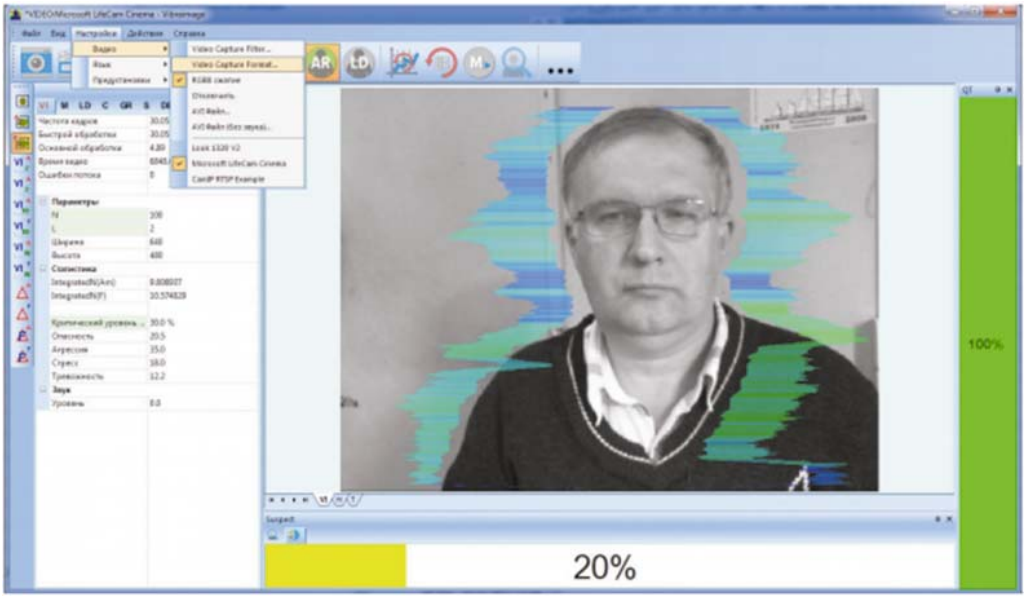

Fig. 7. System shows that the quality is good

In certain scenarios, analyzing video in real time without a recording can be considered an error. It is better to record a video file during important experiments so as to make it possible to run the same test, but with different system settings.

3. Settings errors

Modes that are designed to work with many people in the frame and those that are designed to work with one person in the frame, work differently. The most accurate results can be obtained if you work optimally. For example, if you use the «Micro» mode when there are several people in the frame, results will be not very accurate. With several people in the frame, it is necessary to use the specially developed «Mix» or «Macro» modes. Another very frequent mistake is working with the «Macro» and «Mix» modes with wrong choice of face detection algorithm or with wrong settings. It is crucial to choose parameters that are suitable for a particular system configuration. This is influenced by many factors: camera angle, light, number of people in the frame, size of the room, etc. An example of this would be choosing the face detection mode intended for filming a person positioned sideways to the camera, when all people in the frame are facing this camera. Of course, often an operator tries to change the system settings without

having a complete idea of the impact this may have on the result. In such cases, detailed personnel training should be conducted in accordance with the level required to operate with the system. At the same time, more superficial knowledge will be sufficient for an operator to work with the «Macro» mode, rather than working with lie detection. In some cases, it is required to block the ability to change important parameters, or to conceal the interface that allows to change them. The system settings should be recorded in a separate file if they differ from the default settings. Only a joint analysis of the system settings along with the recorded video can establish the reasons for a possible error in the operation of the vibrating image system or incorrect user actions.

4. Integration errors

Vibraimage technology allows to integrate it with other security systems, or to write your own application using video analysis algorithms based on this technology. An SDK and a brief for developers (VibraMed, 2019) with the necessary information were developed for this case. As practice shows, frequent problems during working with the SDK are not technical competencies, but a poor understanding of the system's basic principles and important principles of working with technology. To avoid difficulties during developing software that uses algorithms of vibraimage technology, it is important to carefully study and understand all the requirements for the input video, as well as evaluate the feasibility of the project. For example, the idea of positioning a camera on a moving car to scan a crowd with high accuracy seems to be unrealistic. It is possible to use a special API that allows to develop customer applications. You can receive video analysis results from the server in a special format. For software engineers, the technical component is also not complicated. However, as is the case with the SDK, it is crucial to understand the purpose of this tool and the limitations of the technology to avoid difficulties in project implementation.

In some cases, it is necessary to combine several computers with installed vibraimage systems into a network (fig. 8). For example, it can be useful to solve the problem of processing video from several cameras and displaying the results of the analysis to a single operator. To implement such architecture, special solutions were developed (VibraMI, 2019).

In this case, there are also errors associated with hardware solutions for organizing the structure (for example, network bandwidth does not allow transmitting uncompressed lossless video; issues with the type of cameras and the way they are installed, etc.) and logical errors, as well as errors in setting up the program part of the solutions. In any case, all these errors are reduced to either those already mentioned in this article, or are the result of a misunderstanding of the basics of technology.

Thoughtful reading of information about the technology, its areas of application and basic requirements will help to maximize the opportunities of the SDK, API, and network solutions.

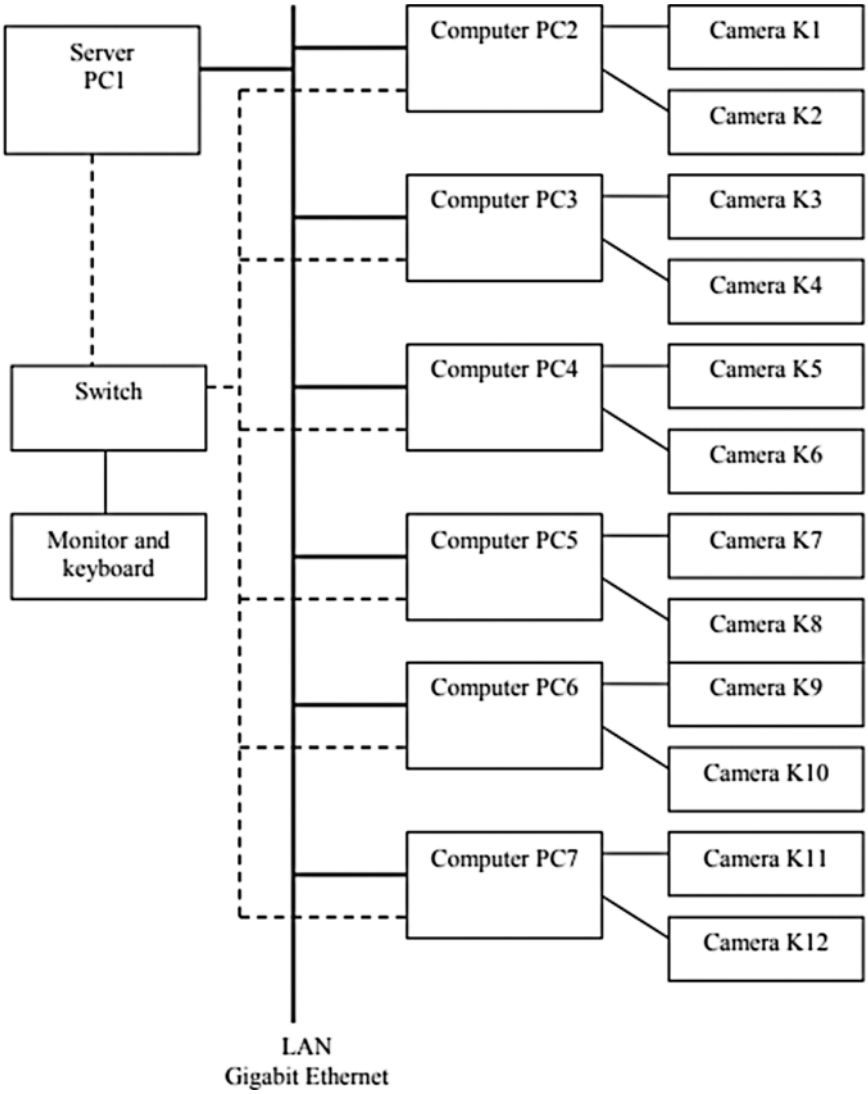

Fig. 8. Network configuration example

Conclusions

For correct operation of software products based on Vibraimage technology, it is extremely important to understand the basic principles of the system (Minkin, 2017; VibraImage10, 2019; VibraMA, 2019; VibraMed, 2019; VibraMI, 2019; VibraMid, 2019; VibraPA, 2019; Vibraimage PRO, 2019; VibraStat, 2019;VI10 SDK, 2019; Vibraimage network software, 2019), which allow to avoid other errors that are not described in this article. At the same time, special attention should be paid to

the training of operators and users. Trainings should fully give an idea of the basic requirements for working with the system.

In addition, before starting any research or collecting information about several subjects, it is necessary to check the correctness of the video and system settings.

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COMPARATIVE ANALYSIS OF VARIOUS ALGORITHMS FOR VIBRAIMAGE CAPTURING

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Abstract: *An experimental study to determine vibraimage by means of mathematical algorithms has been carried out. Test video images of different contrast were developed, making vibrations in the frequency range (1–10) Hz with different displacement resolution. The comparison of Fast Furrier Transformation and Frequency VibraImage algorithms (FFT and FVI) for calculation of object movement frequency by parameters used in vibraimage technology is carried out.*

Keywords: *vibraimage, algorithms, software processing, performance, measurement accuracy, FFT, FVI.*

Vibraimage technology (Minkin&Shtam, 2008; Minkin&Nikolaenko, 2008; Minkin, 2017; 2018 *a*, *b*) converts streaming video by software processing into two different image components that reflect the amplitude and frequency characteristics of object vibrations and movements in frame. Vibraimage technology uses the generated amplitude and frequency images of objects to obtain additional information about said objects. In the case of a living object monitoring, it can be different psychophysiological characteristics, in the case of control of a non-living object, it can be mechanical or reliability parameters. In the general case, the initial amplitude and frequency vibraimage of an object obtains in various ways. The basic principle of vibraimage capturing is maximum information content for solving the set task with minimal operating power and cost. Initially, the following formulas were proposed to obtain the amplitude and frequency components of vibraimage. The amplitude component of each vibraimage point (Minkin&Nikolaenko, 2008; Minkin, 2017) calculates by the equation (1):

$$A_{x,y} = \frac{1}{N}\sum_{i=1}^{N}\left|U_{x,y,i} - U_{x,y,(i+1)}\right| \tag{1}$$

Where: x, y — the coordinates of the point;

$U_{x,y,i}$ — signal value at the point x, y in the i-frame;

$U_{x,y,(i+1)}$ — signal value at the point x, y in the $(i + 1)$ frame;

N — is the number of frames for which the amplitude component of vibraimage is accumulated.

The frequency component of each vibraimage pixel (Minkin&Nikolaenko, 2008; Minkin, 2017) is calculated with the equation (2):

$$F_{x,y} = \frac{F_{in}}{N}\sum_{i=1}^{N}\left\{\begin{array}{l}\left|U_{x,y,i} - U_{x,y,(i+1)}\right| > 0 : 1 \\ other : 0\end{array}\right\} \tag{2}$$

Where: F_{in} — video signal processing frequency.

The amplitude and frequency components of vibraimage are parallel video streams, similar in format to the original video signal. Each frame of the amplitude and frequency component carrying temporal and spatial information about the past of this video stream, limited in time by the number of accumulated frames for frame difference N. Vibraimage technology converts these video streams into primary vibraimage parameters (Minkin, 2017, 2018a, b). Primary vibraimage parameters converts into informative parameters of an object under study, depending on a study purpose. At the same time, the developers of vibraimage technology had a clear understanding that the proposed formulas for calculating the amplitude and frequency components are inherent in the real vibraimage, rather than ideal (Minkin, 2017), which should reflect the movement parameters of all points of the object. This was especially so for the frequency vibraimage (FVI) defined by the equation (2), which reflects the frequency of recorded changes in the signal in each element, and does not reflect the actual frequency of the signal in time for each element. With the similarity of these characteristics, the numerical values obtained for each of these methods may differ significantly.

Of course, the developers of vibraimage technology know that it is possible to measure the frequency of the signal change at each point of the image using the Fast Fourier Transformation method (Heideman et al., 1984), for example, using the equation (3).

$$X_k = \sum_{n=0}^{N-1} x_n e^{-i2\pi kn/N} = \sum_{n=0}^{N-1} x_n w^{-kn}, \quad k = 0,..., N-1. \tag{3}$$

At the default settings for a period of 100 samples with a frame frequency of 30 Hz, corresponding to a time of 3 seconds, the measured frequency of the signal at the selected point X (for example, determined by the fast Fourier transform, FFT or DFT) should have a value of no more than 15 Hz (in accordance with the Kotelnikov-Shenon-Nyquist theorem (Nyquist, 1928; Kotelnikov, 1933; Shannon, 1949), for example, 10 Hz with a signal period of 0.1 s. The calculation for the same settings for the frequency of a signal change of an element according to the formula (2) can give a different value, since the frequency of the signal change does not depend on the signal period, but on how many times the signal change is recorded, i.e. from the signal-to-noise ratio of the photodetector. At the same time, it is impossible to say which of the calculation algorithms is more correct, since both of them have their own limitations. However, is possible definitely say that the algorithm (2) is less powerful especially for large image formats. The high operational cost of the FFT algorithm was determined the choice of the developers of vibraimage technology on formulas (1) and (2) when developing vibraimage technology 20 years ago.

However, the progress of computer technology does not stand still and things impossible 20 years ago is now becoming feasible. The aim of this study is comparing by the tests the possibilities of equations (2) with (3) in order to obtain a vibraimage close to the ideal.

Method and experiment

To test FFT and FVI algorithms for obtaining vibraimage, several test videos with vibrating objects with different optical contrast, different frequency and amplitude of vibrations were developed. The test object is a rectangle measuring 50×30 elements, having a gradient of contrast on the edges and a uniformly gray middle part. The background around the rectangle in the test video is uniform and close to white (brightness 200). The total size of the test video was 160×120 elements. The data on the frequency, displacement and gradient of test objects are shown in table 1. The duration of the test video files was 120 seconds.

Table 1

File	Gradient [1..20;21..30;31..50]	Background level	Displacement, pxl	Frequency, Hz
test_b_g5d1f010.avi	+5;0;–5	245	1	1
test_b_g5d3f010.avi	+5;0;–5	245	1	3
test_b_g5d3f030.avi	+5;0;–5	245	3	3

During the experiment, the created test objects were loaded into Vibraimage 10 PRO program (Vibraimage 10, 2019) and processed by various processing algorithms (2) and (3), focusing on the compliance of the real vibraimage with the ideal one and the load of the Intel Core i7-5600U CPU 2.6GHz.

Experiment results

The vibraimages of the developed test video objects launched in Vibraimage 10 PRO program and processed by the algorithm (2) is given on figures 1–3.

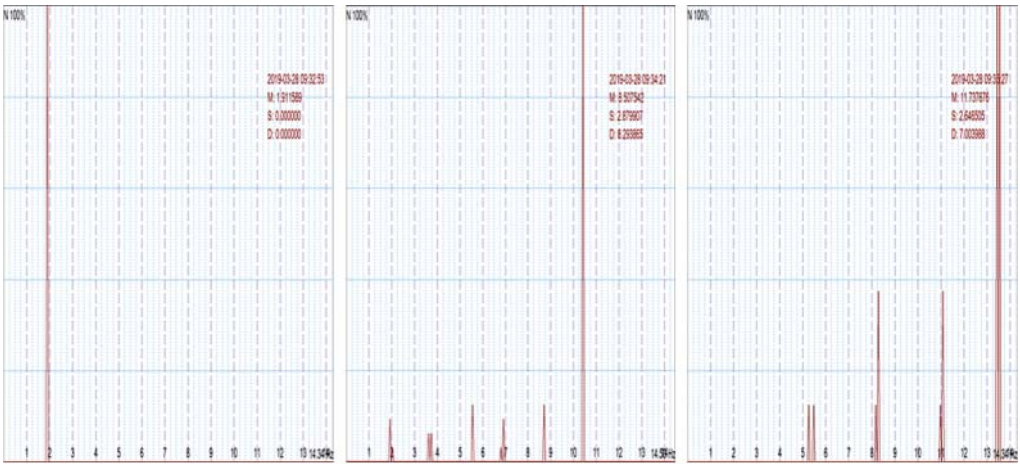
Fig. 1. test_b_g5d1f010

Fig. 2. test_b_g5d3f010

Fig. 3. test_b_g5d3f030

Where: VI — internal vibraimage;
AV — external vibraimage around internal vibraimage (aura-vibraimage);
AR — external vibraimage around real image (aura to real).

The corresponding frequency histograms for the three indicated test videos with a vibraimage determined by the formula (2) are given on figure 4.



test_b_g5d1f010 test_b_g5d3f010 test_b_g5d3f030

Fig. 4. Frequency histograms of test video processed by the algorithm (2)

The vibraimages of the developed test video objects processed by the FFT algorithm are given on figures 5–8.

VI AV AR

Fig. 5. test_b_g5d1f010

VI AV AR

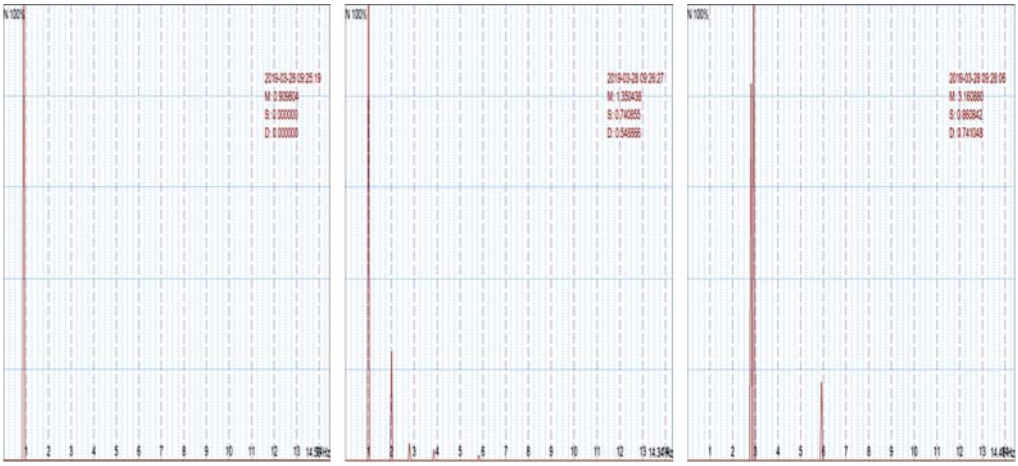
Fig. 6. test_b_g5d3f010

VI AV AR

Fig. 7. test_b_g5d3f030

The corresponding frequency histograms for the three indicated test videos with a vibraimage determined by the formula (3) are given on figure 8.

Table 2 shows the dependence of the processor load on the image format for vibraimage capturing by Vibraimage PRO 10 program for both algorithms with identical program settings.



test_b_g5d1f010 test_b_g5d3f010 test_b_g5d3f030

Fig. 8. Frequency histograms of test video processed by the FFT algorithm

Table 2

Algorithm \ Frame size	160 × 120	320 × 240	640 × 480
FVI	12%	15%	23%
FFT	33%	70%	>100%

Discussion

Consider the resulting figures 1–8. For the first test video (1 Hz frequency, 1 element offset), almost identical vibraimages are observed for both vibraimage (2) and (3) algorithms (figures 1 and 5).

At the same time, frequency histograms are quite similar, however, the stability of vibraimage by the equation (2) is the same as the stability of the FFT algorithm for first test video and differs for second and third test videos. Vibraimage stability indicator is standard deviation or S value on figures 4 and 8. For the second test video (frequency 1 Hz, shift 3 pixels), vibraimage determined by formulas (2) and (3) have significant differences. Despite the fact that the real frequency for this test video was 1 Hz, for the algorithm (2) there was an apparent shift in the frequency of vibraimage in the direction of increasing, due to the fact that the real object shift was 3 elements, and not 1, as the frame frequency of the survey was 15 Hz, and within 15 counts, each element of the test object made a movement in one and the other direction, returning to its initial position. Thus, the frequency of the signal change (8 Hz, fig. 4) significantly exceeded the real

frequency of the object's movement (1 Hz, fig. 8). Only on the edges of the test object vibraimage determined by the FVI algorithm coincided with vibraimage determined by the FFT.

For the third test video, a similar discrepancy was observed between the results of the FVI algorithm and FFT, and again the magnitude of vibraimage obtained by the FVI algorithm exceeds the magnitude of vibraimage obtained by the FFT algorithm. In this case, we note that both algorithms detect the movement of only optically contrasting objects. The middle of the test object, which has no contrasting details (uniform gray background), turned out to be invisible for both algorithms.

Conclusions

Vibraimage obtained by the FFT algorithm showed a greater accuracy in determining the real frequency of the object's movement than the traditional FVI algorithm. At the same time, the software power of supporting the FFT algorithm substantially exceed the traditional FVI algorithm. For full-format work with FFT, you must have processors with a capacity of about 100 times higher than the Intel Core i7-5600U CPU 2,6GHz used in this experiment. The development of processor technology allows us to forecast that such processors will be available on the mass market of electronic devices in about 6–8 years.

However, accurate knowledge of the movement frequency does not guarantee higher accuracy in determining the psychophysiological state by vibraimage technology. The number of detected vibraimage elements captured by the FVI and FFT algorithm is almost the same. Therefore, the number of detected vibraimage elements and methods of vibraimage parameters calculation determine the accuracy of the PPS parameter measurement. It remains an open question which vibraimage is more informative in terms of PPS detection, FVI or FFT? The answer to this question will be available soon, since processors with a capacity of 100 times more than i7 are already available on the current market, for example, the i9 processor. However, the research of the informativity of various vibraimages is the subject of another study.

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ON THE ACCURACY OF VIBRAIMAGE TECHNOLOGY

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Abstract: *This theoretical and experimental study identified the most significant errors of vibraimage technology. The experimental studies of vibraimage errors, including the study of random, systematic, methodological and instrumental errors, have been carried out. Methods for assessing the accuracy of the psychophysiological parameters measurements of the subject using vibraimage technology. The average resulting error in vibraimage measurements within ±6,1% was shown.*

Keywords: *vibraimage, psychophysiology, error, accuracy, measurement.*

Accuracy of measurement is the subject of the science of metrology. Each country has adopted its own metrological standards, which differ relatively little among themselves. Modern metrology is focused on the measurement of physical quantities. A physical quantity is one of the properties of a physical object (physical system, phenomenon, or process) that is qualitatively common to many physical objects and can be quantified (Metrology, 1999; JCGM 200, 2008). Measurement accuracy is one of the measurement characteristics that reflects the proximity to zero of the measurement result error (Novitski, 1975, Guide 99, 2007). Thus, it is possible to speak about accuracy only in relation to measurement, as the very question about the accuracy of a technology is inappropriate. This would be similar to asking about the accuracy of Ohm's law or the Fourier transform (Guide 99,2007). At the same time, the question "what accuracy does Vibraimage technology provide?" is asked by almost every user, hence the a priori erroneous title of this article, since it should be most familiar to the users of vibraimage systems. The measurement process is always a comparison with a measure (Novitski, 1975). However, standardized measures (standards) for measuring the psychophysiological state (PPS) do not currently exist, which makes the question of the accuracy of vibraimage technology even more difficult. In addition, it is not entirely correct to speak about the accuracy of the whole technology, since vibraimage includes measuring more than a hundred different parameters, which are measured with different errors (GOST 34400.1, 2017; JCGM 100, 2008). Despite these uncertainties, this article will attempt to discuss the accuracy of vibraimage technology.

From the above definition of measurement accuracy, it follows that accuracy is determined by various measurement errors. For some of the technical applications of vibraimage technology, the accuracy of measurements of the vibrations of mechanical objects depends on the errors in determining the parameters of the mechanical displacements of physical objects. However, most of the accuracy issues are related not to technical applications, but to the use of vibraimage technology associated with the determination of the PPS parameters or other characteristics of personality. It should be noted that modern science basically avoids the term "measurement" in determining

the characteristics of personality. Most researchers talk about "assessment" (Wilhelm, 2006), "detection" (Gunavan et al., 2018) or "recognition" (Chavan & Kulkarni, 2012) when it comes to human emotions, behavior, abilities or the PPS, although the term "measurement" is also used in psychology (Maus, 2009) and psychophysiology (Meiselman, 2016). There are certain reasons for this, since most psychological research is focused on the qualitative assessment of personality characteristics, while measurement requires a transition to the quantitative properties of an object. However, most psychophysiological technologies that use the measurement of human physiological parameters to determine personality parameters measure physical quantities (electrical signal for EEG, ECG, GSR, mechanical displacement parameters for vibraimage), which means that it is permissible to speak about the measurement of personality parameters.

The aim of this study is to explore and determine the basic errors of vibraimage technology during the direct conversion of the measurand (Novitsky, 1975).

Errors affecting the accuracy of measurement of the PPS parameters by vibraimage technology

Let us consider the main types of errors (Novitski, 1975) affecting the accuracy of the results produced by vibraimage technology, and try to evaluate them.

The instrumental error of vibraimage technology (the error of measuring instruments) includes the errors of measuring the mechanical movements of a human head or any mechanical object. The error parameters for determining the mechanical displacements (frequency, amplitude) depend on the accuracy of measuring instruments and measurement conditions. They are mainly determined by the parameters of the used television camera (dynamic range, temporal noise, contrast), which, in turn, depend on the brightness of an object and processor parameters (performance). Most of these technical parameters are included in the calculation of the quality indicator during measurements (VibraMed, 2019). When the quality indicator is close to 100%, the error of measuring instruments usually does not exceed ±5%, which can be checked by measuring the motion parameters of a test mechanical object having known motion parameters, for example, a fixed frequency of motion. In addition, to test the errors of mechanical displacements, test software objects were created and used for moving with a given discrete frequency of 1, 2, 4, 5, 6, and 10 Hz (Akimov et al., 2019; Vibraimage PRO, 2019). The law of distribution of the mechanical displacements error is close to normal with a quality indicator of 100%. The main ways to reduce instrumental error are the use of recommended equipment, compliance with the recommended measurement conditions and control over the measurement quality indicator, which is implemented in most programs.

Additional (complimentary) error in the measurement of human PPS is associated with the instability of the measured psychophysiological parameters themselves. Human physiological parameters change over time due to natural

causes, as well as under the influence of various external factors and stimuli. All vibraimage programs can be divided into two groups according to the principle of analysis of the PPS of a person. The first group of programs is intended for direct measurement of a quasi-stationary PPS without external stimuli. From the point of view of measurement theory, these are direct-conversion measuring devices. These include the programs VibraMed (VibraMed, 2019) and VibraMid (VibraMid, 2019), which correspond to the Micro and Macro modes in Vibraimage PRO version (Vibraimage PRO, 2019). The second group of programs (VibraMI, 2019; VibraPA, 2019) is intended for comparative measurement of changes in the PPS under the influence of presented stimuli. According to the theory of measurement, these are measuring devices of a balanced transformation (Novitski, 1975). If emotional instability is a problem and an additional error for the programs of the first group, then for the parameters of the second group, the emotional instability of the subject leads to an increase in the measured PPS differential and a decrease in this error (Minkin&Nikolaenko, 2017). Studies show significant instability of most physiological parameters (Minkin&Myasnikova, 2018) and the possibility of changing within 10–20% even during short testing from one to seven minutes. The error of instability of the measured value directly affects the resulting error, especially for the programs of the first group. The most effective method of reducing this error and other random errors is averaging the results. The average median value is more resistant to significant outliers, so this estimate is used in VibraMed program to determine the measured value of the parameter during the measurement time. The error in the instability of the PPS has a random distribution law, if there is no one-sided trend of changing the PPS during the measurement. It was experimentally established (Minkin&Myasnikova, 2018) that 1 minute is enough for the absence of a one-sided trend in changing the PPS, but a decrease in the testing time can lead to a significant increase in the error due to the instability of the PPS.

The methodological error (error of method) of vibraimage technology is determined, first of all, by the correctness of the proposed model for converting the mechanical parameters of head movements into psychophysiological or personal parameters of an individual. The transformation models were investigated during the development of vibraimage technology (Minkin&Shtam, 2008; Minkin, 2018; VibraStat, 2019) and are based on previous studies in the physiology of activity (Darwin, 1872; Sechenov, 1965; Pavlov, 1927; Bernstein, 1967; Lorenz, 1966). Currently, the evaluation of the accuracy of modeling the parameters of the PPS is of considerable complexity, because there are no alternative generally accepted and standardized methods for measuring the PPS. However, the openness and reproducibility of methods for determining the PPS parameters by vibraimage technology for all researchers allow to quickly adjust the developed methods. For example, for multiple intelligences, the Gardner-Minkin-Nikolaenko model (Gardner, 1983; Minkin&Nikolaenko, 2017) was adjusted after collecting statistics for more than 500 subjects (Minkin et al., 2019). Despite the seeming complete

uncertainty of the methodological error, it can also be assessed knowing the other measurement errors, the total measurement error, and the known laws of the distribution of measurement errors.

Method and Participants

In this study, the accuracy of vibraimage technology was assessed by two experiments.

In the first experiment, 100 measurements of one person's PPS were performed using VibraMed10 program (VibraMed10, 2019) installed on an HP EliteBook 840G2 computer with an i7-5600 CPU 2.60GHz processor with an externally connected MS LifeCam Cinema webcam.

Measurements were taken on January 30, 2019, for 2 hours from 11.00 to 13.00. The program settings of VibraMed10 are set to Micro by default, the resolution of the webcam is set to 640×480 elements. The subject was located at a distance of 40–50 cm from the camera, the size of the head of the subject in the image was approximately 200 elements. The illuminance of the subject was uniform, stable, and was 600 lux during testing. The LifeCam Cinema camera was located opposite the subject's face.

In the second experiment, 50 measurements of the same person's PPS were performed using the VibraMA program (VibraMA, 2019) installed on a Samsung Galaxy S8 mobile phone with a Snapdragon 835 processor with an integrated main camera. The measurements were carried out on February 4, 2019, for 2 hours from 11.00 to 13.00. The settings of the VibraMA program are set by default, the resolution of the camera is 800×480 elements. The subject was located at a distance of 40–50 cm from the camera, the size of the head of the subject in the image was approximately 200 elements. The illuminance of the subject was uniform, stable, and was 600 lux during testing.

Measurement results

Consider the results of computer-based testing of the PPSs (Table 1), with the measurement standard deviation (MSD) as the basic error estimate (Novitski, 1975) (experimental standard deviation) (JCGM 100, 2008), especially since it coincides with the standard deviation (SD), which is automatically determined by VibraMed10 program for each main parameter of vibraimage (T1–T10).

The data in Table 1 shows that the spread of the MSD between different parameters is from 1.34 for the parameter T6 of group 2 to 11.29 for the parameter T10 in group 1. The average value of the MSD over 100 measurements of the parameters T1–T10 was 4.34%. At the same time, the spread of the MSD for the same parameters between groups 1 and 2 is significantly less than the spread of the parameters of the MSD in each group.

Table 1

The results of 100 measurements of PPS parameters T1–T10 and I-E, divided into group 1 (first 50 measurements), group 2 (subsequent 50 measurements) and combined into one group. M — the average value of the parameters, б avg — the average value of the standard deviation in the group of measurements (SD), б (M) — measurement standard deviation (MSD).

PPS Parameter	M1 avg %	б1 avg %	б1(M) %	M2avg %	б2avg %	б2(M) %	M avg %	б avg %	б (M) %
T1	33,21	4,24	3,98	32,06	3,95	2,94	32,63	4,09	3,55
T2	31,24	3,76	3,28	29,28	3,69	2,43	30,26	3,72	3,05
T3	26,30	9,74	6,66	20,83	10,07	3,07	23,57	9,91	5,86
T4	30,69	4,05	3,60	27,82	3,86	1,56	29,25	3,95	3,12
T5	62,31	7,87	6,22	65,87	7,67	5,84	64,09	7,77	6,29
T6	72,21	2,01	1,91	70,75	2,14	1,34	71,48	2,08	1,81
T7	18,42	2,83	2,51	18,74	2,94	2,49	18,58	2,89	2,51
T8	67,28	4,28	3,49	68,32	4,17	3,12	67,80	4,23	3,35
T9	14,37	3,85	2,47	15,92	4,65	1,53	15,14	4,25	2,20
T10	38,45	14,23	11,29	46,46	18,35	10,67	42,46	16,29	11,69
E	28,81	2,46	3,14	28,35	2,75	3,05	28,58	2,61	3,05
I	47,95	6,10	5,67	51,66	5,47	5,14	49,81	5,79	5,14
dP	–0,02	0,00	0,09	–0,01	0,00	0,09	–0,01	0,00	0,09

Consider the similar comparative results of computer and telephone testing of the PPS (table 2), with measurement standard deviation (MSD) error as the basic error estimate.

The data in table 2 show that the spread of MSD between different parameters goes from 1.71 for the parameter T9 of group 1 to 11.69 for the parameter T10 in group 2. At the same time, the spread of MSD for the same parameters between groups 1 and 2 is significantly less than the variation of the parameters of the MSD, and the combination of groups 1 and 2 gives a large error (the average value of MSD = 6.1%), due to the addition of instrumental error.

For an accurate error estimation, it is necessary to know the law of changing for the measured value (Novitski, 1975). Most of the measured parameters T1–T10 are based on the calculation of the average frequency of vibraimage (energy characteristic) and the standard deviation of vibraimage frequency (information characteristic). Consider the distribution density of these values (fig. 1 and fig. 2) for computer and mobile measurement of the PPS.

Table 2

The results of 150 PPS measurements of the parameters T1–T10 and I-E, divided into group 1 (50 mobile measurements), group 2 (100 computer measurements) and combined into one group. M is the average value of the parameters, M is the average value of the parameters, б avg is the average value of the standard deviation of the measurement group, б (M) is the measurement standard deviation (MSD).

PPS Parameter	M1 avg %	б1 avg %	б1(M) %	M2avg %	б2avg %	б2(M) %	M avg %	б avg %	б (M) %
T1	49,00	3,54	5,04	32,63	4,09	3,55	38,09	3,91	8,74
T2	23,67	1,92	2,26	30,26	3,72	3,05	28,07	3,12	4,19
T3	21,59	7,97	3,75	23,57	9,91	5,86	22,91	9,26	5,33
T4	31,43	2,85	1,72	29,25	3,95	3,12	29,98	3,59	2,92
T5	71,56	3,76	2,92	64,09	7,77	6,29	66,58	6,43	6,45
T6	75,76	4,38	4,91	71,48	2,08	1,81	72,91	2,85	3,78
T7	36,99	2,94	5,52	18,58	2,89	2,51	24,72	2,90	9,47
T8	73,62	3,28	2,06	67,80	4,23	3,35	69,74	3,91	4,06
T9	22,15	3,12	1,71	15,14	4,25	2,20	17,48	3,87	3,89
T10	31,15	6,56	8,18	42,46	16,29	11,69	38,69	13,05	11,91
E	48,65	2,35	10,46	28,58	2,61	3,05	35,27	2,52	10,39
I	41,29	2,67	6,46	49,81	5,79	5,14	46,97	4,75	6,48
dP	–0,01	0,00	0,08	–0,01	0,00	0,09	–0,01	0,00	0,08

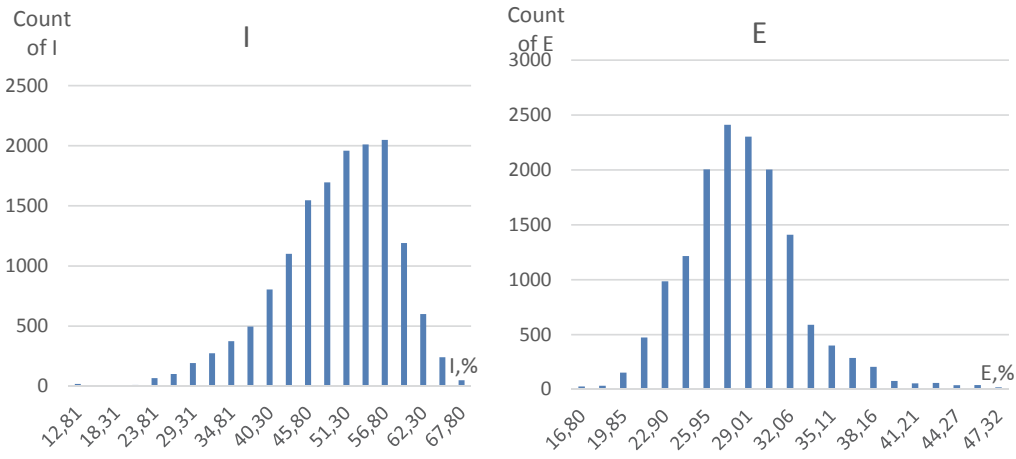

Fig. 1. Distribution of information and energy characteristics in computer measurements

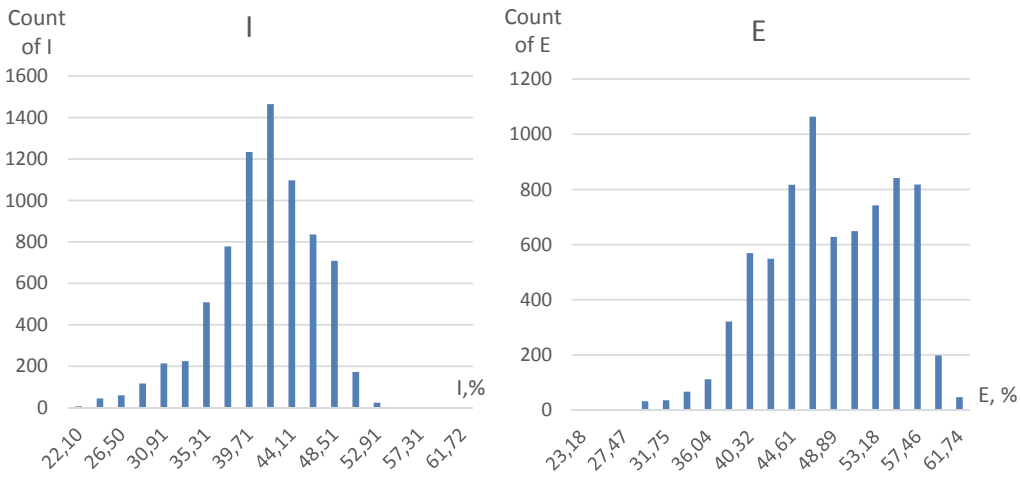

Fig. 2. Distribution of information and energy characteristics for mobile measurements

The given distributions are far from the normal distribution law, which most likely indicates the presence of not only random error in measurements, but also the presence of systematic errors in the captured data.

Discussion of the measurement results

We will try to understand how accurately we can determine the measurement error for the experiment performed. The main advantage of estimating errors by the standard deviation of the measured value is that the total standard deviation includes the sum of all errors of the standard deviation (Novitski, 1975, Shanon, 1946), and this is true for any law of distribution of the measured value in the absence of a correlation between the analyzed errors.

The existence of a correlation between the instrumental, additional, and methodological errors analyzed is difficult to predict; therefore, formulas 1 and 2 should be used to estimate the errors.

$$\boldsymbol{\sigma}_{\boldsymbol{\Sigma}}^2 = \sum_{i=1}^{n} \boldsymbol{\sigma}_i^2. \tag{1}$$

From this follows that in the presence of three basic errors, each individual of them will be less than the total. An individual error is determined by the formula:

$$\boldsymbol{\sigma}_1 = \sqrt{\boldsymbol{\sigma}_{\boldsymbol{\Sigma}}^2 - \boldsymbol{\sigma}_2^2 - \boldsymbol{\sigma}_3^2} \tag{2}$$

The number of measurements made for each measured value is approximately 150 counts for each PPS testing, and for 100 testings it is 15,000 samples, which makes it possible to estimate the accuracy of the measurements made with a confidence level no lower than 0.997. In the measurement theory, it is customary to estimate the limiting measurement error $\Delta = 2\sigma = \pm\sigma$ (Novitski, 1975).

Consider the results of table 2 comparative testing of PPSs on a mobile device (M1) and PC (M2) in the form of a histogram in figure 3, drawing attention to significant differences in the value of the measured mean values of the parameters M.

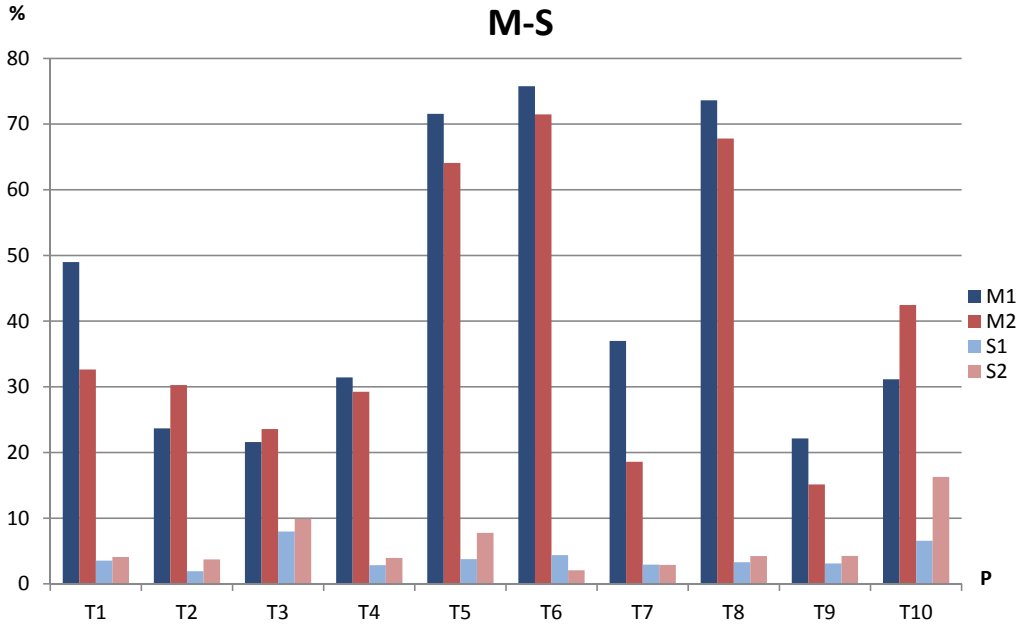

Fig. 3. The results of M and the standard deviation of 150 measurements of parameters T1–T10 PPS, divided into group 1 (50 mobile measurements) and group 2 (100 computer measurements). M is the average value of the measured parameters; S is the SD of the measured parameters.

The given values of M show significant differences that exceed the measurement error of the parameters within each group, primarily for the parameters T1, T7 and T10, i.e. indicate a noticeable instrumental error. To understand the causes of this phenomenon, it is necessary to move away from the theory of measurements to the technology of vibraimage. The main difference in the compared groups is the differences in the photodetectors used in this experiment. The Samsung S8 mobile phone uses a low-noise CMOS matrix made using the backside technology, the main advantage of which is increased sensitivity and low level of own noise. The LifeCam Cinema webcam is equipped with conventional CMOS (frontside), the sensitivity of which is about 4 times lower than that of the backside (Lesser, 2015). Vibraimage technology is based on the calculation of elements having a different signal level (Minkin; 2007, Akimov et al., 2019), so the threshold sensitivity of a photodetector is of primary importance when calculating the original vibraimage. For a contrast object, differences in the threshold sensitivity of photodetectors may not be as significant as in the analysis of a low-contrast human face. For a low-contrast object, its vibraimage while vibrating is directly proportional to the

threshold sensitivity of the photodetector, i.e. if a low-sensitivity photodetector with sensitivity S sees N changed elements, then a highly sensitive photodetector with 4S sensitivity sees 4N changed elements. Theoretically, such an increase in the number of elements does not have to affect the change in the average value, but judging by the experiment, the shape of the distributions (histogram of the frequency of vibrations) turns out to be different, the best camera sees more vibrations, and the average value of vibrations determined by the camera with high sensitivity and clarity is higher which is consistent with one of the basic principles of obtaining an ideal vibraimage (Minkin, 2008). The ideal vibraimage was explained as a vibraimage, in which ALL points with a changed signal are defined. Naturally, a better camera sees more points than the camera with worse parameters. That is why the parameters T1 and T7, the calculation of which is based on the average value of the frequency of vibrations, are higher in the group of mobile measurements with the best camera. Conversely, for the parameter T10, which determines the variation of the signal period of vibraimage, camera with the best parameters (sensitivity, clarity) is more stable and more accurately measures the value of vibraimage signal. Therefore, the parameter T10 defined on the mobile device shows a smaller value. The remaining parameters of vibraimage characterize the spatial and temporal characteristics of the vibrations, and they turn out to be not so sensitive to the total number of identified vibration points. For example, the parameter T3 characterizes the ratio of high and low vibration frequencies. This ratio is stable and does not depend on the total number of elements of vibraimage. As for the methodological error of the parameters of vibraimage, it is rather difficult to evaluate it at the present time, since there are no other generally accepted methods and standards for determining the psychophysiological parameters and the psychophysiological state of a person. Existing methods for assessing psychophysiological parameters provide only qualitative characteristics (Chavan, 2015), and measurement methods do not provide any accuracy indicators (Mauss, 2009; Meiselman, 2016). The standard for assessing the accuracy of psychological data (Standard, 2014) is based only on the processing of a person's conscious reaction and does not include psychophysiological responses. Therefore, the accuracy declared in it has no practical relation to the actual behavior and measurement of the human psychophysiological parameters.

Vibraimage technology, according to developers' reports, is the first open technology of psychophysiological detection, calculating ANY psychophysiological parameters using open algorithms (Minkin, 2000; Minkin, 2018; VibraStat, 2019, Minkin, 2019). This approach allows customers to adjust algorithms for measuring the PPS and minimize the methodological errors while receiving statistical results.

Conclusions

This study is practically the first comprehensive research and analysis of direct conversion vibraimage system errors. Separate studies of vibraimage errors were carried out earlier, although they were not identified as independent works. For

example (Minkin, 2017) analyzed the noise of various chambers (similarly to the analysis of instrumental error), and (Minkin&Nikolaenko, 2017) investigated the stability of the measured parameters in comparative testing (similarly to the analysis of the errors of the balanced conversion method in metrology).

The main objectives of this work were metrological examination of vibraimage technology, finding ways to improve accuracy for developers and developing proposals for reducing errors for users. The conducted research allows drawing the following conclusions:

1. The average value of the marginal error of measurements of psycho-physiological parameters was ±6.1% (without instrumental error ±4.3%). This value is a rather low value for measurement errors of psycho-physiological parameters compared to data from analogs (Shmelev, 2010; Kosti, 2017), the resulting error (20–50)%, which considers good results, indicates a highly informative vestibular-emotional reflex (Minkin&Nikolaenko, 2008) as an indicator of the PPS.

2. The instrumental error can make a significant contribution to the errors of vibraimage. The parameters of a television camera (sensitivity, clarity, dynamic range, temporal noise) have a significant impact on the result, for individual parameters the instrumental error can reach ±4%. However, when collecting statistics and obtaining verified dependencies of the PPS on the factor under study on one hardware, the instrumental error has only a minimal effect on the result. Therefore, users of vibraimage systems should collect their own statistics on specific hardware and use it when determining the parameters of the PPS. This allows to significantly reduce the instrumental error.

3. The systematic error is mainly determined by the additional error associated with the one-sided trend from changing the PPS under the influence of external factors (time, incentives); it is not eliminated by averaging the measurement results used in each test. However, the one-sided trend of changes in psycho-physiological parameters in the quasi-stationary state of the subject does not exceed ±3% per hour and rarely can be long in time. At the same time, the free oscillations of the PPS parameters in a short time (within a minute) significantly exceed the slow trend and can be up to ±10% for individual PPS parameters (the anxiety parameter in table 2), which does not allow for significantly reducing the measurement time without loss of accuracy.

Studies have shown that currently the technology of vibraimage has minimal errors in measuring the parameters of the PPS in comparison with the known analogues (Polonnikov, 2013; Gunavan, 2018). At the same time, there are significant resources to improve the accuracy in measuring individual parameters of the PPS. These reserves relate to the refinement of both hardware and software vibraimage.

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