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Vibraimage, Cybernetics and Emotions

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The monograph presents a new look at the cybernetic approach to the behavioral characteristics of personality. The classification of behavioral characteristics based on mathematical and metrological principles is proposed. Emotions and psychophysiological parameters of a person are determined by measuring physical quantities and physiological parameters of a person. It is proposed to use Pearson linear correlation as the classification feature that separates behavioral characteristics into emotions, psychophysiological parameters and consciousness parameters. Algorithms for calculating 12 emotional and 4 psychophysiological parameters using vibraimage technology are described. The density distribution functions of emotional and psychophysiological parameters given for the database of 10 266 tests. Open database on emotional and psychophysiological parameters includes test results of VibraMed, VibraMI and PsyAccent programs. Correlation dependencies (correlation matrixes and graphs) for all given behavioral characteristics are constructed and analyzed. The investigated databases of behavioral characteristics are publicly available.

The monograph intends for specialists in the fields of physics, mathematics, cybernetics, computer science, psychology, biology, physiology, vibraimage and biometrics, as well as a wide circle of readers interested in emotions, psychophysiological parameters, character traits, abilities, consciousness parameters and other behavioral characteristics of personality.

Includes 37 figures, 23 tables, 18 equations, 140 references.

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Much of the psychology of the past has proved to be really nothing more than the physiology of the organs of special sense…

Norbert Wiener

INTRODUCTION

This book summarizes twenty years of research on the emotional and psychophysiological parameters of a person by vibraimage technology. In the process of these studies, my idea of both vibraimage technology and man has noticeably changed, although people and their emotions have changed little over the past thousands years. It is naive to think and hopes that technological progress can quickly change the nature of man. In order to discuss such changes, one must first learn to objectively measure the characteristics of a personality, however technical progress has not yet reached this point. One of the cybernetics tasks as a science is to study the general laws of the processes of control and transmission of information in living organisms (Wiener, 1948), therefore, measuring the emotional and psychophysiological parameters of a person and determining the relationship between them is one of the directions of cybernetics. The founder of cybernetics, Norbert Wiener, in his classic work "Cybernetics: or Control and Communication in the Animal and the Machine" (Wiener, 1948) gave many examples directly related to the analysis of human behavior, for example, in the chapter Cybernetics and Psychopathology. At the same time, Wiener's analysis of the behavior and psychophysiological state of a person was descriptive, despite the fact that he emphasized that mathematical logic is the basis of cybernetics. Wiener's genius lies in the fact that he was the first scientifically substantiate the general patterns of information transfer using feedback in the control of complex systems — technical, biological or social. Similar unified approaches to biological

and technical objects (without using the term feedback) can be found in the earlier works of Sechenov (Sechenov, 1965), Darwin (Darwin, 1872), Freud (Freud, 1900), Pavlov (Pavlov, 1904; 1951) and Bernstein (Bernstein, 1967). After the appearance of Wiener's works, many researchers from different countries tried to find practical application of cybernetic principles in the study of humans and animals, for example, Anokhin (Anokhin, 1998), Lorenz (Lorenz, 1963), Mira y Lopez (Mira y Lopez, 1957), Simonov (Simonov, 1986), Polonnikov (Polonnikov, 2003; 2006; 2013). However, the lack of technology to objective measure human emotions deprived researchers the possibility of using the main cybernetic component — mathematical logic based on an empirical test of theoretical assumptions.

Vibraimage technology (Minkin, 2017) was originally developed as a technology for measuring the emotional and psychophysiological parameters of a person using mathematical formulas that convert motion parameters into psychophysiological parameters. In this it differs fundamentally from other psychophysiological detection technologies based on the measurement of known physiological parameters, such as frequency heart rate (HR), blood pressure (BP), galvanic skin response (GSR), or respiratory rate (RR) (Varlamov, 2010). The technical basis of vibraimage technology is information on the temporal and spatial movements of the human head, in terms of the amount of information processed — this is a huge data stream, the processing of which is limited only by the hardware capabilities. Over the past 20 years, the ability to transmit and process information has increased dozens of times, which has significantly increased the number of measured in real time emotional and psychophysiological parameters of a person. At the same time, of course, the number of applications of vibraimage technology is also growing (Minkin, 2019b), since the task of measuring the

psychophysiological state of a person turned out to be necessary not only for security technologies and for identifying terrorists, but also for many other areas, such as education, recruiting and medicine. The increase in the number of applications has allowed the creation of significant databases of emotional and psychophysiological parameters of people in various psychophysiological states. Mathematical analysis of the obtained databases of psychophysiological parameters allows us to review and recheck the existing assumptions about the norm and pathology, as well as the relationships between various emotional parameters, psychophysiological states and character traits.

The physiological basis of vibraimage technology is the vestibular-emotional reflex (Minkin & Nikolaenko, 2008a; 2008b; Blank et al., 2014). Starting with the works of a hundred fifty years ago Ivan Sechenov (Sechenov, 1965) and Charles Darwin (Darwin, 1872), scientists predicted that reflex movements mostly reflect the emotions and parameters of the psychophysiological state. However, before the invent of vibraimage technology, there was practically no possibility of automatic measurement of the reflex movements parameters of a person, which means that it was impossible to collect and analyze statistics on the dependencies between the emotions studied. From the point of view of biomechanics (Bernstein, 1967; 1990), it is enough to study some part of the human body in order to have information about all human movements. The developers of vibraimage technology did not accidentally choose the human head as the most informative object for tracking, since its vertical position in the Earth's gravity system is ensured by the continuous reflex work of the cervical muscles under the control of the vestibular system. 3D head movements are a rather complicated process (Lyapunov, 1950; Dugué, 2017) and it is almost impossible to determine all spatial movements using a flat image obtained

with a single camera. But stitching images of the human head from two video cameras to more accurately determine spatial displacements in real time is an even more difficult technical task. Therefore, the simplest and most logical way was previously proposed for determining various parameters of head movement that have minimal correlation between each other (Minkin, 2017), assuming that with the help of such parameters we will be able to accurately calculate all object movements. The specified mathematical approach to measuring head movements allows to comprehensively record all movements of a person's head with a single camera, since each measured parameter is responsible for a certain process of movements.

Currently, more than 200 parameters characterizing the emotional and psychophysiological states of a person are known (Ekman, 1999; Scherer, 2005). In modern scientific literature that studies behavior and personality traits, there is no clear distinction between emotions, psychophysiological parameters, character, and other personality traits (Darwin, 1872; Ekman, 1999); different researchers use different terms, since there is no single universally accepted approach to determining behavioral personality characteristics (Murik, 2005; Scherer, 2005). In biometrics, it is customary to divide all biometric characteristics into biological and behavioral (ISO/IEC 2382-37-2016, 2016). Initially, researchers divided the personality behavioral characteristics according to the rate of their change over time, quickly changing characteristics are considered to be emotions (for example, aggression or anxiety) (Ekman, 1999), and slowly changing personality characteristics (for example, extraversion, neuroticism) are called personality traits) or psychological types (Jung, 2016; Spielberger et al., 1983). However, this time division is rather arbitrary, almost all behavioral characteristics of the personality are dynamic characteristics,

interconnected and can change under the influence of external factors (Bradley & Lang, 1994; Chakraborty & Konar, 2009). It is difficult to expect that a person who is in an aggressive and calm state will have an unchanged level of neuroticism or anxiety, therefore, relatively slowly changing character traits cannot remain stable. In the next pages (until I offer my own definitions), I will use these three different terms (emotions, psychophysiological parameters, personality traits) given their historical applicability, although from the point of view of cybernetics and mathematical logic, they are more correctly combined under the same term behavioral characteristics, until they are clearly not delimited by definitions. In accordance with the cybernetic approach to humans, all behavioral characteristics — emotions, psychophysiological parameters and personality traits reflect the psychophysiological response of a person to stimuli. The essence of each behavioral parameter is determined by the formation mechanism and the equation for its calculation, and not by the term used to denote a behavioral characteristic like a label. In this regard, it was easier for physicists, since it was possible to introduce new terms when discovering new physical quantities. As for the characteristics of personality, there are so many of them that it's simply pointless to come up with new labels, we need to use the ones that are. It turns out that on the one hand, we have several hundred terms that characterize a person's personality. On the other hand, in vibraimage technology, there are several hundred parameters that characterize the movements of a person's head. Since in cybernetics any complex system is characterized by parameters, in the following chapters of this book I will divide the behavioral characteristics of a person into groups of parameters — emotional, psychophysiological, and consciousness parameters (or personality traits).

In my opinion, the task of converting the parameters of a person's head movement to known psycho-emotional and psychophysiological parameters comes down to finding the closest match between the determined parameters of the head movement and the known behavioral characteristics of the person (emotions, psychophysiological parameters, personality traits). Over the past 20 years after the discovery, vibraimage technology has been continuously developing, allowing measuring and evaluating new human characteristics. In the first monograph on vibraimage technology (Minkin, 2017), was described in detail the algorithm for calculating only two emotional parameters — Aggression and Stress. Modern vibraimage systems in real time calculate 16 emotional and psychophysiological parameters of a person, which will be discussed later. I think that it is time to describe in more detail the principles used in the analysis of the emotional and psychophysiological state, since at present the information on vibraimage technology is scattered across various publications and descriptions of programs (Minkin, 2017; 2019; Vibraimage PRO, 2019; VibraMI, 2019; PsyAccent, 2019; VibraMed10, 2019).

I hope that this book will be useful to users of vibraimage systems and specialists studying cybernetics, artificial intelligence, psychology, psychophysiological parameters and human behavior. Initially, I planned to write this book together with Doctor of Psychology Yana Nikolaenko, my co-author in a number of scientific publications (Minkin & Nikolaenko, 2017a; Minkin & Nikolaenko, 2017b; Minkin & Myasnikova & Nikolaenko, 2019). Different views of the authors on the problem under study, in my opinion, contributed to the objectivity of material presentation in the study of multiple intelligence (Minkin & Nikolaenko, 2017a). However, my conception of views on cyber psychology turned out to be too different from

traditional psychological approaches and it was necessary to refuse the presentation of versatile opinions in order not to violate the integrity of presented material. Although, perhaps, my engineering approach to a person as a physical object has led to some loss of a holistic picture of the psychology of emotions and personality characteristics.

In this book, I did not set the task of analyzing in detail various approaches to determining the characteristics of a personality, since there are many review publications on this subject (Bradley & Lang, 1994; Ekman, 1999; Rothmann & Coetzer 2003; Scherer, 2005; Gardner, 2007; Mauss & Robinson, 2009; Chakraborty & Konar, 2009; Meiselman, 2016; Gunavan et al., 2018; Ilyin, 2005; Murik, 2013). I tried to describe the possibilities of cybernetic approach and vibra-image technology, which allows using mathematical logic to indicate the general laws existing in the relationships between emotions, psychophysiological parameters, and personality traits of a person. It seems to me a real task to make cybernetic psychology the same exact science that studies man as physics and technical cybernetics. Then the success of cybernetic psychology development will be comparable with the technical areas of cybernetics, which ensure modern technological progress and IT development.

I believe that only cybernetic approach to a person, as to information-physical object, will make possible to understand psychology and human behavior. Text descriptions and subjective approaches to emotions and behavior should be a thing of the past. Math logics, digital measurements of physical quantities and generally accepted algorithms for determining the behavioral characteristics give the next level for understanding of emotions and psychophysiological parameters of personality. The readers of this book will judge how convincing are the presented arguments and study results.

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1. BEHAVIORAL CHARACTERISTICS OF PERSONALITY. EMOTIONS, PSYCHOPHYSIOLOGICAL PARAMETERS, STATES AND TRAITS

Each person considers himself a specialist in determining their own or others' emotions, and each scientist explores emotions based on their specialization and experience. Doctors and physiologists believe that the manifestation of emotions is determined by physiological parameters and suggest determining emotions based on the physiological, psychophysiological, functional or psychosomatic characteristics of a person (Sechenov, 1965; Murik, 2005; 2013; Chernorizov et al., 2016; Shu et al., 2018) reducing emotions to reflexes and instincts. The famous developer of the evolution theory Charles Darwin believed that emotions are the product of the evolutionary development of species (Darwin, 1872). Psychologists offer various classifications of emotions associated with independent human qualities, including using psychophysiological parameters in the form of independent axes to determine the emotional state or typology of a person's character (Russel, 1980; Jung, 2016; Eysenck, 1947). Psychiatrists believe that emotions should be studied by analyzing the conscious response to questionnaires (MMPI) of patients with pathological mental disorders (Schiele & Baker & Hathaway, 1943). Researchers involved in the practical analysis of emotions believe that emotions are measurable, distinguishable, and physiologically justified (Ekman, 1993; 1999). Many works on the emotions recognition are associated with an attempt of philosophically interpret emotions as a human characteristic opposed to reason and logic (Mulligan, 2009; Solomon, 1999). Eastern philosophy, in its own way, refers to the essence of human

emotions, connecting spiritual and physical processes into a single whole (Jain et al., 2015). In many ways, the eastern approach to human is close to cybernetic, which also relies on the interaction of various physiological systems in the human body through biological feedback (Wiener, 1948; Bernstein, 1967; Chakraborty & Konar, 2009; Scott, 2011). Thus, at present, there is a complete variety of approaches and opinions to the assessment and mechanisms of the emergence of emotions, psychophysiological parameters, psychological types, character traits and other behavioral characteristics of a person.

The first attempts to analyze emotions were made by philosophers of ancient Greece (Solomon, 2009), and a qualitative assessment in the study of psychological types of man was proposed by Hippocrates (Hippocrates, 1936). He was one of the first researchers of the archaic era who posed the problem of finding a measure of psychophysiological magnitude hidden in the person himself, features of his mental and physical organization.

The next significant step in assessing emotions, psychological types and psychophysiological states was made by the founders of analytical psychology, including James (James, 1884), Jung (Jung, 2016), Vygotsky (Vygotsky, 1925), Wundt (Wundt, 1867) and Eysenck (Eysenck, 1947; 1970). Studies have led to the development and justification of various classifications of psychological types and emotional states. The psychometric approach of Hans Eysenck, who proposed a method for the quantitative calculation of personality traits (extraversion, neuroticism, psychoticism) that form psychometric axes, has received significant practical application. Eysenck proposed several variants of questionnaires with a quantitative assessment on the scales of “neuroticism” (imbalance in the processes of excitation and inhibition of the nervous system) and “extraversion” — “introversion”

(directing of personality outward or inward), having real practical application. The subjectivity of the survey method forced Eysenck to resort to the introduction of a control group of questions assessing the sincerity of the subject, which made it possible to reject data with low reliability.

In the works of Wundt (Wundt, 1867) and Russell (Russel, 1980), the emotional factor becomes dominant in determining the psychophysiological state. It was near to transfer from macro level to micro level — basic affect in which emotion is a measure of a physical quantity. Most models of emotions are two-factor, as well as previously considered models of temperament and personality, the main parameters of which are the sign of emotion (positive / negative) and the level of activation (high / low). Wundt distinguishes three dimensions of emotions: pleasure — displeasure, calm — excitement, tension — discharge. Despite attempts at a quantitative approach to assessing emotions and the psychophysiological state, all these researchers relied primarily on a conscious reaction and psychological rather than physical scales for assessing a psychophysiological state of a person.

In Multiple Intelligences (MI) theory, Howard Gardner supposed that human brain includes several independent centers for accepting any solution (Gardner, 1983). Later Gardner added 5 minds as consciousness parameters and did not use the term intelligence for it. The term of minds is near to the term intelligences in the next Gardner's publications (Gardner, 2007). Independent centers in brain (intelligences or minds) must give uncorrelated conscious response to stimuli and I will develop this principle in the next chapters of this book.

Since psychological, physiological, and behavioral components are present in each psychophysiological state, in descriptions of the nature of behavioral states known from the prior art, one can find concepts from different sciences (general psychology, physiology, medicine, biology, labor

psychology, etc.). At the same time, there is no single point of view on the problem of the origin and measurement of psychophysiological states, since they are also sections of the personality dynamics, due to its relationships, many feedbacks, behavioral needs, motivation, goals of activity and adaptability in the environment and situation. The overwhelming majority of modern research methods of the current psychophysiological state of a person are aimed at assessing the already existing psychophysiological state without taking into account the dynamics, direction and nature of the change in this state during the observation period. So approach does not allow us to identify the onset of crisis conditions or the formation of uncontrolled emotions, as well as the creation of prerequisites for their occurrence. The impossibility of assessing the nature of changes in the current psychophysiological state of a person by methods of psychological questionnaires is due to the lack of practice and methods for simultaneously evaluating not only the nature of changes in any particular indicator (physiological or psycho-emotional) state of a person during research, but also their relationship. It makes possible to evaluate only one components of the psychophysiological state, either at the level of the psyche-motional state or emotions, or at the level of physiological (energy) reactions. Since said components are inextricably linked with each other, and the change in each of them is associated with a large number of internal physiological and psycho-emotional changes, as well as external influences on the person: psychological, physical, informational, etc. Then obviously, known methods analyzing only the conscious response of the subjects to the stimuli cannot provide a reliable analysis of the current changes in the psychophysiological state of a person. The lack of understanding of the mechanisms of information-energy interaction between physiological systems of a person under

the influence of changing external factors and the limited methods of objective measurement of information exchange between physiological systems of a person leads to the absence of generally accepted approaches for determining the behavioral characteristics of a personality.

To summarize this chapter, I want to emphasize once again, that researchers are using the terms as “emotions”, “psycho-physiological parameters”, “functional states”, “psychosomatic states”, “character traits”, “behavioral characteristics” as the qualitative characteristics of a personality. The boundaries between the above terms are quite blurred, and the choice of these terms is determined mainly by the specialization of the researcher.

2. CYBERNETICS MODEL OF HUMAN

The cybernetic approach to a person, a technical analogue (equivalent), which is a complex cybernetic or information-measuring system proposed by the founders of cybernetics (Wiener, 1948; Shannon, 1948; Bernstein, 1967, 1990), suggests the use of two basic concepts of "information" and "energy" to characterize an object of any complexity. Despite the obviousness of this approach, from the point of view of characterizing the current psychophysiological state of a person, it has not been used in practice to date. While the characteristic of human energy (in kcal / min) is quite popular for determining the functional state of a person, but in most cases it is used only in dietetics and medicine (Broderick et al., 2014; Ceaser, 2012). The main obstacle to the adoption of the proposed approach to characterizing the psychophysiological state of a person was the practical non-use in psychology and physiology of the terms "information", "information state" and "information exchange". As well as the term information efficiency as an indicator of information exchange (i.e., an indicator of changes in the level of information exchange within and between human physiological systems). If the term information was used to characterize human emotions, then it was used in a slightly different sense, in relation to the founders of cybernetics. For example, the information theory of emotions developed by academician Simonov (Simonov, 1986) suggested an emotional reaction in response to an external informational impact on a person, but used immeasurable concepts at its core. The closest synonym in essence to the term information exchange (or indicator of information

exchange), which characterizes the information state of an object (person), is the term psychological state of a person, which determines the state of his psychological comfort.

From the point of view of sensory physiology (Sechenov, 1965; Tamar, 1976; Pokrovsky & Korotko, 2001), any mental and physiological processes that occur in a person are determined by information interaction through physical, chemical and metabolic (information) processes (Wiener, 1948). Therefore, the mental and psychological state of a person can be determined using informational characteristics that reveal the state of his psychological comfort, and the physiological state, in turn, can be displayed using mostly energy characteristics.

I suggested (Minkin, 2019a) that the information state of a person and the information exchange that characterizes him is determined by information efficiency, i.e. the quality of information exchange (speed, magnitude of signals, information losses, signal-to-noise ratio, etc.) during the passage of information signals within and between human physiological systems (Minkin, 2019a). This approach is similar to the classical approach of Shannon (Shannon, 1948), Wiener (Wiener, 1948), and Bernstein (Bernstein, 1967) to transmit information for a technical and biological system and is confirmed in works related to the information theory of emotions and sensory physiology (Simonov, 1986; Tamar, 1972; Baevsky et al., 2001). If we consider a person as a physical or cybernetic system, then the indicators of his information state (information exchange) depend on controllability and losses, i.e. on the speed and synchronism of the passage of sensory feedback signals in each of the physiological systems and functionally related physiological systems (Bernstein, 1967; Blank et al., 2014; Orbach, 2008). Moreover, according to Academician Pavlov, all physiological systems of a person are interconnected (Pavlov, 1951). In the

course of psychophysiological studies, it was found that in the case of improved mood and emotional recovery, an increase in the degree of synchronization of the functioning of various physiological systems of a person is observed. In the case of a deterioration in the functional state of a person, this degree of synchronization decreases (Minkin, 2019a; Minkin & Myasnikova & Nikolaenko, 2019). The indicator of information exchange can be, for example, the Pearson correlation coefficient (Pearson, 1895), determined by processing various physiological signals, for example, heart rate (cardiovascular system), skin galvanic reaction (skin system), vestibulometry (vestibular system). In this case, the average sum of Pearson's correlation coefficients determined between several different physiological signals will reflect the general level of human controllability or an indicator of his information state (information exchange). When conducting research on subjects using vibraimage technology, it was empirically established that another possible information characteristic, which is an indicator of the synchronization of physiological systems, is the spread in the frequency of micro vibrations of the human head (Minkin, 2019a).

For greater clarity, consider an example in which a person is represented as a conditional cybernetic system (Fig. 1) consisting of a number of physiological systems Ph1-PhK (cardiovascular, nervous, digestive, vestibular, etc.), each of which solves a certain physiological task. Each of the physiological systems has a certain effect (transfers its information and receives the corrected information back, in the form of feedback) on all other systems, the mutual influence of one physiological system on another is characterized by the correlation coefficient Ckn. The "input" of a person is constantly fed with input stimuli in the form of E_{ex} energy carriers (food, oxygen) and Iex input information (light, sounds, heat, etc.). Stimuli are transformed through the metabolism of internal physiological processes (I_{in} – E_{in})

into external manifestations in the form of human energy E_{out} (heat, movement) and I_{out} information (words, appearance, behavior, changes in physiological parameters of heart rate, SGR, ECG, etc.). Of course, this is a general scheme of human functioning, however, it is such a scheme that most fully covers the physical, chemical and information processes that occur with a person and well explains the characteristics of a person as parameters that change under the influence of external stimuli or various factors. I emphasize that a person is always under the influence of external factors, the existence of a person who does not feel any external, internal or extraneous influences is impossible. Only a dead person does not feel or transform external stimuli.

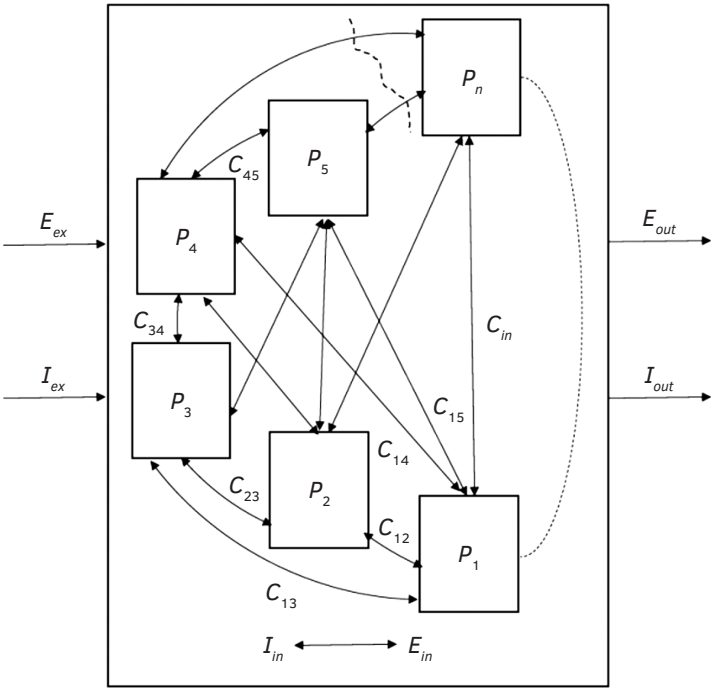

Fig. 1. Cybernetic scheme of a person

The diagram shown in Figure 1 allows one to assess the psychophysiological state of a person, which is inextricably linked with the need to determine changes in internal energy as a result of physicochemical processes (E_{in}) occurring inside a person and an indicator of changes in his information state (I_{in}), characterized by information exchange. It follows from the diagram that the closest analogues of the internal values of the informational and energetic state of a person are their external components I_{out} and E_{out}, which can be physically measured in the form of physiological parameters or physical quantities. The calculation of expended or consumed energy by a person is a well-known physical problem that has many technical solutions (Ceaser, 2012; Broderick et al., 2014). It has been proposed to define the internal information state (Minkin, 2019a) as information efficiency coefficient $I_{in} = I_u / I_t$ or reduced function of averaged correlations of various physiological systems ($I_{in} = F(\sum(C_{kn}))$. This process can be carried out in various technical ways, for example, using the technology of vibraimage, or when measuring the average correlation of time dependences of various physiological signals, or by analyzing heart rate variability (Bayevsky et al., 2001; Fleishman et al., 2014). A decrease in the useful signal exchange and correlation dependence during the functioning of various physiological systems of a person is characterized by a loss of control, chaos, an increase in entropy and, in extreme cases, a person's death.

Obviously, the proposed cybernetic or informational-physical approach to the analysis of the current psychophysiological state of a person has a number of undeniable advantages. The parameters traditionally used to characterize the psycho-emotional and psychophysiological state (aggression, stress, pleasure, neuroticism, extraversion) are usually subjective if they do not have clear physical algorithms for their determination. Most of the existing approaches to the analysis of the psychophysiological state of a person are based

on the well-known statement of the ancient Greek philosopher Protagoras, who claimed that "man is the measure of all things" (Bartlett, 2016). However, to obtain objective metrological results in measuring the psychophysiological state of a person, it is necessary to minimize the use of subjective work of consciousness, and apply physical quantities and objectively measured technical characteristics. In the proposed cybernetic model of a person, two basic parameters are physically measured that determine the energy and informational state of a person, and the psychophysiological state is determined by the ratio of these two parameters, in coordinates information/energy (I/E).

Under the information indicator of human state is understood the level of control (i.e., information efficiency, as the ratio of the received amount of informative signals to the entire amount of transmitted information) or the correlation between various physiological systems of a living organism. Information efficiency can be objectively detected, for example, by correlations between the signals of the electrocardiogram, electroencephalograph, skin-galvanic reaction and vestibulometry, which vary in time and are interconnected. Under the energy indicator of human state means physically consumed or emitted by a person energy (reduced to maximum human expended energy). In balance the expended energy and energy released are near the same for a long period of time. If the value of the parameter reflecting the energy characteristic of the organism E decreases, and the value of the parameter reflecting the information state of the organism I increases, then we can conclude that the person goes into a more relaxed state. If, on the contrary, the value of the parameter corresponding to the energy characteristic of the body increases, and the value of the parameter responsible for the informational state of the body decreases, then the person is in a state of nervousness, stress. If the values of both parameters E and I increase, then the person goes into

an active collected state, ready for action. If the values of both parameters fall, then the person is in a depressed or stress state. Thus, two defining parameters of the system appear, by the ratio of which one can unambiguously interpret the change in the psychophysiological state of a person. We obtain a two-dimensional array of data, which respectively determine the information and energy characteristics of the recorded reaction (I (t) / E (t)), which allows to establish a correlation with the change vector of the current psychophysiological state (PPS), that is, at least, allows to determine whether this reaction positive or negative. It is the degree of positivity or negativity of changes in the current PPS under the influence of external and / or internal factors, including the perception of an external stimulus, that are the determining factors for psychophysiology, as 1 and 0 of modern computer technology (Minkin, 2019a).

Thus, on the basis of obtained data, is possible to draw unambiguous conclusions about the nature of the change in the current psychophysiological state of a person in the information and energy scale (% / kcal, or relative units), so definitely as, for example, the volt-ampere characteristic of a transistor is measured. Said approach is somewhat close to Eysenck's assessment of personality on the scales of "extraversion" — "neuroticism" (Eysenck, 1970). A parallel can be drawn between the energy characteristics of a person's state and the degree of extraversion of his behavior, as well as level of psychological comfort and the degree of its balance (neuroticism). However, the Eysenck test is based on the subjective conscious response to the presented stimulus, while the cybernetic approach to the person is based on objective measured physical quantities and / or physiological parameters.

One of the technologies suitable for implementing the cybernetic approach is vibraimage technology, which allows measuring both human energy costs and indicators of his

informational state. It was found that the frequency spread (dispersion or standard deviation) of vibraimage characterizes the information indicator of the psychophysiological state of a person, and the average frequency of vibraimage characterizes its energy indicator (Minkin, 2019a).

For compatibility of scaling or additivity of estimates of information and energy characteristics of a person, they can be expressed in physical units (information efficiency in percent, energy in joules or calories, and for a fixed period of time — power in J / min or kcal / min), or both can have relative values (% or per-unit system). In this case, the energy characteristic should be reduced to the ultimate human capabilities (Minkin, 2019a). The ratio of information exchange between and within physiological systems of a person to the total volume of signal exchange between and within physiological systems, accepted as Information indicator looks follows:

$$I_{in} = I_r / (I_r + S) \tag{1}$$

where I_{in} — information efficiency of human state;

I_r — the amount of useful information accepted by human physiological systems per unit of time;

$I_r + S$ — total amount of information sent by human physiological systems per unit of time (including errors and lost information or entropy S).

Indicator of a person's energy state expressed by the following equation:

$$E_{in} = E_{cur} / E_{\max} \tag{2}$$

where E_{in} — reduced indicator of energy state of a person;

E_{cur} — amount of energy consumed by a person per unit of current time;

$E_{\max}$ — physiological limit of the maximum amount of energy consumed by a person per unit of time.

The above equations for calculating the given indicators of information and energy characteristics explain the general meaning of these indicators. Obviously, it is impossible to accurately measure the total amount of information transmitted by a person per unit time, because the brain of one person, containing approximately 50×10^{10} neurons (Herculano-Houzel, 2009), transmits more information in one second than all computers in the world. However, if the proposed hypothesis about the proportionality between information efficiency and correlation in the work of physiological systems is true, then with the established inverse relationship between the dispersion of vibraimage and the control of physiological systems (Minkin, 2019a), one can evaluate the information efficiency of a person. The physiological meaning of vibraimage frequency dispersion is determined by the general connection of the vestibular system with all physiological systems of the human body. The higher the controllability between physiological systems, the smaller the frequency spread in the control of the cervical muscles that determine the vestibular-emotional reflex (Minkin & Nikolaenko, 2008b). Using the proposed approach (Minkin, 2019a), the characteristics of the psycho-emotional state for the claimed method can also be obtained using the technologies, as ECG, SGR, EEG, etc. For this, it is necessary to measure the energy released by a person, for example, using a thermal imager, and evaluate averaged synchronism (Pearson correlation coefficient) of the captured physiological signals like ECG, SGR, EEG, etc. It is possible to determine PPS by the other similar methods (Minkin & Nikolaenko, 2017a), however, the described method is easier to understand, while more complex equations for calculating PPS usually give a result close to the above equations (Minkin & Myasnikova & Nikolaenko, 2019).

The reasoning given in this chapter reflects the general cybernetic approach to humans, however, they are of little use

for physical measurements of internal processes, since internal information and energy processes are difficult to measure and control. For real measurements of human behavioral characteristics, it is necessary to control external changes in parameters, which are defined in Figure 1 as I_{out} and E_{out}.

2.1 Cybernetic approach to emotions measuring

There are many different approaches to measuring emotions, assessment of psychophysiological parameters and personality traits (Van Egeren, 2009; DeYoung, 2014; Hoffman et al., 2012; Scherer, 2011; Cacioppo et al., 2007). One of the most cited experts in the study of emotions and personality traits, Klaus Scherer, who has published more than 100 articles and monographs on this topic, concludes that the "definitions cannot be proven" (Scherer, 2005). However, I believe that this conclusion is valid only when maintaining the existing approach to emotions in psychology, based on the determination of emotions by processing of conscious responses of a person. While the cybernetic approach to person allows us to give clear proven definitions of emotions based on mathematical logic.

Professionals in cybernetics should understand the cybernetic approach described in the previous chapter to determine the current psychophysiological state of a person, but an ordinary person is unlikely to say about his emotional state that he has lost information efficiency. It is rather a phrase from the communication of robots. The translation of this phrase into human language will be, for example, "I'm tired", or "I'm in a bad mood", or "I have a headache", or "I'm tired of everything" every of these answers may correspond to a decrease in a person's information efficiency.

The task of cybernetic psychology is not only the determination of the current psychophysiological state of a person

and its information and energy components, but also the measuring of habitual emotions, psychophysiological parameters, character traits and psychological types in established qualitative terms, and with a quantitative assessment.

The set of psychophysiological parameters of vibraimage system is based on a cybernetic approach to a person as a complex informational-physical object, which is why it differs from the traditional approaches of psychology classics (James, 1884; Jung, 2016; Eysenck, 1970). In physics, it is customary to characterize objects as having positive or negative properties, for example, for elementary particles there are particles with a negative charge (electron) and with a positive (proton). There are also neutral particles, for example, a neutron. This physical principle was used to classify a person's emotional parameters when developing a set of parameters measured by a vibraimage system. In metrology, the basis of the measure of all physical objects is a physical quantity — one of the properties of a physical object (physical system, phenomenon or process) that is common in a qualitative sense for many physical objects, but in a quantitative sense, individual for each of them (JCGM 200, 2008). In accordance with this definition, emotions can be considered a physical quantity characterizing one of the properties of a person, since each person to one degree or another has all the known emotions and psychophysiological states. Moreover, the quantitative characteristic of each emotion of the current psychophysiological state of a person is purely individual. These quantitative differences in the qualitative (behavioral and biological) characteristics that make each person a unique person.

To implement the classification of emotions using cybernetics, it is necessary to formulate several postulates and methodological principles that are generally accepted in the exact sciences and metrology, but so far have not been

used in psychometrics when measuring the emotional and psychophysiological state of a person.

- Object of measurement should be directly a person, as a physical object.
- Characteristics of only current emotional or psychophysiological state (properties of a physical object) can be measured.
- Primary characteristics of an emotional or psychophysiological state (properties of a physical object) are its physical characteristics and its measurement method (calculation formula).
- Every behavioral (qualitative) characteristic of a person must have a clear and unambiguous definition.
- Determination of the quantitative expression (measurement) of a qualitative characteristic (emotion, psychophysiological parameter, character traits) should be carried out by an unambiguous method, algorithm or equation.

Using vibraimage technology as an example, I will demonstrate the ability to measure emotions, psychophysiological parameters and character traits of a person based on the principles of cybernetic psychology and metrology.

2.2 Emotions measurement by vibraimage technology

An inquisitive reader (who do not know vibraimage) must have questions after reading the previous material: Why does the author distinguish vibraimage technology from all known psychophysiological detection technologies? What is there in it that other technologies do not have? Why it is so good for cybernetics?

The main element of cybernetics is the amount of information (Wiener, 1948). The main element of vibraimage technology is video streaming converted to frame difference (Minkin &

Shtam, 2004; Minkin, 2017). Each vibraimage pixel carries information about the temporal and spatial components of object movement and depending on used time constant and spatial characteristics, the vibraimage at each pixel can be represented as an innumerable set of temporal and spatial characteristics. The restriction in obtaining the initial and processed information about the object is only real hardware and processor power. In terms of the volume of initial information about the measurement object (at the existing level of hardware), the technology of vibraimage is orders of magnitude superior to all known psychophysiological detection technologies, for example, contact polygraph, magnetic resonance imager, EEG, etc. An IT expert may object — what an advantage, a large amount of initial information is not an advantage, but a disadvantage, because it needs to be processed in real time mode. I can partially agree with this statement, of course, it is easier to get a small amount of information and use it correctly. In terms of processor costs, vibraimage technology is the most difficult to process among the well-known psychophysiological detection technologies. This limitation markedly limits its widespread distribution. However, if the information is superfluous, then you can always get rid of it and compress the information flow. If the necessary information is missing, then it can no longer be find. Therefore, in cybernetics for solving complex problems there can not be a lot of information, it may just not be enough to solve the tasks. In vibraimage technology, you can always extract additional information about the measurement object if information is not enough.

Now about the informativity of vibraimage technology. Vibraimage transforms signals from the vestibular system. The vestibular system provides a mechanical balance of a person and is functionally connected with all physiological systems of a person (Minkin & Nikolaenko, 2008b; Blank et al., 2014). Any changes in the physiological or mental state make their

own unique impact on the functioning of the vestibular system and affect the maintenance of the vertical state and movement of the human head. Any movement of a person's arm or leg makes a change in head movement; this is one of the rules of biomechanics (Bernstein, 1990). In addition, human movement is uniquely behavioral characteristic. Freud claimed that a person has no random movements (Freud, 1926). Assessment of human reflex movements by vibra-image technology combines physiological and behavioral characteristics into a single whole, which is not available to other technologies (Bradley & Lang, 1994).

Vibraimage technology is non-contact, user friendly and allows to explore a person without violating his usual activities. In this, it differs significantly from most contact technologies that require the placement of sensors on the human body, especially since it is far from computed tomography, which requires placing a person in special closed equipment.

These properties allow vibraimage technology to become basis in cybernetic psychology and measure not only individual parameters of emotions, but also determine the set of known behavioral characteristics of a person.

The developers of vibraimage have proposed a unified algorithmic approach to all parameters of emotions and psychophysiological states, which allows determining the range in each parameter in relative units from 0 to 1, or in percent from 0 to 100% (Minkin, 2014; 2017; 2019; Vibra-image PRO, 2019). The maximum value of each psycho-physiological parameter is characterized by a value close to 1 per-unit (or 100%). At the same time, we do not see the need to normalize the value of all parameters in such a way that, in norm, each parameter is approximately 50%, as the developers of the MMPI questionnaires (Schiele & Baker & Hathaway, 1943) for T parameters. Artificial double reduction of parameters (initially a range from 0 to 100, then

norm to 50) does not have mathematical sense. Dynamics of change and the density of distribution of the measured parameters are important for the analysis of dependencies and correlations, and the range from 0 to 100% (0–1, per-unit) is sufficient for a single perception and joint processing of psychophysiological parameters.

The psychophysiological meaning of vibraimage technology is to consider the physiology of the reflex movements of the human head at the micro level, at the level of movements invisible to the eye. The fact that the physiology of visible reflex movements reflects the emotional and psychophysiological state was previously known (Sechenov, 1965; Darwin, 1872; Bernstein, 1990; Lorenz, 1963; Mira y Lopez, 1957). The invisibility to the eye of micro motion of the head does not change anything in the theories of outstanding scientists of the past, the movement remains a movement, even if it occurs with micron amplitude. Moreover, any repeating and oscillatory process is easier to convert into information than non-repeating macro-movements; it is easier to measure and normalize. The principles of the analysis of reflex movements remain approximately the same as in the analysis of human macro movements. Greater uniformity, symmetry and smoothness of movements indicates a normal and positive psychophysiological state, while any unevenness, asymmetry and sharpness of movements indicates a certain pathology. These simple principles for the analysis of reflex micromotion of the head were the basis for calculating the psychophysiological parameters in vibraimage technology (Minkin, 2017).

I emphasize that the principle of algorithmic identification of mathematically independent (primary) characteristics determined from human micromotion allows successfully use these characteristics for applications not related to the determination of emotions, since the determined parameters carry basic information about physiological processes in the human body,

which can be used to determination of secondary parameters. This is a direct consequence of the cybernetic approach to humans, in which the algorithm for calculating the output parameter is associated with internal physiological processes as shown in Figure 1. In the works (Bobrov et al., 2019a; Novikova et al., 2019) was shown that a certain combination of emotional and psychophysiological parameters allows to diagnose somatic diseases (Novikova et al., 2019) and determine the functional capabilities of a person (Bobrov et al., 2019b) with high accuracy comparable to biochemical research methods. Moreover, the primary emotional parameters of vibraimage technology correlate well with other physiological parameters of a person (Bobrov et al., 2019b). Based on the available primary emotional parameters, one can study other emotional states and analyze the positivity or negativity of stimulus perception (Kosenkov et al., 2019; Miroshnik et al., 2019).

Vibraimage users often ask me questions regarding specific psychophysiological conditions, for example: "What means the level of Aggression — *E*1, the level of Stress — *E*2, ... the level of Inhibition — *E*9, etc." Since the current vibraimage system (VibraimagePRO, 2019) includes a combination of 16 behavioral characteristics measured from 0 to 100%, so a simple enumeration of various combinations gives an almost infinite number of results and a separate analysis of specific data becomes meaningless. Is necessary to find general trends and patterns of change in psychophysiological parameters that will be simple and understandable to researchers. It seems to me that the correlation dependencies between emotional and psychophysiological parameters are that objective characteristic that can be laid down as the main principle of analysis and classification of the behavioral characteristics of a person. Next, we consider in detail the dependences for each behavioral parameter with a maximum level of correlation with respect to other behavioral characteristics.

The proposed classification of the emotional parameters of a person, including four groups of emotions and psychophysiological parameters causes a certain number of questions of vibraimage systems users, because differs significantly from previously well known, (Jung, 2016; Wundt, 1867; Eysenck, 1970; Simonov, 1986). In the first group of conditionally negative emotional parameters are characteristics of aggression, stress, tension (anxiety) and suspect level (danger of this person to others). The second group includes conditionally positive emotional parameters — balance, charm, energy and level of self-regulation. The third group of emotional parameters includes physiological parameters of inhibition, neuroticism, depression and level of happiness. The fourth group includes psychophysiological parameters (extraversion, stability, satisfaction, the period of brain activity), the difference between the psychophysiological parameters of the fourth group and the emotional parameters of the first three groups will be shown below when determining the correlation dependencies between behavioral characteristics.

2.3 Correlation between emotional states

In the introduction to this book, it was said that in determining the set of informative psychophysiological parameters, the developers of vibraimage system use parameters with minimal correlation between themselves. This principle allows to characterize the object of study as informatively as possible with minimal information costs, i.e. the minimum number of parameters (Polonnikov, 2006; 2013). Parameters with significant correlation between themselves do not add new information about the studied object, but on the contrary, lead to the fact that the required information is lost in numerous repetitions. In many applications of cybernetic psychology, it is required to reduce all information about

a person to one parameter, for example, is a person able to carry out the work entrusted to him, is there sufficient psychological compatibility between two people, is the person aggressive and poses a danger to others, etc. However, information about one characteristic of a person determines the object of research on the one hand only, for the most complete characterization of a person, a number of independent parameters must characterize it. One of the most famous methods of complex personality research is the Minnesota Multiphasic Personality Inventory (MMPI) test, developed in the late 30s and early 40s of the last century at the University of Minnesota (Schiele & Baker & Hathaway, 1943). The methodology was based on the responses of sick people with a certain type of mental pathology. It was assumed that similar answers to presented questions-stimulus are associated with a similar pathology in the subjects. The current version of MMPI-2 (Drayton, 2009) includes 567 questions and provides information on 10 parameters (scales). Now, the MMPI technique (and its various updates) is one of the most popular and significant methods of psychometric testing; it reflects the typical medical approach to a person as an object of research with a certain pathology. MMPI method is based on the analysis of a person's conscious reaction to stimuli, while in (Minkin, 2019e) it was found that a conscious and unconscious response to stimuli does not have a significant correlation between themselves. It means that an approach to a person using only conscious responses to stimuli cannot obtain complete information about the personality, since it does not analyze the unconscious component of personality. In addition, a large number of questions in the MMPI method leads to a significant test time for one person, usually taken 1–2–3 hours per test. Such a significant testing time imposes significant restrictions on the assessment of rapidly changing emotional processes, allowing the measurement of only static

characteristics of the person. But metrologists know that an AC voltage cannot be measured with a voltmeter to measure DC voltage, the measurement error will be huge. The emotional state of a person changes quite quickly under the influence of many factors, and due to biological feedbacks, a change in one emotion always leads to the measurement of a number of other characteristics of a person (Scherer, 2005).

The cybernetic approach is based on determining the general laws of obtaining, storing, transforming, and transmitting information in complex control systems (Wiener, 1948). Measurement of emotions and psychophysiological parameters of a person as physical quantities allows determining the general patterns of changes in his behavioral characteristics when analyzing the distribution of measurements results of psychophysiological parameters, establishing norms according to the criteria for the obtained distributions of measured values, and analyzing the mutual correlation between the studied parameters. If the hypothesis that the vestibular-emotional reflex is informative (Minkin & Nikolaenko, 2008a) is correct, then each mathematically independent parameter reflecting the movements of the human head should reflect part of its emotional and psychophysiological parameters. In this case, it is necessary to distinguish between mathematically independent parameters and functionally independent parameters characterizing the object of study. Mathematically independent parameters include those parameters in the calculation formulas of which there is no mathematical correlation. For example, the Stress and Aggression parameters measured by vibraimage technology (which will be discussed in more detail below) determine various properties of human vibration (stress is the spatial characteristic of vibration, and aggression does not take into account the spatial characteristic), which means that there is no mathematical correlation between these

parameters. However, due to its functional characteristics and general patterns of functioning of the human body, under certain conditions, a noticeable negative correlation can be observed between the parameters Aggression and Stress, for example, with an increase in the level of Aggression of a healthy person, the level of Stress usually decreases.

Medical (by pathology) and cybernetic (by statistics) approaches to the analysis of behavioral characteristics differ fundamentally. In my opinion, the cybernetic approach is more objective, since it analyzes the entire sample of the results obtained and the norms for the parameters are established on the basis of statistical laws. However, as Jung wrote, an introvert and an extrovert see the same event in different ways (Jung, 2016), and therefore there is no single point of view in classical psychology. In the exact sciences, which include cybernetics, on the contrary, there are no subjective points of view, everything is determined by mathematical equations and obtained statistical dependencies.

To determine the correlation dependencies between psychophysiological parameters, Table 1 shows the correlation between emotions and psychophysiological parameters obtained from united database of more than 10 000 tests of healthy people done by vibraimage technology testing (in total 10 266 results of measuring emotions and psychophysiological parameters). The united database of emotions and psychophysiological parameters measurements include the test results of the subjects using VibraMed10 (VibraMed10, 2019) VibraMI (VibraMI, 2019) PsyAccent (PsyAccent, 2019) programs. The M file (VibraMed10, 2019) for the above programs, containing the results of emotions and psychophysiological parameters measurements, has a single interface and allows the joint processing of M files received by different programs. This approach allowed us to study the change in the emotions of the subjects under

the influence of various stimuli or in the absence of evoked stimuli that simulate various human conditions and explore the unconscious human reaction both separately and in conjunction with a conscious reaction.

VibraMed10 program (VibraMed10, 2019) measures the emotions of a person who is in a free state without presenting fixed (evoked) stimuli. Of course, various non-fixed stimuli still have an effect on the subject (computer, television camera, external environment), but a person can sit in front of the camera freely immersed in his usual thoughts and experiences (it is impossible to turn off the work of consciousness), we can conditionally characterize this test as recreation.

The standard time for such testing is 60 seconds, although a certain part of the measurements was obtained over a longer time, reaching 380 seconds. I consciously do not distinguish between different testing times, because, firstly, only the average value of the parameters obtained for the entire measurement time is taken into account for processing, and secondly, different measurement times give greater variability of the results, which should increase the information content of the studied dependencies. The total number of results of MED tests in the united database is about 5000 (4994).

VibraMI program measures a person's emotions when they pass the multiple intelligences test (Gardner, 1983), including 24 questions and stimulus images (VibraMI, 2019). The questions presented are neutral and the general psychophysiological state of a subject usually corresponds to his active working condition. The total number of MI test results in the full database is about 3500 (3521).

The PsyAccent program measures a person's emotions during passing test for personality accentuation (Leonhard, 1976), which includes 24 questions and stimulus images (PsyAccent, 2019). The questions presented have conflicting

contents and the general psychophysiological state of a subject usually corresponds to the stress state during such testing. The total number of PA test results in the full database is about 1750 (1751).

I assume that the combination of different testing options allows studying the emotions of people in different emotional states (rest, work, stress) and allows a universal classification of the results and dependencies, as they characterize human behavior in various situations. The age of the tested was quite wide, from 15 to 80 years, the national composition of the sample also varied significantly. About half of the subjects were European descent (Russia), and the second half were of Asian descent (Japan and China). The dependencies of the multiple intelligence profile on the nationality and residence of the tested were previously studied, which showed a certain difference in the results (Akiho & Nikolaenko, 2019), however, the distribution and correlation dependencies obtained for the emotional parameters practically did not differ for different testing regions. This suggests that the emotional characteristics of a person are quite stable and a little susceptible to change, while the conscious reaction and processes of consciousness are more susceptible to various influences. The total number of results of testing emotions and psychophysiological parameters in the united database amounted to more than 10 000 (10 266) measurements, which in my opinion is quite enough to form general patterns and conclusions from the studies.

Table 1 shows the values of the Pearson correlation coefficient for emotions and psychophysiological parameters with a significance level of at least 0.4 in absolute value for the united measurement database including test results by VibraMed, VibraMI and PsyAccent programs.

Table 1

Correlation matrix between emotions and psychophysiological parameters of healthy people (10 266 tests). Pearson correlation coefficient above /0.4/

	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
Aggression (*E*1)				0,523033			0,678226					–0,7968				
Stress (*E*2)				0,536778		–0,77592	–0,61614				0,651776					
Tension / Anxiety (*E*3)				0,635567					–0,50713	–0,52597						
Suspect (*E*4)	0,523033	0,536778	0,635567			–0,43759						–0,47183				
Balance (*E*5)										–0,42401	–0,43296					
Charm (*E*6)		–0,77592		–0,43759			0,494234				–0,55181					
Energy (*E*7)	0,678226	–0,61614				0,494234					–0,77274					
Self-regulation (*E*8)												0,508488				
Inhibition (*E*9)			–0,50713							0,522614						
Neuroticism (*E*10)			–0,52597		–0,42401				0,522614							
Depression (*E*11)		0,651776			–0,43296	–0,55181	–0,77274									
Happiness (*E*12)	–0,7968			–0,47183				0,508488								
Extraversion (*P*13)																
Stability (*P*14)																
Brain period (*P*15)																
Satisfaction (*P*16)																

For ease of reading, in Table 1 the results of correlation of the parameters for itself located in the gray diagonal and naturally equal to 1 for each parameter are deleted. The results shown in Table 1, indicates that the principle of using only independent parameters was confirmed on the united database. In Table 1, there is no correlation between psychophysiological parameters with a level above 0.8 in absolute value, which is typical for parameters in the calculation of which the correlation is based on the level of mathematics. All given parameters carry independent information about the behavioral characteristics of a person and the set of used parameters is quite informative, since none of the parameters can clearly replace the other. Noted that for the last four parameters, a correlation of Pearson coefficient (Pearson, 1895) higher than 0.4 is not observed with any other parameter given in this table. Those, the parameters given in Table 1 can be divided into parameters with a high degree of correlation between each other (correlation level 0.4–0.8) and parameters with a low degree of correlation between each other (correlation level 0–0.4).

For introducing new (additional) parameters for assessing the emotions of the psychophysiological state, they must undergo a similar test and, from the point of view of mathematical logic, introducing each new parameter that does not have a significant correlation with the previous ones will become more and more difficult.

Table 2 shows a similar correlation table between all the studied behavioral characteristics, only without a correlation threshold (0.4), which was given for Table 1 for united database of measurements including testing results by VibraMed, VibraMI and PsyAccent programs.

Naturally, all the emotional and psychophysiological parameters of a person have one degree or another of mutual correlation between themselves, as follows from Table 2.

Table 2

Correlation matrix between emotions and psychophysiological parameters of healthy people (10 266 tests). Pearson correlation coefficient above 0

	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
Aggression (*E*1)		–0,155	–0,049	0,523	0,244	0,125	0,678	–0,252	0,051	–0,068	–0,197	–0,797	0,127	–0,259	–0,060	–0,154
Stress (*E*2)	–0,155		0,234	0,537	–0,235	–0,776	–0,616	–0,304	–0,109	–0,111	0,652		–0,216	–0,108	0,083	–0,029
Tension / Anxiety (*E*3)	–0,049	0,234		0,636	0,180	–0,218	–0,188		–0,507	–0,526	0,197	0,058		–0,066	0,023	
Suspect (*E*4)	0,523	0,537	0,636		0,110	–0,438		–0,324	–0,301	–0,379	0,329	–0,472	–0,040	–0,267	0,021	–0,095
Balance (*E*5)	0,244	–0,235	0,180	0,110		0,320	0,374	0,319	–0,052	–0,424	–0,433	0,115	0,021	0,285	–0,040	–0,070
Charm (*E*6)	0,125	–0,776	–0,218	–0,438	0,320		0,494	0,325	0,082	0,107	–0,552		0,168	0,220	–0,061	
Energy (*E*7)	0,678	–0,616	–0,188		0,374	0,494		0,054	0,092	0,025	–0,773	–0,387	0,231	0,071	–0,109	–0,058
Self-regulation (*E*8)	–0,252	–0,304		–0,324	0,319	0,325	0,054		–0,027	–0,133	–0,328	0,508	0,097	0,113	–0,042	0,103
Inhibition (*E*9)	0,051	–0,109	–0,507	–0,301	–0,052	0,082	0,092	–0,027		0,523	–0,088	–0,056		–0,021	–0,020	
Neuroticism (*E*10)	–0,068	–0,111	–0,526	–0,379	–0,424	0,107	0,025	–0,133	0,523		–0,056	–0,049				
Depression (*E*11)	–0,197	0,652	0,197	0,329	–0,433	–0,552	–0,773	–0,328	–0,088	–0,056		–0,163	–0,272	–0,316	0,092	–0,022
Happiness (*E*12)	–0,797		0,058	–0,472	0,115		–0,387	0,508	–0,056	–0,049	–0,163			0,260		0,155
Extraversion (*P*13)	0,127	–0,216		–0,040	0,021	0,168	0,231	0,097			–0,272				–0,026	
Stability (*P*14)	–0,259	–0,108	–0,066	–0,267	0,285	0,220	0,071	0,113	–0,021		–0,316	0,260				0,074
Brain period (*P*15)	–0,060	0,083	0,023	0,021	–0,040	–0,061	–0,109	–0,042	–0,020		0,092		–0,026			
Satisfaction (*P*16)	–0,154	–0,029		–0,095	–0,070		–0,058	0,103			–0,022	0,155		0,074		

Pearson correlation coefficient between the parameters is an objective mathematical characteristic and can be used to classify emotions and psychophysiological parameters.

It is well known that many researchers considered emotions to be interrelated (Pavlov, 1951; Smith et al., 2007; Vygotsky, 1925; Lerner et al., 2014); therefore, it is logical to name behavioral characteristics with a significant correlation between each other — the emotions or emotional parameters. In Table 1, these are the first 12 parameters.

Therefore, behavior parameters having an insignificant correlation between each other are logical to name — psychophysiological. It is known that psychophysiological parameters are based on the functioning of relatively independent physiological systems of a person with less correlation between themselves (Pokrovsky & Korotko, 2001; Tamar, 1973; Varlamov & Varlamov, 2010; Alekseev, 2011; Tiberio et al., 2013).

Note that in Table 1, among the first 12 parameters of emotions, there are parameters that have a greater number of correlations with others, for example, the Suspect parameter has a correlation in the level above 0.4 with five other parameters, and the parameters Stress, Tension, Charm, Energy and Depression have correlation with four other emotional parameters. It is need to explain Suspect parameter sense and tell about the history of the appearance of this term. Suspect is the only parameter in the described set, where the developers of vibraimage technology consciously departed from the mathematical principle of minimal correlation between the emotional parameters of a person. By the level of Suspect, the developers understand the level of danger that the subject poses to others. At the beginning of development, vibraimage system was intended primarily for identifying potentially dangerous people and, for the convenience of working with the system, it was necessary to propose one parameter that allows assessing the level

of potential danger of explored person for others. Given the three most well-known parameters characterizing the negative properties of a person (Aggression, Stress, Tension), it was logical to propose one parameter that includes data on these three characteristics. Thus, the level of Suspect appeared, representing the average value of the levels of Aggression, Stress and Tension therefore, a certain mathematical correlation between Suspect and each of these three parameters was laid down by the developers. Perhaps in the future, the calculation of Suspect parameter should be revised or adjusted if another approach is proposed that will show greater efficiency in identifying potentially dangerous people. According to practical studies, the accuracy of identifying potentially dangerous people (suspicious) with the current algorithm is 94% (Minkin & Tseluyko, 2014), which means that the new algorithm for determining Suspect parameter should work even more efficiently.

Consider similar correlation matrixes for testing databases by different programs and pay attention to the differences and similarities of the results. Table 3 shows the values of the Pearson correlation coefficient for emotions and psychophysiological parameters with a significance level of at least 0.4 in absolute value for a complete measurement base including test results by VibraMed programs.

By general appearance and correlation values between emotional and psychophysiological parameters, Table 3 practically does not differ from Table 1. Of course, the correlation value for each pair of parameters in Table 3 does not completely repeat the correlation value in Table 1. For example, the maximum negative correlation in the upper row between the parameters Aggression and Happiness in Table 1 is –0.7968, and in Table 3 is –0.77643. A slight difference in the values must be present, since the sizes of the bases differ quite noticeably and people are tested in different conditions, it is impossible to expect complete identical results.

Table 3

Correlation matrix between emotions and psychophysiological parameters for healthy people (4994 tests by VibraMed program). Pearson correlation coefficient above /0.4/

	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
Aggression (*E*1)				0,581126			0,689196					–0,77643				
Stress (*E*2)				0,420682		–0,74477	–0,6257				0,618731					
Tension / Anxiety (*E*3)				0,670532					–0,43055	–0,5327						
Suspect (*E*4)	0,581126	0,420682	0,670532							–0,40772		–0,50283				
Balance (*E*5)							0,450428			–0,40818	–0,4818					
Charm (*E*6)		–0,74477					0,440802	0,465638			–0,48492					
Energy (*E*7)	0,689196	–0,6257			0,450428	0,440802					–0,75853					
Self-regulation (*E*8)						0,465638					–0,45215			0,524431		
Inhibition (*E*9)			–0,43055							0,535763						
Neuroticism (*E*10)			–0,5327	–0,40772	–0,40818				0,535763							
Depression (*E*11)		0,618731			–0,4818	–0,48492	–0,75853	–0,45215								
Happiness (*E*12)	–0,77643			–0,50283										0,493424		
Extraversion (*P*13)																
Stability (*P*14)								0,524431				0,493424				
Brain period (*P*15)																
Satisfaction (*P*16)																

Of the significant changes between Table 1 and 3, only the appearance of a correlation with a level of more than 0.4 between the Stability and Self-Regulation parameter, as well as between the Stability and Happiness parameter, should be noted. The reason for this phenomenon is unlikely to be the different size of the databases, most likely this difference is due to a really greater relationship between the indicated emotional parameters when passing the test in a free state when testing with VibraMed program.

Table 4 shows the values of the Pearson correlation coefficient for emotions and psychophysiological parameters with a significance level of at least 0.4 in absolute value for measurement database including testing results for VibraMI program.

Table 4 also has some differences from Tables 1 and 3. For example, the level of negative correlation between the Aggression and Happiness parameters is –0.74904, and the stability parameter has a correlation of a level above 0.4 with the Depression and Happiness parameters.

Table 5 shows the values of the Pearson correlation coefficient for emotions and psychophysiological parameters with a significance level of at least 0.4 in absolute value for measurement database including testing results by PsyAccent program.

Table 5 is perhaps the most markedly different from Tables 1, 3 and 4. Although the Aggression-Happiness pair that we selected for comparison has a correlation value of –0.79402 that is quite close to the full base, we see a larger value of the correlations between the psychophysiological parameters Extroversion and Stability to other emotional parameters. Most likely, an increase in the correlation between emotional and psychophysiological parameters occurs in the case of increased stress on the subject, since testing in VibraMed mode is performed without external stimuli, testing in VibraMI mode is performed with neutral stimuli, and testing in PsyAccent mode is performed with significant stimuli for the subject.

Table 4

Correlation matrix between emotions and psychophysiological parameters of healthy people (3521 tests by VibraMI program). Pearson correlation coefficient above /0.4/

	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
Aggression (*E*1)							0,595839					–0,74904				
Stress (*E*2)				0,706123		–0,81161	–0,67422				0,691181					
Tension / Anxiety (*E*3)				0,728817					–0,69386	–0,48977						
Suspect (*E*4)		0,706123	0,728817			–0,59711			–0,47289	–0,43693	0,48572					
Balance (*E*5)								0,402232		–0,44605						
Charm (*E*6)		–0,81161		–0,59711			0,589748	0,405833			–0,63563					
Energy (*E*7)	0,595839	–0,67422				0,589748					–0,84606					
Self-regulation (*E*8)					0,402232	0,405833										
Inhibition (*E*9)			–0,69386	–0,47289						0,467187						
Neuroticism (*E*10)			–0,48977	–0,43693	–0,44605				0,467187							
Depression (*E*11)		0,691181		0,48572		–0,63563	–0,84606							–0,43625		
Happiness (*E*12)	–0,74904													0,539889		
Extraversion (*P*13)																
Stability (*P*14)											–0,43625	0,539889				
Brain period (*P*15)																
Satisfaction (*P*16)																

Table 5

Correlation matrix between emotions and psychophysiological parameters of healthy people (1751 tests by PsyAccent program). Pearson correlation coefficient above /0.4/

	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
Aggression (*E*1)				0,424183			0,61395					–0,79402		–0,40872		
Stress (*E*2)				0,642675		–0,84796	–0,70809	–0,40351			0,75139		–0,42487			
Tension / Anxiety (*E*3)				0,618681					–0,6924	–0,50584						
Suspect (*E*4)	0,424183	0,642675	0,618681			–0,55104				–0,42493	0,477959			–0,50731		
Balance (*E*5)								0,463883		–0,45755						
Charm (*E*6)		–0,84796		–0,55104			0,639744	0,481376			–0,70488		0,422248			
Energy (*E*7)	0,61395	–0,70809				0,639744		0,437192			–0,87813					
Self-regulation (*E*8)		–0,40351			0,463883	0,481376	0,437192				–0,54478					
Inhibition (*E*9)			–0,6924							0,523653						
Neuroticism (*E*10)			–0,50584	–0,42493	–0,45755				0,523653							
Depression (*E*11)		0,75139		0,477959		–0,70488	–0,87813	–0,54478					–0,42751	–0,44666		
Happiness (*E*12)	–0,79402													0,51784		
Extraversion (*P*13)		–0,42487				0,422248					–0,42751					
Stability (*P*14)	–0,40872			–0,50731							–0,44666	0,51784				
Brain period (*P*15)																
Satisfaction (*P*16)																

The reader may ask, why do I consider it possible to classify behavioral characteristics according to the degree of mutual correlation, if this degree of correlation is not an absolutely constant sign, it also depends on the conditions of testing?

To answer this question, let us return to the beginning of this paragraph, where I talked about the need to check behavioral characteristics on united database modeling various (ideally, all) human influences. When we talk about the behavioral characteristics of a personality that characterize a person's reaction to external influences, in the particular case a situation of some unique connection between one and the other is possible. Special cases may be interesting as special cases, but they do not carry a general pattern. The cybernetic approach, I repeat, is the science of general laws, if the correlation between two parameters under different test conditions differs in hundredths of a percent, then this is a general pattern, and if for other parameters the correlation changes significantly, then there is no general pattern between these parameters.

Tables 1–4 confirm that the correlation between the behavioral characteristics of a person obtained through various tests have common patterns. Moreover, the obtained dependences were determined when measuring only physical parameters and physiological characteristics of a person, the work of consciousness was not taken into account when measuring. This does not mean that the work of consciousness does not affect the result of emotion measuring, on the contrary, a comparison of various options for the work of consciousness shows this effect. Consequently, it is unacceptable to determine the emotions and psychophysiological parameters of a person by his conscious reaction upon presentation of questionnaires using a conscious reaction to determine emotions. The obtained result confirms the earlier conclusions that consciousness

and the unconscious perform different behavioral functions and do not have a significant correlation between each other (Minkin, 2019; Minkin & Myasnikova & Nikolaenko, 2019).

2.4 Correlation between emotions and parameters of consciousness

In previous works, we were convinced the absence of correlation between consciousness and unconscious parameters (Minkin, 2019e; Minkin & Myasnikova & Nikolaenko, 2019). However, the presence of a larger database of behavioral characteristics and the desire to double-check the result led to the need to bring new data on the correlation between the parameters of consciousness and the unconscious. Moreover, in a previous work (Minkin, 2019e) data are presented on the absence of a correlation between conscious and unconscious responses to identical stimuli, and not between different characteristics of consciousness and the unconscious. Table 6 shows the correlation data between the parameters of emotions and the types of multiple intelligences, processed based on 3521 tests by VibraMI program.

The results presented in Table 6 confirm the absence of a significant correlation between the parameters of consciousness (types of multiple intelligences) and unconscious (emotions). Emotions were measured by measuring physical quantities, and multiple intelligence was determined by jointly calculating the conscious response to the presented stimuli and the physical measurement of the unconscious response to the same stimuli (Minkin & Nikolaenko, 2017a). A slight negative correlation (–0.28) between Self-Regulation and Naturalistic type of MI confirms the practically absence of a correlation between various parameters of consciousness and emotions.

Table 6

Asymmetrical correlation matrix between emotions and multiple intelligences of healthy people (3521 tests by VibraMI program). Pearson correlation coefficient above /0.1/

P	Aggression (*E*1)	Stress (*E*2)	Tension / Anxiety (*E*3)	Suspect (*E*4)	Balance (*E*5)	Charm (*E*6)	Energy (*E*7)	Self-regulation (*E*8)	Inhibition (*E*9)	Neuroticism (*E*10)	Depression (*E*11)	Happiness (*E*12)	Extraversion (*P*13)	Stability (*P*14)	Brain period (*P*15)	Satisfaction (*P*16)
P (IA)																
P (ET)																
P (LM)			–0,101				0,116		0,111							
P (BM)																
P (VS)																
P (NL)								–0,284								
P (BK)																
P (MR)																
P (AS)																
P (VL)																
P (AB)																
P (IE)																

As for the indicated negative correlation, it is explainable from the psychology point of view by the fact that people with a pathologically low level of Self-Regulation are attracted to nature and they show a high level of positive conscious responses when presenting pictures of nature. At the same time, unconscious responses when assessing Naturalistic type of MI does not show significant correlation with the level of Self-Regulation. None of MI levels by the physical measurement (IE) has a correlation higher than 0.1 with the physical measurement of emotional parameters, so it makes no sense to give an absolutely empty correlation table of consciousness and the unconscious parameters, similar to Table 6.

3. CLASSIFICATION OF BEHAVIORAL CHARACTERISTICS OF A PERSON

I would be very proud to consider myself the discoverer of using the principle of correlation to classify personality characteristics, but I have to admit that Karl Pearson in the 19th century developed a mathematical correlation apparatus specifically for classifying biometric parameters (Pearson, 1895; 1914). The fact that correlation is practically not used today as an element of classification in modern psychology just shows a departure from the naturalistic principles of object research. Naturalistic principals has been actively used since the 18th century in the development of natural sciences and the theory of evolution by such outstanding scientists as Karl Linnaeus (Linnaeus, 1735), Charles Darwin (Darwin, 1872) and Francis Galton (Galton, 1865), who is considered to be the founder of psychometrics.

The principles of person's behavioral characteristics classification according to the degree of correlation and information capturing, set forth in the previous chapter allow proposing the following definition for emotions.

Emotions are behavioral characteristics of a person that have a significant correlation between themselves and are determined by measuring physical quantities or physiological parameters of a person. In the above study (Tables 1–5), these are the first 12 emotional parameters.

In the previous chapter, was suggested that level /0.4/ of Pearson's correlation coefficient be considered as the threshold significant correlation. Immediately I foresee the opponents' objections that, claiming to be objective, I set this criterion

a little arbitrarily, although it divides the correlation range 0–0.8 into two equal ranges. Of course, any classification is always somewhat subjective. However, at the same time, the proposed classification according to the level of correlation is clearly defined, it reflects a clear mathematical criterion. In physics, along with the SI system, in parallel there are a number of non-systemic units that we constantly use, for example, the unit of time — a minute is not included in the SI system (SI, 2019). Therefore, psychologists can argue and give various verbal (qualitative) definitions to groups of emotions, it will be an endless and inefficient process, if psychology do not go to quantitative and standardized characteristics like non-systemic SI units for emotions and psychophysiological parameters.

A similar approach to behavioral characteristics that have a slight correlation between themselves allows us to give the following definition of the psychophysiological parameters of personality.

Psychophysiological parameters are behavioral characteristics of a person that do not have a significant correlation between themselves and are determined when measuring physical quantities or physiological parameters of a person.

To emphasize the different properties of groups of emotional and psychophysiological parameters, they are described in different chapters of this book. Physical measurements always have priority objectivity over the subjective measurement of personality characteristics based on a person's conscious reaction. Therefore, to determine the emotional and psychophysiological parameters of a person, it makes no sense to use a conscious reaction or conscious responses, as information used to measure.

However, of course there are a number of behavioral characteristics of the personality, the characterization of which is impossible without an analysis of the conscious reaction

of a person. In this case, physical measurements of the unconscious response should also be carried out to control the objectivity of the answers, as described in (Minkin & Nikolayenko, 2017a; Minkin & Myasnikova & Nikolaenko, 2019) in which it was proposed to consider the significance of the conscious and unconscious components as 50/50. In this case, is necessary to give the following definition to the third group of behavioral characteristics of personality.

Personality traits (consciousness parameters) are behavioral characteristics of the personality, determined by measurement of physiological (physical) parameters and a person's conscious response to stimuli. Consciousness parameters are independent and have not correlation with emotional parameters and between each other.

In this paper, I will not consider consciousness parameters in detail, an example of the study of which was given in the previous monograph Vibraimage and Multiple Intelligence (Minkin & Nikolaenko, 2017a). Moreover, the work of consciousness is a specific function of the human body, separated by many researchers from emotions and the unconscious (Penrose, 1994; Polonnikov, 2006).

The proposed definitions of the behavioral characteristics of a person differ markedly from those used previously (James, 1884; Russel, 1980; Scherer, 2005). The need to change the current state of affairs in the study of the characteristics of a personality is obvious to many researchers who offer various approaches for determining emotions (Schmidt & Thews, 1983; Scherer, 2005; Murik, 2005). Since over the last 150 years after the appearance of the basic publications of Sechenov (Sechenov, 1965) and Darwin (Darwin, 2001) has made virtually no progress in developing a theory of emotions.

I hope that the proposed three principles of classification (the method of obtaining information, unambiguous algorithm for determining emotions and correlation processing) of

the personality's behavioral characteristics will increase the objectivity of measuring the emotions and psychophysiological parameters of a person. They use standard metrological and mathematical approaches to a person as a physical object, accepted in exact and natural sciences. To understand the conscious and unconscious processes that take place in a person, the vector of discussion must be shifted from qualitative descriptions to quantitative calculations. Then progress in understanding the essence of a personality will be compared with the scientific and technological progress that has occurred in technology since the advent of cybernetics as a science.

4. EMOTION TYPES

In modern science, there are many different definitions of emotions and their types (Ekman, 1999; Scherer, 2005; Mesurado et al., 2018). The cybernetic approach to a person consists in the fact that a person is considered as a physical object having certain characteristics, input stimuli are constantly acting on it, and the output parameters of the object change (Fig. 1). Almost any non-verbal and verbal reaction of a person to stimuli characterizes a change in his behavior and can be measured in the form of a certain parameter, which is usually called emotion. In the previous chapter, it was shown that correlation relationships are possible between these emotional parameters, and parameters with a high degree of correlation were proposed to be considered as emotions. In psychology, it was customary to use the separation of emotions into types according to subjective characteristics into positive, negative and neutral or physiological (Russel, 1980; Scherer, 2005), so I use this established classification of emotions types, which is also used in vibraimage technology (VibraimagePRO, 2019).

Let's clarify that I use the term negative emotions primarily from a physical point of view, which does not mean at all that these emotions are bad. In physics, there is no such thing as good or bad, this science studies natural phenomena. However, the human body and any biological creature in the process of evolution develops criteria for a positive or negative perception of any stimulus (Darwin, 1873). In addition, in psychology, there is an idea of a person as a carrier of positive and negative qualities and there are many examples of such a division

(Lerner, 2014; Carver & Scheier, 1990; Mesurado et al., 2018). I use the term negative emotions for a group of parameters (Aggression, Stress, Anxiety, Suspect), characterizing conditionally negative properties of a personality. For negative emotions, it is assumed that their change from the statistical center in the direction of decreasing the parameter value characterizes the improvement of the psychophysiological state.

The set of positive emotions proposed by the developers of vibraimage technology (Balance, Charm, Energy, Self-Regulation) causes users more questions than negative emotions set. We repeat the thesis about the physical conditionality of positivity or negativity of emotions given for negative emotions, a similar approach applies to conditionally positive emotions, so the presence of high values of positive emotions does not guarantee a normal psychophysiological state of a person.

Despite the fact that the general approach to positive emotions suggests that the higher value of positive emotions characterizes the best psychophysiological state of a person (Fredrickson, 1998; Kok, 2013), the abnormally high values obtained for positive emotions also indicate a deviation from the norm, similarly to the low values obtained for negative emotions. For positive emotions, it is assumed that their change from the statistical center in the direction of increasing the value of the parameter characterizes the improvement of the psychophysiological state.

With the cybernetic approach to emotions, it is possible not to divide emotional parameters into different groups, since all parameters are mathematically independent, and the essence of the parameter is determined by the formula for calculating it. However, for some applications, it turns out to be more efficient to analyze a group of parameters united by a certain trend, this allows us to do the assessment of personality by smaller number of characteristics and

simplifies the understanding of the processes taking place. Returning to the description of emotion types, it seems possible to replace the term neutral to physiological for emotional parameters, which should not be classified as conditionally positive or negative. For such group of physiological emotions (Inhibition, Neuroticism, Depression, Happiness), it is assumed that their change from the statistical center can characterize both an improvement and a deterioration in the psychophysiological state.

Next, we will examine in more detail each of the emotional parameters that are familiar to users of vibraimage systems, their distribution and correlation dependencies obtained from more than ten thousand psychophysiological tests.

4.1 Aggression

The most famous researcher of aggression and aggressive behavior was, of course, the Nobel laureate Konrad Lorenz, who published the book Aggression in 1963 (Lorenz, 1963). Lorenz used the term Aggression, although many subsequent researchers prefer the term aggressivity when they talk about a measurable parameter that characterizes aggression in humans or animals (Plutchik & Van Praag, 1989; Cadoret et al., 1995). Lorenz argued that intraspecific aggression is necessary to preserve the species, intraspecific aggression is older than friendship and love, therefore, aggression is a natural characteristic of animals and humans, without which evolution is impossible. We will use the term Aggression in the future, without going into terminological discussions about this term, since the calculation equation is more important than term for the cybernetic approach to any parameter.

In paper (Minkin, 2014) was proposed to calculate the level of human aggression by the equation (3):

$$E1 = Ag = \frac{F_m + 4 \cdot \sqrt{\frac{1}{n}\sum_{1}^{n}\left(F_i - \overline{F}\right)^2}}{2F_{in}} = \frac{F_m + 4\sigma}{2F_{in}} \cdot 100\% \quad (3)$$

where F_m — frequency of the maximum in the histogram of the frequency distribution density;

F_i — number of counts with the i-th frequency in the histogram of the density distribution of the frequency obtained during N frames;

F_{in} — vibraimage processing frequency;

n — number of counts with an frame difference above the threshold in N frames.

The Aggression is determined by the vibraimage frequency histogram and reflects the maximum distribution of the frequency and the standard deviation (in further equations I will not describe in detail the calculation of the standard deviation (SD) of vibraimage frequency) person's vibrations (Minkin, 2017). The higher value of the maximum of the frequency distribution and the higher value of the standard deviation, the greater value of the parameter Aggression. The proposed formula for determining Aggression closely correlates with the principle of its definition proposed by Lorenz; in Lorenz, aggression is proportional to the intensity of reflex movements (Lorenz, 1963). Hereinafter, I use the principles of determining emotional parameters known in psychology, translating them into algorithms for calculating vibraimage technology. Micromotion of the head obey the same laws of physiology of activity (Bernstein, 1967) that were identified by researchers for human movements. However, macro movement is more difficult to algorithmic calculations, therefore, processing a continuous physiological process of maintaining the head in an upright state (vestibular-emotional reflex) has so many algorithmic and physiological advantages over the

analysis of other physiological processes. In addition to the proportionality noted by Lorenz between Aggression and the frequency of reflex movements, the proportionality between the Aggression value and the standard deviation of the frequency is also introduced in formula 1. Naturally, such a parameter cannot be visually evaluated, and Lorenz, without a computer and vibraimage technology, could not make this assumption.

However, using vibraimage technology, it was not difficult to draw such a conclusion, since people in an active and aggressive state differ in the dispersion of the vibration frequency, for people in an active state, for example, athletes, this spread is minimal. While a person in an aggressive state is characterized by both a high frequency of reflex movements and a high spread of this frequency, characterized by a high value of SD.

Figure 2 shows the distribution (distribution density) of Aggression measured values of over the sample of 10 266 tests.

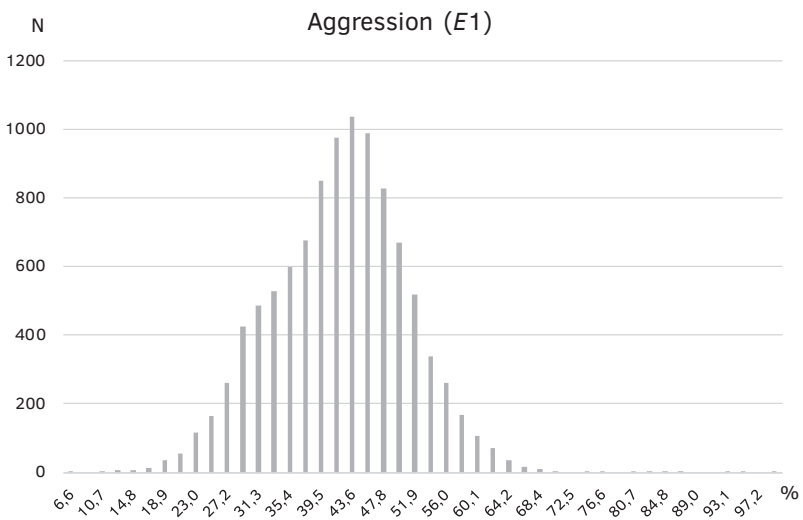

Fig. 2. Distribution of Aggression parameter (united database of 10 266 tests)

To compare the distribution form of the Aggression parameter under various testing conditions, Figure 3 shows the distribution of the Aggression parameter by VibraMed testing (Figure 3*a*, 4994 tests in total), VibraMI (Figure 3*b*, 3521 tests in total) and PsyAccent (Figure 3*c*, 1751 tests in total). The united base of 10266 tests is formed by adding up three databases of emotions and psychophysiological parameters obtained by these three (VibraMed, VibraMI, PsyAccent) programs.

Let consider the distributions of the Aggression parameter shown in Figures 2 and 3 using Table 6 in detail, since, using Aggression as example, we examine various changes in the distribution depending on the testing conditions. On other emotional parameters, I will not give similar detailed studies, but readers will be able to check everything themselves, since links to files with the source test data by various programs are given in the appendix to this book.

All four distributions of the Aggression parameter shown in Figures 2 and 3 resemble the normal distribution relatively closely, Table 6, which shows the main numerical characteristics of these distributions in the form of mathematical expectation M, standard deviation SD and the percentage of counts outside the range. Table 6 helps us deal with the features of these distributions outside M ± SD; M ± 2SD; M ± 3SD.

Note that in Table 7, the smallest average value of the parameter Aggression has in group of measurements done in VibraMed mode. It was previously said that testing in this mode can be conditionally compared with rest, since a person just sits in front of a television camera in his free state. Naturally, on rest state, the average level of Aggression is the minimum of all testing options and is 38.85%. When stimuli are presented by VibraMI and PsyAccent programs, the average level of Aggression increased markedly.

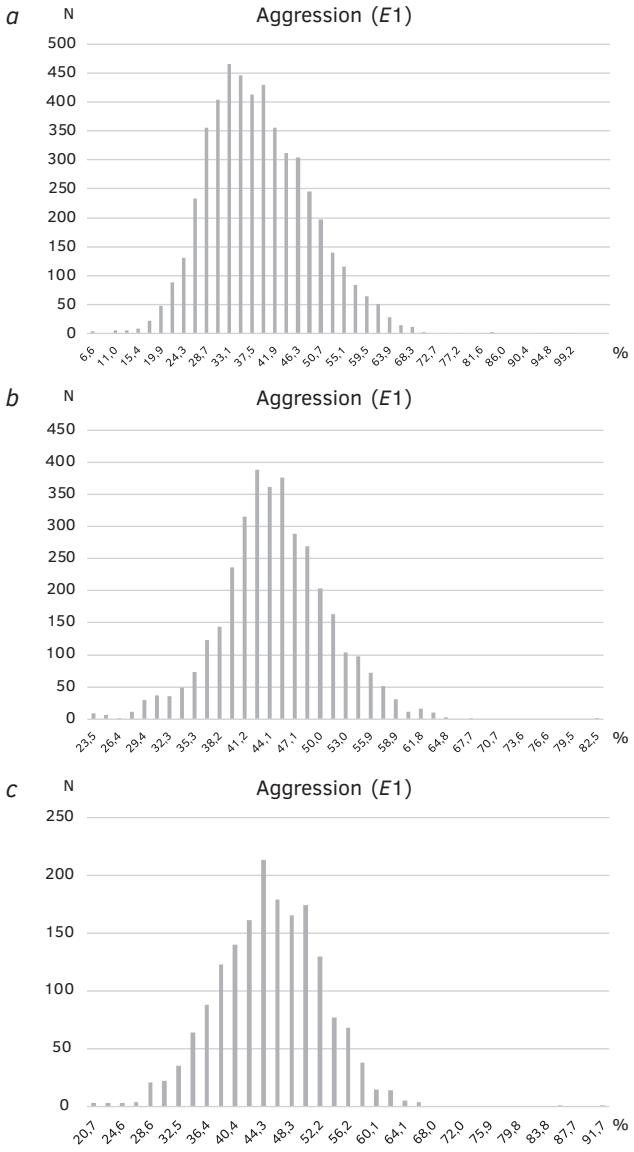

Fig. 3. Distribution of Aggression parameter in VibraMed (*a*), VibraMI (*b*), and PsyAccent (*c*) programs databases

Table 7

Numerical analysis of Aggression distribution over the sample array in 10 266 tests

Designations of mathematical characteristics for Aggression state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	41,99	38,85	44,80	45,29					
SD	9,00	10,01	6,31	7,34					
M + SD	50,99	48,85	51,11	52,63	14,56	15,86	14,85	14,51	15,8
M – SD	32,99	28,84	38,49	37,95	16,86	14,78	13,43	15,36	15,8
M + 2SD	59,98	58,86	57,43	59,98	1,99	3,38	2,64	2,00	2,2
M – 2SD	23,99	18,83	32,17	30,61	2,33	0,94	3,07	2,68	2,2
M + 3SD	68,98	68,87	63,74	67,32	0,19	0,34	0,20	0,11	0,1
M – 3SD	15,00	8,82	25,86	23,27	0,18	0,08	0,43	0,34	0,1

The average level of Aggression when testing multiple intelligence with VibraMI program (equivalent to active working capacity) is 44.80 %, and the average level of Aggression in the stress mode of testing PsyAccent is 45.29 %, which is already approaching the threshold upper norm, if it is defined as M ± SD.

The greatest asymmetry in the level of M ± SD has united distribution with the maximum number of counts (column 10 of Table 2 shows the number of counts beyond the specified range for the normal distribution). This is due to the fact that the united distribution includes three local, that differ in the level of the average value of the Aggression parameter, and

the Med distribution obtained by VibraMed has the largest number of counts and shifts density of united distribution to lower values. In addition, the distribution obtained by VibraMed program (Fig. 3*a*) is rather asymmetric and has a center shift towards lower values. The shift of average VibraMed value to left is caused not by mathematical reasons, but by psychological ones, since most of the tested really perceive the testing itself as rest and feel free in front of the camera. But the other part of the test group more aggressively perceives this testing as an unpleasant procedure, therefore the right distribution border in Figure 3*a* is wider and more blurred. This high dispersion of the psychophysiological state in the testing group by VibraMed program is also confirmed by the maximum value of SD = 10.01 %. From a psychological point of view, this is understandable, since without the presentation of external incentives and in the absence of clear tasks, each testee in his own way understands the task of being natural. Someone can relax in front of the camera, and someone is straining from uncertainty or some kind of internal problems.

In comparison with other testing options, we see that the testing option with VibraMI program (active working capacity) is distinguished by the minimum scatter of results in the SKO group = 6.31 %. This is also well explained from a psychological point of view, since neutral questions asked in a fixed rhythm contribute to concentration, and the entire group of subjects responds approximately equally to the presented stimuli. While questions of the PsyAccent program, which are quite provocative, lead to a greater dispersion of emotions in the group, some perceive the presented stimuli aggressively, others passively.

The given example shows the sufficient complexity of setting general norms for each emotional parameter, since the

norm and the nature of the distribution of the parameter are determined not only by the psychophysiological state of the subject, but also by the external conditions for testing. In engineering and metrology, it is customary to determine the conditions for measuring physical quantities or parameters with standard values of external conditions, for example, normal measurement conditions (reference conditions). Reference conditions characterized by a set of values or ranges of values of influencing quantities, under which a change in the measurement result is neglected due to smallness (JCGM 200). For most technical devices, their properties significantly depend on external conditions, for example, the dark current of silicon chips, the basis of modern microelectronics, doubles when the temperature increases by 8–10 degrees (Zee, 1984). Natural physical processes and various external conditions, however, do not interfere with comparing products with each other, since in engineering products are compared in the identical conditions and in metrology only physical quantities of the same name are compared.

A similar metrological approach should be applied to measuring the emotional and psychophysiological parameters of a person to determine the norms for his behavioral characteristics. For example, setting the norms to the parameter Aggression by the general distribution (Fig. 2) will give a wider scatter (23.99–59.98)% for the same selected criterion (for example, M ± SD) than when setting the norm for a certain type of testing VibraMI (32.17–57.43)%. Thus, the establishment of norms to the emotional and psychophysiological parameters of a person requires that a specialist in psychometrics understand not only the studied parameter of a person, but also a clear understanding of the conditions for obtaining this parameter. This requirement is again standard

for metrology, since in order to minimize the measurement error it is necessary to clearly understand the nature of the change in the measured value (Novitsky, 1975).

In addition, when determining the norm for a parameter, the researcher must imagine what percentage of deviations from the norm should be considered pathology, and what percentage within the parameter interval is the norm. To solve different problems, it is permissible to set different norms on the same emotional and psychophysiological parameter, depending on different conditions for its testing. In vibraimage technology, norms are established for each parameter based on the most general conditions of use (VibraimagePRO, 2019), but each user of vibraimage system can adjust the established norm based on their experience and specific task. The default norms for Aggression parameter (VibraMed, 2019) are 20% for the lower boundary and 50% for the upper boundary of the parameter, which approximately corresponds to the boundaries of the Aggression parameter within the range $M - 2SD < Norm < M + SD$. The asymmetry in the choice of norm is determined by the asymmetry of the final distribution of the parameter, since in the case of asymmetric distributions, using only SD for determining the norm leads to a different percentage of readings that are outside of SD. Therefore, the real distribution density of each emotional parameter is important for the correct determination of the norms and it is necessary to analyze in detail the nature of the distribution for each parameter studied. In cybernetics, measurement theory, and information theory, the nature of the distribution of the studied parameter is one of the most important characteristics (Novitsky, 1975); therefore, we present the distributions for all studied behavioral characteristics.

The researcher's understanding of the principles of norm formation for each emotion parameter should include mathematical and psychological knowledge, since, I repeat, standard metrological rules require the researcher to know the nature of the change in the measured value. The lack of this knowledge leads to a significant increase in measurement errors and distortion of measurement results. It should not be assumed that the transition to a digits in assessments of human emotions allows only an unambiguous interpretation of events that is objective for all life situations. The determination of the norms for each emotional parameter depends not only on statistical dependencies, but on the measurement conditions, the equipment used, the measurement methods, and the measurement error. The transition from psychometrics to metrology is not a transition from uncertainty to the complete certainty of the result, the science of measurements is always associated with uncertainty (Minkin, 2019b) and blindly trusting the resulting digit is no less dangerous than using ambiguous verbal assessments of a person's emotional parameters.

I will not describe in such detail the nature of the distribution of values for other emotional parameters, so as not to clutter up the book with technical details. But the general conclusion on the analysis of the distribution of the Aggression parameter is obvious to me — vibraimage technology allows us to quantitatively characterize almost any changes in this parameter and obtain various dependences of the Aggression parameter on external factors and other emotional parameters. The conclusions done for measurements group statistics are also valid for each personal measurement, since the result of each individual measurement is determined by statistics too (VibraimagePRO, 2019). In this book, I analyze only group dependencies according to the obtained databases of behavioral characteristics, and

each reader can examine the statistics of single measurements independently using the DEMO mode of vibraimage programs (VibraMed10, 2019; VibraMI, 2019; PsyAccent, 2019).

From Table 1 it follows that the parameter having the maximum correlation with Aggression is the level of Happiness. The Pearson correlation coefficient between the parameters Aggression and Happiness was –0.79 according to the results of the available sample of 10 266 tests. The correlation statistical relationship between the parameters Aggression and Happiness is shown in Figure 4.

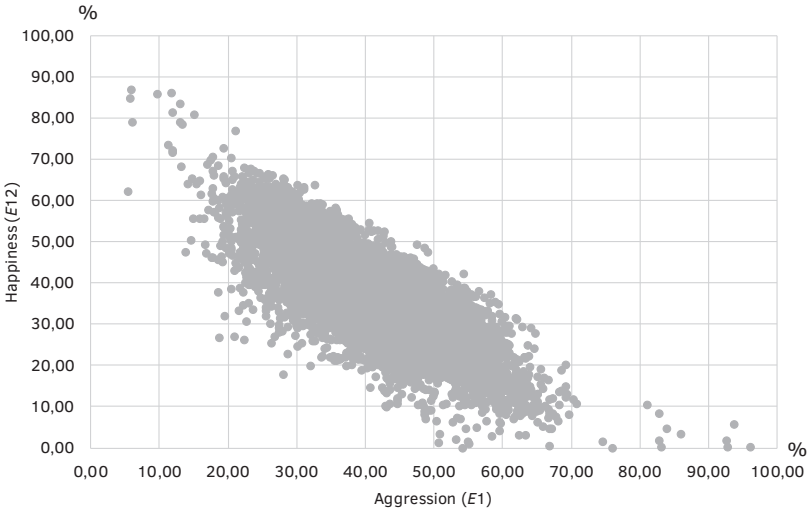

Fig. 4. Correlation dependence between Aggression and Happiness parameters (united database of 10 266 tests)

Each point in the Figures of distributions and correlations of behavioral characteristics displays the results of one measurement, and the number of tests is approximately equal to the number of subjects, since usually one person was tested once. The database of measurements of emotional and psychophysiological parameters presented in the application

includes more than 10 000 measurements of each parameter and allows readers to make their own calculations and build additional dependencies, since in this book I tried to reflect only the basic relationships between emotions.

From the point of view of psychology, it is quite understandable that the state of a person with the highest level of Aggression is characterized by a minimum level of Happiness. Accordingly, and vice versa, people with a minimum level of Aggression usually have high values of the level of Happiness. From Figure 4 it follows that the correlation between emotions of Aggression and Happiness is higher at an average level of Aggression, and at extreme values (high and low level) of Aggression, the correlation between the given parameters is slightly reduced.

4.2 Stress

The most famous stress researcher was Canadian endocrinologist Hans Selye (Selye, 1936), who used the term stress as a characteristic of the general adaptive stress of the body. Stress by Selye is the nonspecific response of an organism to any requirement presented to it. Since the existence of a person is impossible without incentives presented to him, each person is constantly in a state of stress, but the level of stress can vary significantly. Modern researchers offer various approaches to determine the level of stress (Kirschbaum et al., 1993; Cassar et al., 2009); however, there is no single approach to stress assessment methods, despite the wide use of this term in everyday life and scientific literature.

In vibraimage technology, an algorithmic approach to determining the level of stress was proposed (Minkin, 2014), its calculation equation (4) is given below:

$$E2 = St = \frac{\sum_{1}^{n}\left(\frac{|A_L^i - A_R^i|}{A_{\max}^i} + \frac{|F_L^i - F_R^i|}{F_{\max}^i}\right)}{2n} \cdot 100\% \qquad (4)$$

where A_L^i — total amplitude of vibraimage frequency component of *i*-th line of the left side of the object;
A_R^i — total amplitude of vibraimage frequency component of *i*-th line of the right side of the object;
$A_{\max}^i$ — maximum value from A_L^i и A_R^i;
F_L^i — maximum frequency of vibraimage frequency component of the i-th line of the left side of the object;
F_R^i — maximum frequency of vibraimage frequency component of the i-th line of the right side of the object;
$F_{\max}^i$ — maximum value from F_L^i и F_R^i;
n — number of lines occupied by the object image.

Stress in vibraimage technology is determined by the degree of asymmetry of the external frequency vibraimage, and therefore the asymmetry of the micromotion of the left and right parts of the human head. A large difference in the amplitude and frequency of movements of the left and right parts of the face (head) characterizes the increased level of Stress parameter. First of all, this is due to the fact that a large asymmetry in the movements of the head occurs when a person is practically motionless, when the body is relaxed and the person is in a free state, all his movements are quite smooth and uniform. But the stressful, and almost motionless state cannot last long; it necessarily goes into intermittent movements that create spatial unevenness recorded by vibraimage technology. The use of parameters characterizing the amplitude and frequency of movements in formula (4) makes it possible to increase the sensitivity of the algorithm to various manifestations of a person's stress state.

Figure 5 shows the distribution of Stress parameter measured values over the sample array in 10 266 tests.

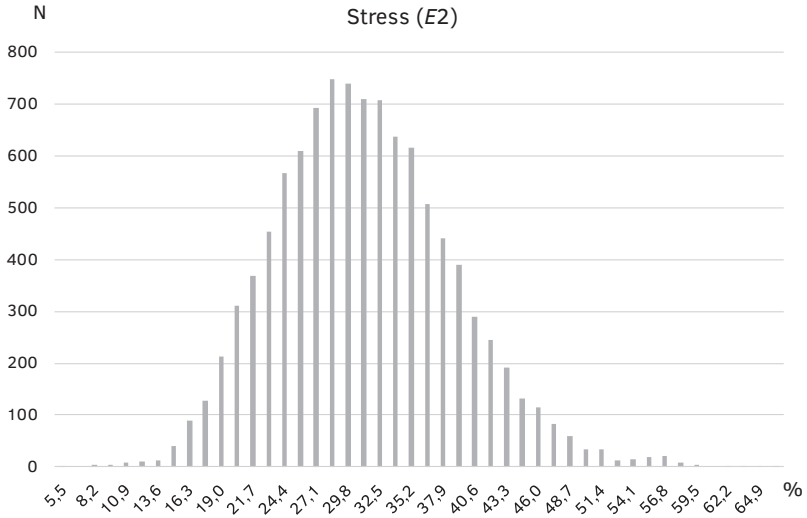

Fig. 5. Distribution of Stress parameter
(united database of 10 266 tests)

The distribution of Stress parameter shown in Figure 5 is quite close to the normal distribution, however, the left boundary is somewhat shorter, see the data M – 2SD and M – 3SD, shown in columns 6–9 of Table 8.

For Stress parameter, the dispersion between the average values and SD in various testing groups turned out to be minimal and does not exceed 1 %. It should be noted a noticeable decrease in the left boundary of the distribution for those tested by the PsyAceent program. At the level of M – 2SD, the number of samples beyond the specified boundary differs 10 times from the normal distribution, but at the level of M – 3SD there are no samples at all. This suggests that the level of Stress when testing with PsyAccent is noticeably higher than under normal conditions and people with a minimum

level of Stress under normal conditions experience noticeable discomfort when passing this test.

Table 8

Numerical analysis of Stress parameter distribution

Designations of mathematical characteristics for Stress state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	31,17	30,66	31,87	31,23					
SD	7,54	7,88	7,09	7,31					
M + SD	38,71	38,54	38,96	38,54	15,48	15,68	15,59	15,25	15,8
M – SD	23,63	22,77	24,78	23,92	15,67	15,88	16,36	16,16	15,8
M + 2SD	46,25	46,42	46,06	45,84	3,13	3,12	2,95	3,77	2,2
M – 2SD	16,09	14,89	17,68	16,62	0,99	0,92	0,77	0,23	2,2
M + 3SD	53,80	54,30	53,15	53,15	0,63	0,66	0,54	0,63	0,1
M – 3SD	8,54	7,01	10,59	9,31	0,03	0,04	0,00	0,00	0,1

The parameter with the maximum correlation with the level of Stress is the level of Charm (Charisma). The Pearson correlation coefficient between the Stress and Charm parameters was –0.78 according to the results of the available sample of 10 266 tests. The correlation statistical dependence between the parameters Stress and Charm is shown in Figure 6.

From the point of view of classical psychology, it is quite understandable that the state of a person with the highest level of Stress is characterized by a minimum level of Charm. Accordingly and vice versa, people with a minimum level of Stress have high values of the level of Charm. From Figure 6

it follows that the correlation between Stress and Charm is noticeably higher with a minimum level of stress, and with a high level of Stress, the correlation between the given parameters is significantly reduced.

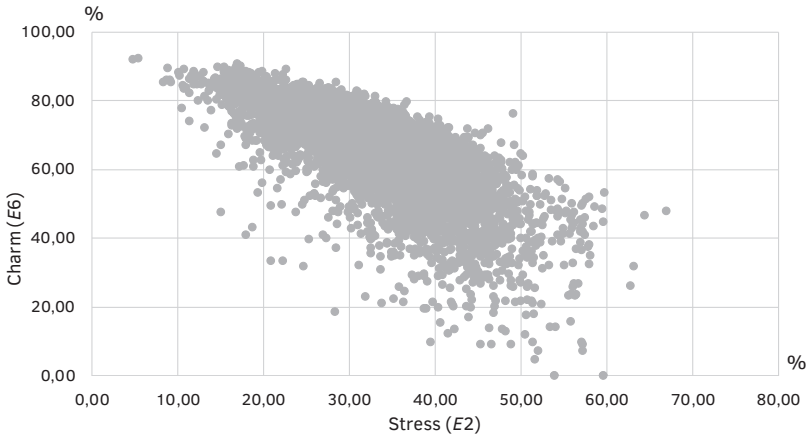

Fig. 6. Correlation dependence between Stress and Charm parameters (united database of 10 266 tests)

4.3 Tension (Anxiety)

The term Tension or Anxiety as a negative emotional state has been used for a long time to describe the expectation of a negative event or threat. Sigmund Freud distinguished three types of anxiety (Freud, 1926): real fear, neurotic anxiety, and moral anxiety. One of the most well-known methods for determining anxiety using a questionnaire — STAI (State-Trait Anxiety Inventory) (Spielberger et al., 1970), is an informative way to self-evaluate the level of anxiety at a given time (anxiety as a volatile state) and personal anxiety (as persistent personality characteristics of a person). Moreover, Spielberger in his works analyzed the correlation in the assessment of

anxiety between the results obtained by STAI and other well-known questionnaires (Spielberger et al., 1983). Modern researchers offer various methods for assessing psychophysiological anxiety (Verbitsky, 2003), including based on measuring the physiological parameters of a person.

In vibraimage technology, an algorithmic approach to determining the level of stress was proposed (Minkin, 2014), its calculation equation (5) is given below:

$$E3 = Tn = \frac{\sum_{\frac{f_{max}}{2}}^{f_{max}} P_i(f)}{\sum_{0,1}^{f_{max}} P_i(f)} \cdot 100\% \qquad (5)$$

where $P_i(f)$ — spectral power of vibraimage frequency distribution;

f_{max} — maximum frequency in the spectrum of the distribution of vibraimage frequency.

Tension is determined by the ratio of the high-frequency density of the vibration spectrum to the total power in the frequency spectrum of the micromotion of the human head. A high density of high-frequency vibrations characterizes a high value of Tension parameter. A similar approach to determining the weight ratio of high-frequency processes is used in the EEG to detect anxiety states (Moretti et al., 2013). It is assumed that the high activity of high-frequency physiological processes indicates increased nervousness of a person. Note that the above three parameters of negative emotions describe three fundamentally different approaches to measuring the parameters of the movement of the human head. The first parameter — Aggression connects head movement with statistical parameters (mathematical expectation, standard deviation) characterizing the integral characteristics of movement

with a frequency of 5 Hz. The second parameter — Stress characterizes the spatial processes of motion. The third parameter — Anxiety, characterizes high-frequency processes of movement with a frequency of 30 Hz. Theoretically there is no mathematical correlation between these characteristics.

Figure 7 shows the distribution of the measured values of Tension parameter over the sample array in 10 266 tests.

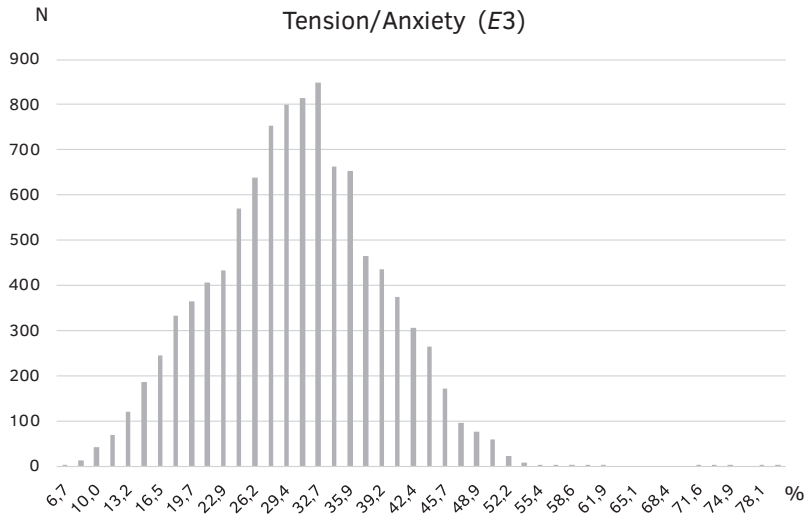

Fig. 7. Distribution of Tension parameter (united database of 10 266 tests)

The distribution of Tension parameter shown in Figure 7 is relatively close to the normal distribution, however, the left border is slightly shorter (M – 3SD = 0), and the right one has a noticeable deviation in the level of M + SD, see the data given in Table 9.

The parameter having the maximum correlation with the level of Tension is the level of Suspect. The Pearson correlation coefficient between the Tension and Suspect parameters

was 0.64 based on the results of an united database of 10 266 tests. The correlation statistical relationship between the Tension and Suspect parameters is shown in Figure 8.

Table 9

Numerical analysis of the distribution of Tension parameter

Designations of mathematical characteristics for Tension state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	30,46	31,70	29,24	29,35					
SD	8,53	9,43	7,48	7,23					
M + SD	38,99	41,13	36,72	36,59	12,47	15,68	12,47	14,68	15,8
M – SD	21,93	22,28	21,77	22,12	15,68	15,88	15,68	17,13	15,8
M + 2SD	47,52	50,56	44,20	43,82	2,27	3,12	2,27	1,83	2,2
M – 2SD	13,39	12,85	14,29	14,89	2,56	0,92	2,56	2,23	2,2
M + 3SD	56,06	59,99	51,68	51,05	0,26	0,66	0,26	0,00	0,1
M – 3SD	4,86	3,42	6,81	7,65	0,00	0,04	0,00	0,00	0,1

Clarify that the dependence obtained in Figure 8 shows a positive correlation between the Tension and Suspect parameters, in contrast to the previous correlation dependencies presented in Figures 4 and 6. A positive correlation between the Tension and Suspect parameters is explained mathematically (Tension by 1/3 is included in calculating the level of Suspect), and psychologically it is clear that an anxious person can be dangerous to others. Accordingly, and vice versa, people with a minimum level of Tension have low Suspect level values, and the correlation dependence is approximately the same for low and high values of Tension level.

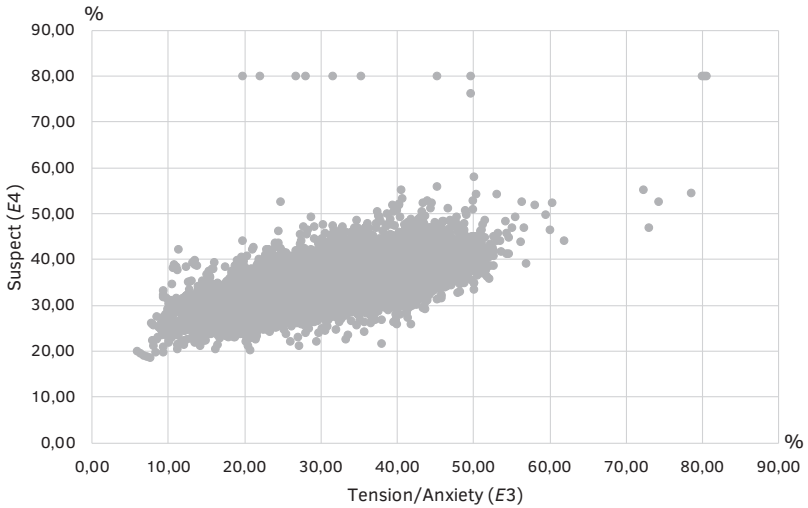

Fig. 8. Correlation dependence between Tension and Suspect parameters (united database of 10 266 tests)

4.4 Suspect (Suspicious)

In modern security systems, which usually work in real time, it is immediately necessary to make a decision on the possibility of admission or inadmissibility of a controlled person to a guarded object. In conditions of limited time for making a decision, it is impractical to consider the values of different emotional parameters of a controlled person, they should be reduced to one parameter characterizing the danger of a person to others at the moment. The standard task of such security systems is the prevention of terrorist acts, which becomes possible if a person's intentions are controlled by analyzing his psychophysiological state. The relevance of creating such systems became apparent after the September 11, 2001 terrorist attack, although individual terrorist acts accompany the entire history of humanity. Naturally, all countries take certain measures to protect

their interests and citizens (Nunamaker, 2009; SPOT, 2008), although in any team it is interesting to understand the danger to others that is posed by a new or already working employee. A practical solution to the problem of identifying potentially dangerous people within 10 seconds of psychophysiological control using vibraimage technology was shown during the Sochi Olympics (Minkin & Tseluyko, 2014).

In vibraimage technology was proposed the algorithmic approach for determining the level of Suspect (VibraStat, 2019), its calculation equation (6) is given below:

$$E4 = SI = \frac{\left(E1 + E2 + E3\right)}{3} \tag{6}$$

where $E1$ — Aggression level;
$E2$ — Stress level;
$E3$ — Tension level.

In vibraimage technology, Suspect parameter is defined as the average value of the sum of the first three conditionally negative emotions (Aggression, Stress, Tension), shows the level of potential danger that a person poses to others, and characterizes the general level of negative emotions in a person's condition (VibraStat, 2019). For the Suspect parameter, as mentioned earlier, the general approach to the calculation of emotional parameters has been slightly changed. Suspect parameter is not independent and reflects the negative properties of a person. On the contrary, Suspect parameter must have a mathematical correlation of approximately 0.3 with each of its constituent parameters. Perhaps in the future, we should revise the algorithm for calculating this parameter if another characteristic of the person's Suspect level, based on an individual algorithm and not on a sum of the three previous ones.

Figure 9 shows the distribution of the measured values of Suspect parameter over the sample array of 10 266 tests.

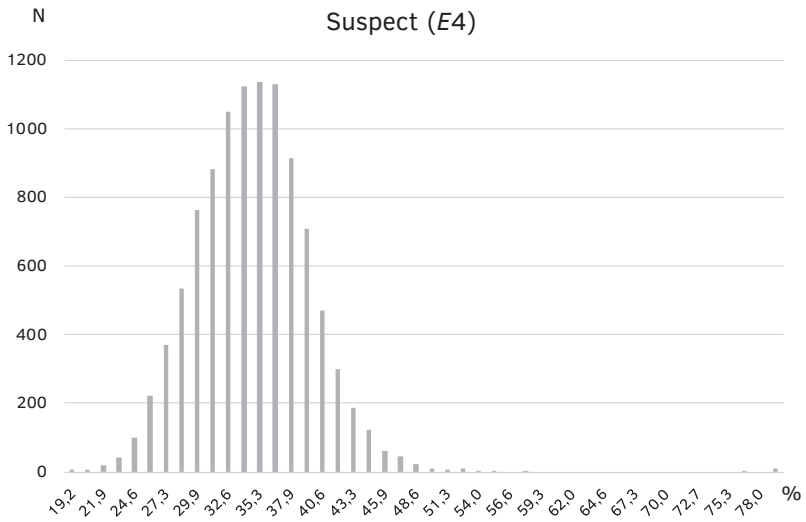

Fig. 9. Distribution of Suspect parameter
(united database of 10 266 tests)

The distribution of Suspect parameter in the united database has a minimum SD (less than 5 %) in relation to the previous three parameters (Table 10). Most likely this is determined by the fact that in a normal state of a person, the emotions of Aggression and Stress change in different directions (weak negative correlation in Table 2), which leads to the fact that the distribution is somewhat more compressed than normal.

The parameter having the maximum correlation with the level of Suspect is the level of tension. Both of these parameters have the maximum mutual correlation between each other. The Pearson correlation coefficient between the Suspect and Tension parameters was 0.64 based on the results of the united database of 10 266 tests, the Suspect-Aggression correlation coefficient was 0.52, the Suspect-Stress correlation coefficient was 0.53. The correlation statistical relationship between the Suspect and Tension parameters shown on Figure 10.

Table 10

Numerical analysis of the distribution of Suspect parameter

Designations of mathematical characteristics for Suspect state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	34,68	33,76	35,55	35,55					
SD	4,96	5,38	4,33	4,39					
M + SD	39,64	39,13	39,88	39,95	13,48	14,34	13,15	13,93	15,8
M – SD	29,72	28,38	31,23	31,16	15,06	14,88	14,68	15,02	15,8
M + 2SD	44,60	44,51	44,20	44,34	2,21	2,42	2,41	2,40	2,2
M – 2SD	24,76	23,00	26,90	26,76	1,31	0,94	1,70	0,29	2,2
M + 3SD	49,55	49,89	48,53	48,73	0,43	0,46	0,51	0,46	0,1
M – 3SD	19,80	17,62	22,58	22,37	0,06	0,00	0,03	0,00	0,1

Note that the dependence obtained in Figure 10 shows a positive correlation between Suspect and Tension parameters, although other parameters of the group of negative emotions (Aggression, Stress) have the maximum negative correlation with positive emotions. The positive correlation between the Suspect and Stress parameters is again explainable both mathematically (Tension by 1/3 is included in the calculation of the Suspect level) and psychologically it is clear that a person in an anxious state is inadequate and can be dangerous for others. Accordingly, and vice versa, people with a minimum level of Suspect have a low level of Tension, the correlation dependence of Suspect-Tension for low levels of Suspect is slightly higher than at high values of Suspect-Tension. It is explained by psychological reasons too, since

high levels like Suspect, so Tension can have various causes. The presence of counts at 80 % noticeable in Figure 10, is due to a closed algorithm (additional to equation 6) that sets this value for Suspect level at abnormally high values based on Aggression-Stress pair and high Aggression level.

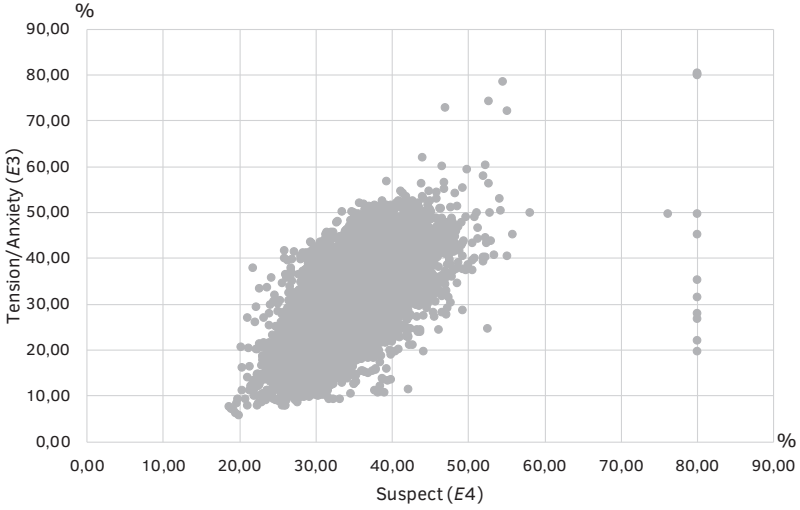

Fig. 10. Correlation dependence between Suspect and Tension parameters (united database of 10 266 tests)

4.5 Balance

The proposed cybernetic approach to the analysis of positive emotional states determines respectively the technical principles of the analysis of uniformity, symmetry and smoothness of movements. Moreover, the study of positive emotional states is significantly inferior to the study of negative states, since the medical approach to the study of pathology clearly does not work when studying positive emotions. This leads to an even wider spread of various definitions and opinions about positive emotions in classical psychology.

Balance or psychological equilibrium is certainly one of the most important characteristics of the psychophysiological state of a person. The main thesis of the developer of the myokinetic methodology for assessing the personality of Mira-i-Lopez (Mira y Lopez, 1957): “Mental imbalance and myokinetic imbalance are two sides of the same individual process. Changes in the level of mental stress are reflected in the level of muscle tension.”

In vibraimage technology, was proposed the algorithmic approach to determine the level of Balance (VibraStat, 2019), the equation for its calculation (7) is given below:

$$E5 = Bl = (100 - 2Va)\% \tag{7}$$

where Va — variability sum of emotional parameters.

Variability of each emotional parameter is calculated as the ratio of the standard deviation to the mathematical expectation. Variability more steadily reflects the characteristics of each emotional parameter and is used not only to determine emotions, but also in medical diagnostics (Blank et al., 2014). Minimum variability characterizes the temporal stability of emotional parameters, which corresponds to the maximum balance of a person. Text definitions of the parameters Balance and Stability are quite close. Initially, the equation (16) was used to determine the Balance parameter, which is now used to determine the Stability parameter, since the proposed approach to the determination of emotions as parameters with significant correlation showed the feasibility of using this calculation formula to determine the Balance parameter, which is in the group of positive emotional parameters.

Figure 11 shows the distribution of the measured values of the Balance parameter across the sample array in 10 266 tests.

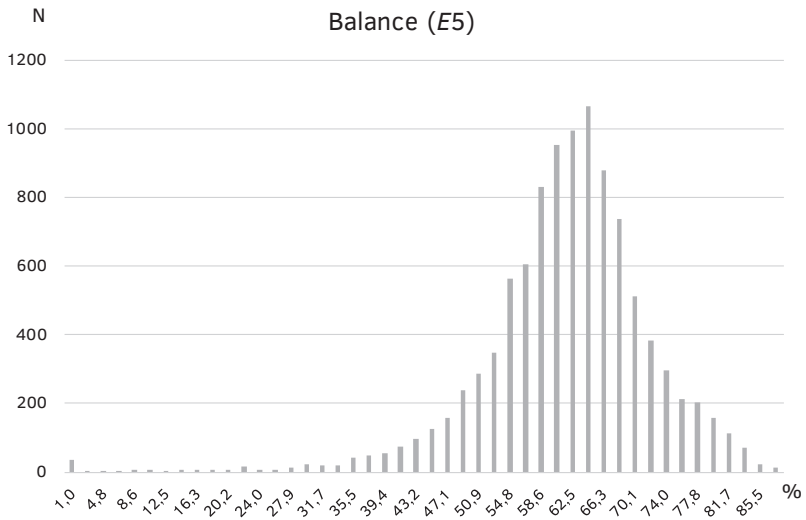

Fig. 11. Distribution of Balance parameter (united database of 10 266 tests)

The distribution of the Balance parameter is close to the normal law, taking into account the noticeably shorter right boundary. We note a significantly larger SD in Balance measurement by VibraMed program in relation to all other programs (Table 11), which indicates that freedom of behavior conditions increases the dispersion of not only negative emotions (the largest deviation of the standard deviation was observed for the Aggression parameter), but also positive ones. The numerical analysis of the distributions of the Balance parameter is given in Table 11. It is interesting to note that a decrease in the Balance spread in various testing conditions does not lead to a noticeable change in the average value of this parameter in groups. This suggests that testing with VibraMI and PsyAccent programs with periodic presentation of stimuli affects the balance of individuals with deviations of this parameter towards both high and low values.

Table 11

Numerical analysis of the distribution of Balance parameter

Designations of mathematical characteristics for Balance state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	61,64	62,81	60,41	60,78					
SD	10,58	13,44	6,66	6,61					
M + SD	72,22	76,25	67,06	67,39	12,00	12,94	14,51	13,02	15,8
M – SD	51,06	49,37	53,75	54,17	11,55	12,45	14,03	15,08	15,8
M + 2SD	82,79	89,69	73,72	74,01	0,95	0,00	0,60	0,69	2,2
M – 2SD	40,49	35,93	47,09	47,55	3,25	4,08	3,15	5,14	2,2
M + 3SD	93,37	103,13	80,38	80,62	0,00	0,00	0,00	0,00	0,1
M – 3SD	29,91	22,49	40,43	40,94	1,32	1,82	1,11	0,69	0,1

The parameter having the maximum correlation with the level of Balance is the level of Depression. The Pearson correlation coefficient between the Balance and Depression parameters was –0.43 based on the results of the united database of 10 266 tests. The correlation statistical relationship between the Balance and Depression parameters shown on Figure 12.

Note that Balance is one of the few emotional parameters that do not have a correlation with other psychophysiological parameters at a level above 0.5, which confirmed in Table 1, and brings it closer to the psychophysiological parameter since the proposed separation threshold in the Pearson correlation coefficient between emotions and psychophysiological parameters is 0.4 in absolute value.

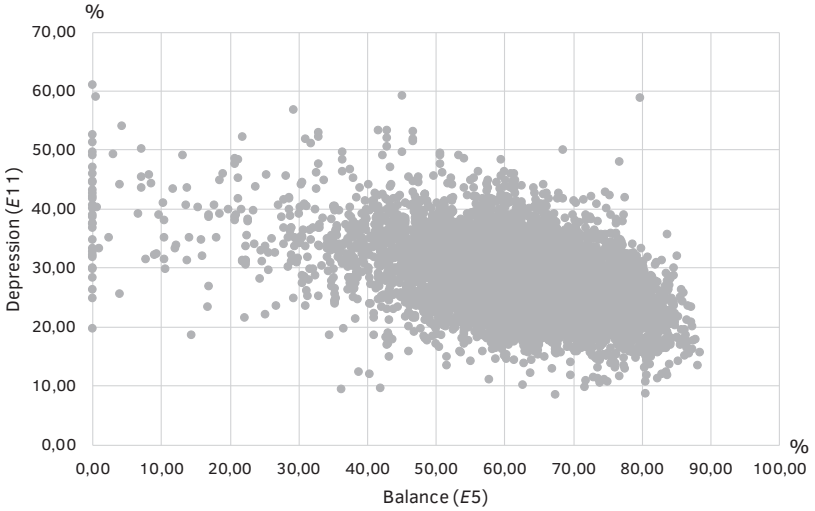

Fig. 12. Correlation dependence between Balance and Depression parameters (united database of 10 266 tests)

From the point of view of classical psychology, the positive correlation between the Balance-Depression parameters is reasonably well explained, since a person in the Depression state is most often in an unbalanced state.

4.6 Charm (Charisma)

Typically, this parameter raises the greatest number of questions among users of vibraimage system and readers, since it is associated not with the person being studied, but with the perception of this person by other people. However, the perception of the personality by other people depends primarily on the characteristics of the personality itself, therefore this characteristic seems to us quite important and is one of the proposed characteristics of positive emotions. Modern studies of positive emotions (Fredrickson, 1998; Kok et al., 2013)

offer a wide selection of principles for the formation of positive emotional states, which are determined almost exclusively by the subjective imagination of researchers. In this regard, the proposals of the developers of vibraimage technology (VibraStat, 2019) are objective, since a clear algorithm for determining proposed for each positive emotion.

In vibraimage technology, an algorithmic approach to determining the level of Charm was proposed (VibraStat, 2019), its calculation equation (8) is given below:

$$E6 = Ch = \frac{\sum \frac{|W_{li} - W_{ri}|}{\max(W_{li}, W_{ri})} + \sum \frac{|C_{li} - C_{ri}|}{255}}{N} \cdot 100\% \qquad (8)$$

where $|W_{li} - W_{ri}|$ — difference between the average values of the amplitude on the left and right sides of vibraimage amplitude component for each line;
$|C_{li} - C_{ri}|$ — difference between the maximum frequency values on the left and right sides of vibraimage amplitude component for each line.

Charm parameter is determined by the symmetry of micromotions of the head and face, the maximum symmetry of movements (frequency and amplitude) characterizes a high level of Charm. In the current version of vibraimage system, the mathematical calculation of the Charm parameter is based on the same principles as the Stress parameter, but with the opposite sign, the Stress parameter is processed from the frequency vibraimage component, but Charm parameter is processed from the amplitude vibraimage component (Minkin & Myasnikova & Nikolaenko, 2019). This approach was chosen on the assumption that vibraimage frequency is more stable for detecting negative states with sharp movements, and positive emotions are better displayed by the amplitude vibraimage

characterizing smooth movements. When developing a set of positive-negative emotional parameters, it was tempting to use characteristics close to the opposite if the negative correlation between them does not exceed a critical level (it was assumed before that the Pearson correlation coefficient between the parameters should not exceed 0.8 in absolute value).

Figure 13 shows the distribution of the measured values of the Charm parameter over the united database of 10 266 tests.

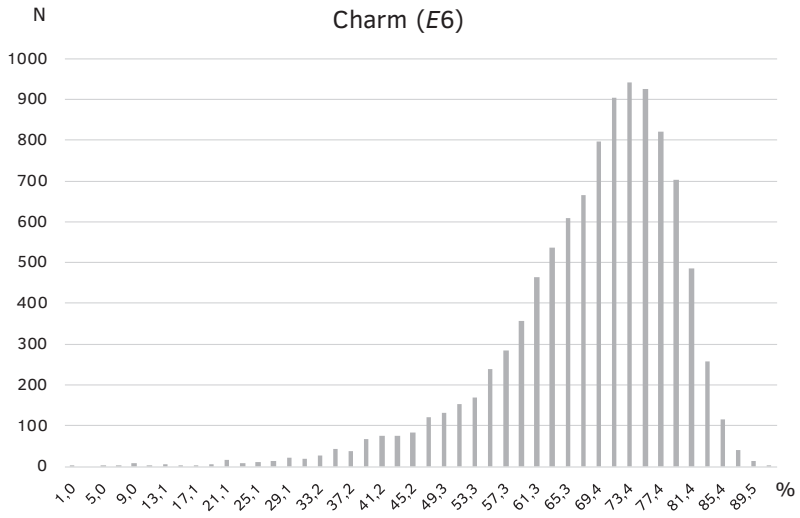

Fig. 13. Distribution of Charm parameter (united database of 10 266 tests)

The distribution of the Charm parameter shown in Figure 13, like the Balance parameter, has a longer left border (correspondingly shorter right), which is confirmed by the numerical values of the distribution given in Table 12. Note that this is the first parameter, the numerical values of which very little depend on environmental conditions and the main numerical characteristics of the parameter Charm remains unchanged when tested by three different programs.

Table 12

Numerical analysis of Charm parameter distribution

Designations of mathematical characteristics for Balance state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	68,20	68,13	68,22	68,36					
SD	11,40	12,56	9,97	10,55					
M + SD	79,60	80,69	78,18	78,91	11,51	11,83	12,33	11,42	15,8
M – SD	56,80	55,57	58,25	57,80	13,75	13,96	13,72	13,93	15,8
M + 2SD	90,99	93,26	88,15	89,47	0,02	0,00	0,00	0,00	2,2
M – 2SD	45,41	43,00	48,28	47,25	4,77	4,85	4,54	5,43	2,2
M + 3SD	102,39	105,82	98,12	100,02	0,00	0,00	0,00	0,00	0,1
M – 3SD	34,01	30,44	38,31	36,70	1,42	1,46	1,19	1,43	0,1

The parameter with the maximum correlation with the level of Charm is the level of Stress. The Pearson correlation coefficient between the Charm and Stress parameters was –0.78 according to the results of the available sample of 10 266 tests. The correlation statistical dependence between the Charm and Stress parameters shown in Figure 14.

We note that Charm has the greatest correlation not with the positive parameters, but with Stress parameter, which belongs to the group of negative parameters, and they have negative correlation. This is probably due in part to the inverse principles of determining these parameters, the Charm parameter is proportional to the symmetry of the vibrations of the human head, and the Stress parameter is proportional to the asymmetry of the vibrations. For reducing the mathematical

correlation, the Stress parameter processed using the frequency component of vibraimage, and the Charm parameter processed using the amplitude component of vibraimage (Minkin & Myasnikova & Nikolaenko, 2019).

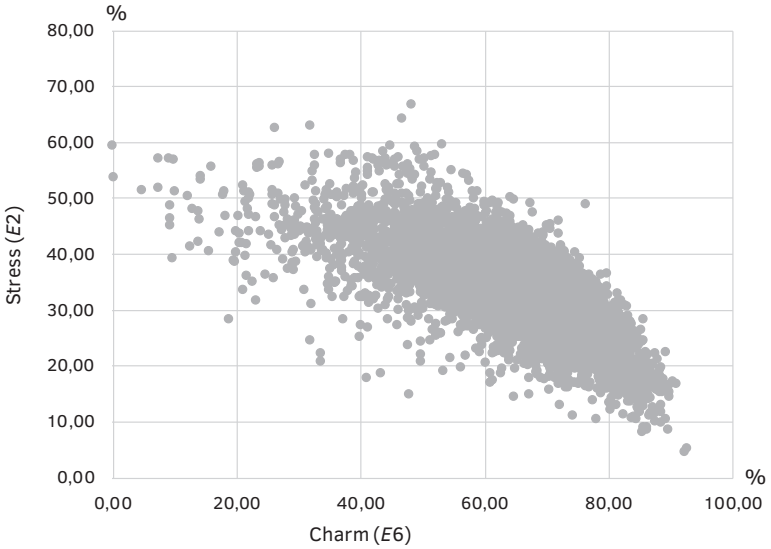

Fig. 14. Correlation dependence between Charm and Stress parameters (united database of 10 266 tests)

From the point of view of classical psychology, the negative correlation between the Charm-Stress parameters is also well explainable, since these terms are opposite and a charismatic person cannot be stressed and vice versa, a stressed person is unlikely to look charismatic.

4.7 Energy (Activity)

I had doubts about the appropriateness of Energy parameter to a group of positive characteristics of a person. Despite doubts, the perception of an energetic person, as one of

success characteristics, won. Although the term Energy itself directly connects a person's state with energy costs, which are determined mainly by the nature of the activity at any given time. At the current level of tech development, there are many methods and devices measuring human energy costs (Ceaser, 2012; Broderick et al., 2014). In vibraimage technology, an algorithmic approach was also proposed to determine the level of Energy based on measuring the energy consumption of person under study (VibraStat, 2019), the equation for calculating Energy (9) is given below:

$$E7 = En = \frac{M - \sigma}{F_{ps}} \cdot 100\% \tag{9}$$

where M — maximum value of counts on the frequency histogram;
σ — SD of vibraimage frequency, calculated by the frequency histogram;
F_{ps} — maximum of vibraimage input frequency.

Energy is determined by the frequency histogram and characterizes the difference between the values of the maximum density of vibration frequency and SD of vibration frequency for the face and head of a person. The higher frequency density maximum value and the lower the standard deviation or the dispersion of vibrations, the higher the Energy value. The calculation of Energy parameter is similar to the calculation of Aggression, the difference is that an increase in the parameter Aggression occurs with an increase in the dispersion of vibrations (SD), and an increase in the value of Energy occurs with a decrease in the dispersion of vibrations (SD). At the same time, Aggression and Energy are proportional to the average vibration frequency, this characteristics combines both states. If high values of Aggression can

talk about the danger of a given person to others, then high values of Energy usually indicate that a person spends a lot of physical energy, it can be an athlete performing heavy physical exercises or a person solving a difficult mental task.

Figure 15 shows the distribution of the measured values of the Energy parameter over united database of 10 266 tests.

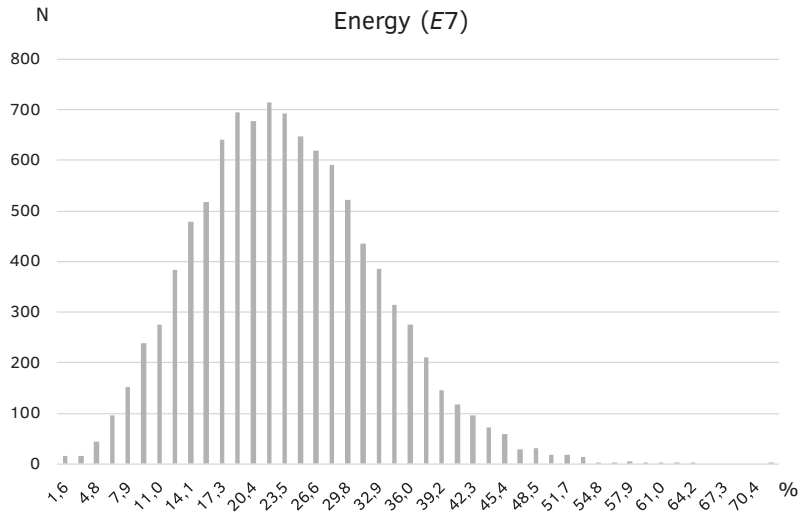

Fig. 15. Distribution of Energy parameter (united database of 10 266 tests)

The distribution of Energy parameter is close to the normal distribution law; the left side of the distribution is somewhat shortened, which follows from the numerical analysis shown in Table 13. We also note about a 20 % increase in human energy costs when tested by VibraMI and PsyAccent programs compared to the free state by VibraMed testing. In this case, the scatter of the values of the Energy parameter during testing with questionnaires is much less than with a free state of a person.

Table 13

Numerical analysis of Energy distribution

Designations of mathematical characteristics for Energy state	Parameter value,%				The number of counts beyond the specified range,%				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	23,82	21,80	25,72	25,77					
SD	9,10	10,15	7,30	7,87					
M + SD	32,92	31,95	33,01	33,63	15,72	15,84	15,68	17,25	15,8
M – SD	14,72	11,65	18,42	17,90	15,98	13,64	15,68	15,99	15,8
M + 2SD	42,02	42,10	40,31	41,50	3,24	4,49	3,07	2,28	2,2
M – 2SD	5,62	1,50	11,12	10,03	0,77	0,12	1,93	2,11	2,2
M + 3SD	51,12	52,25	47,61	49,37	0,54	0,82	0,43	0,06	0,1
M – 3SD	–3,48	–8,65	3,83	2,16	0,00	0,00	0,00	0,00	0,1

The parameter having the maximum correlation with the level of Energy is the level of Depression. The Pearson correlation coefficient between the Energy and Depression parameters was –0.8 according to the results of the united database of more than 10 000 tests. The correlation statistical dependence between the parameters Energy and Depression shown in Figure 16.

Note that Energy as well as Charm has the greatest correlation not with positive parameters, but with the Depression parameter, which belongs to the group of negative parameters, and they have a negative correlation. This is again connected both with the mathematical logic of determining the parameters and the psychological meaning of both parameters. If Energy is characterized by a direct dependence on the energy consumed

by a person, then a depressed state is usually associated with minimizing energy costs and a breakdown.

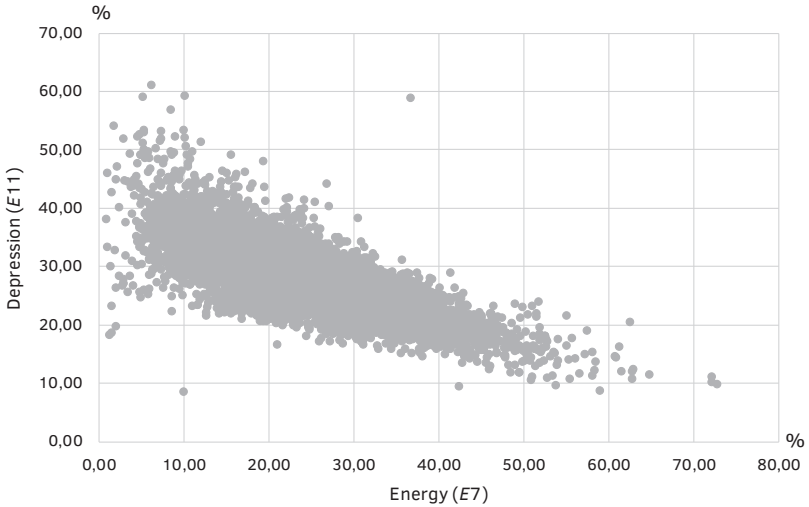

Fig. 16. Correlation dependence between Energy and Depression parameters (united database of 10 266 tests)

4.8 Self-Regulation

For the successful functioning of the human body, the mechanisms of metabolism and self-regulation of physiological systems that constantly processing in the human body are of particular importance (Tamar, 1976; Bayevsky et al., 2001). The psychological aspects of Self-Regulation have also been studied extensively by different researchers (Carver & Scheier, 1998).

In vibraimage technology the algorithmic approach was also proposed to determine the level of Self-Regulation based on measuring the stability of the positive characteristics of the person under study (VibraStat, 2019), the equation for calculating it (10) is given below:

$$E8 = Sr = \left(1 - \frac{\mathrm{d}E5 + \mathrm{d}E6}{\mathrm{d}E5 + \mathrm{d}E6 + E5 + E6}\right) \cdot 100\% \qquad (10)$$

where $E5$ — average value of Balance parameter during the measurement process;
$\mathrm{d}E5$ — the range of Balance parameter changes;
$E6$ — average value of Charm parameter during the measurement process;
$\mathrm{d}E6$ — the range of Charm parameter changes.

The Self-Regulation parameter is inversely proportional to the change in emotions ($E5$, $E6$) and characterizes the level of positive emotions stability for a person at a given time. It is interesting to note that the original equation for calculating Self-Regulation did not use the additional sum $\mathrm{d}E5 + \mathrm{d}E6$ in the denominator of the fraction, but this calculation had to be abandoned since obtained result had a significant correlation at a level above 0.8 with the Balance and Charm parameters. For the given equation (10), the correlation between the Self-Regulation and Charismatic parameters also turned out to be quite high, but not exceeding the value of 0.8 and satisfy to the established requirements.

Figure 17 shows the distribution of the measured values of the Self-Regulation parameter over the united database of 10 266 tests.

The distribution of the Self-Regulation parameter has the form of a multimodal distribution with three distinct maxims. It seems logical to tie each maximum to different testing conditions, but consideration of individual distributions shows that this is not so. In order to show this, I will slightly depart from the existing order of presentation of parameters and in Figure 18, I will give an additional graph of the distribution of the Self-Regulation parameter when testing with VibraMI.

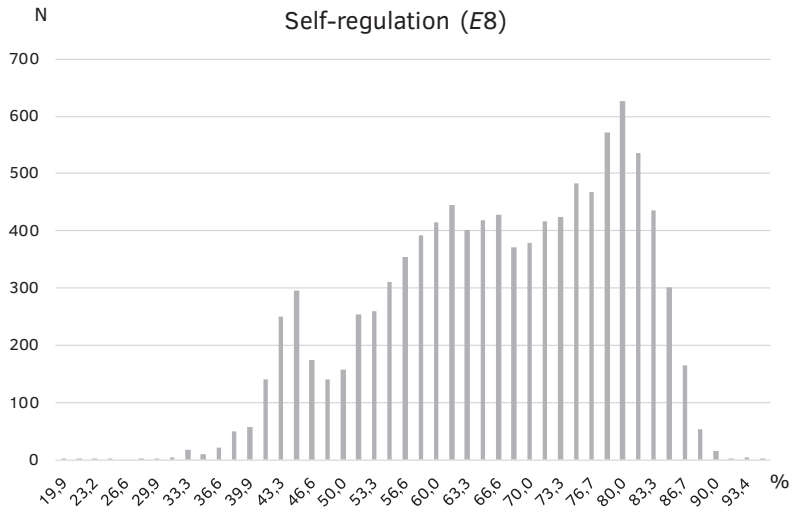

Fig. 17. Distribution of Self-Regulation parameter (united database of 10 266 tests)

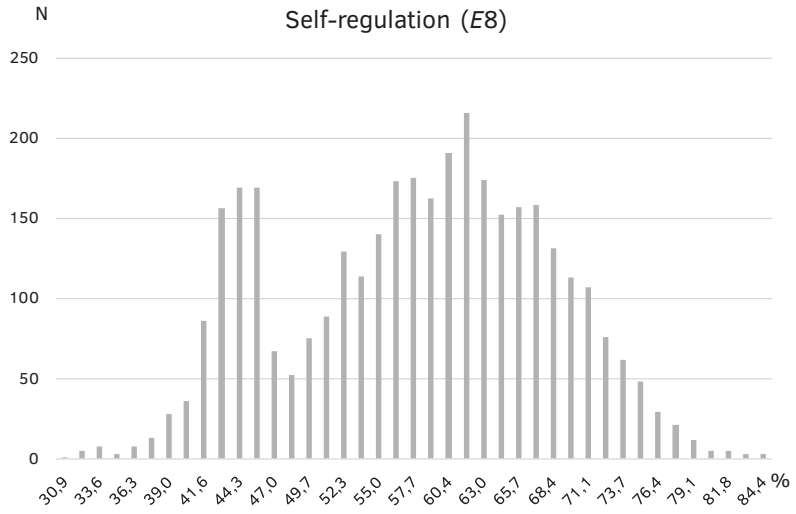

Fig. 18. Distribution of Self-Regulation parameter (3521 tests by VibraMI program)

The distribution shown in Figure 18 shows that for a certain group of subjects, testing with VibraMI questionnaire was not so harmless and the level of self-regulation during this test significantly decreased (43 %) compared with the main group (63 %). This also affected to SD when testing with VibraMI program, which for the first time (for all previous emotional parameters, the SD for VibraMI testing was lower than when testing with PsyAccent or VibraMed programs) exceeded the spread of similar values for other programs shown in Table 14.

Table 14

Numerical analysis of Self-Regulation distribution

Designations of mathematical characteristics for Self-Regulation state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	66,87	75,69	57,94	59,70					
SD	12,76	9,16	9,96	9,09					
M + SD	79,64	84,85	67,90	68,79	19,26	7,97	16,81	15,19	15,8
M – SD	54,11	66,52	47,98	50,61	17,94	12,90	21,58	15,88	15,8
M + 2SD	92,40	94,01	77,86	77,87	0,08	0,08	1,02	1,71	2,2
M – 2SD	41,35	57,36	38,02	41,52	2,07	5,13	0,97	2,80	2,2
M + 3SD	105,16	103,18	87,82	86,96	0,00	0,00	0,00	0,06	0,1
M – 3SD	28,59	48,19	28,06	32,44	0,05	2,22	0,00	0,00	0,1

The parameter having the maximum correlation with the level of Self-Regulation is the level of Happiness. The Pearson

correlation coefficient between the Self-Regulation and Happiness parameters was 0.51 based on the results of the united database of 10 266 tests. The correlation statistical dependence between the Self-Regulation and Happiness parameters shown in Figure 19.

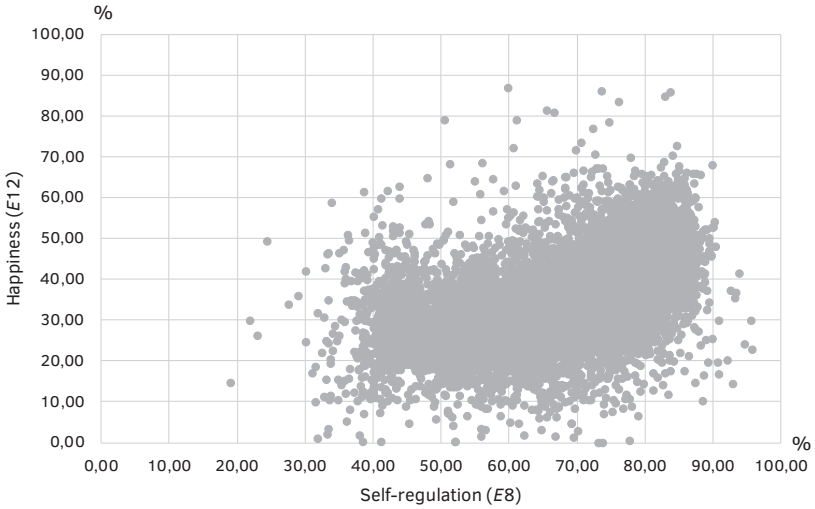

Fig. 19. Correlation dependence between Self-Regulation and Happiness parameters (united database of 10 266 tests)

Note that Self-Regulation has a positive correlation with the level of Happiness, and this correlation is almost the same for high and low values of the Self-Regulation parameter. A positive correlation between the emotional characteristics of Self-Regulation-Happiness has only a psychological explanation, since the mathematical calculation of the parameters does not give grounds for a high positive correlation. From a psychological point of view, it is quite understandable that in a person who is in a positive and comfortable emotional state, the levels of Self-Regulation and Happiness should be at high values.

4.9 Inhibition

In contrast to the previous emotional parameters, initially oriented towards proximity to the expert assessment of emotions, in vibraimage technology, the Inhibition parameter was conceived as a physical characteristic of the minimum human reaction time to the presented stimulus. It is known that the time delay constant (inhibition) of a trained person per stimulus (Bernstein, 1990) is about 0.1 second. This value (in relative units or in per-unit system, when calculating the parameter in percent, the value is multiplied by 100%) is obtained when calculating the reaction of tested people when calculating according to equation (11), proposed by the developers of vibraimage technology (VibraStat, 2019). Longer reaction times correspond to higher Inhibition level:

$$E9 = Ih = \frac{T_m(F_1)}{T} \cdot 100\% \qquad (11)$$

where F_1 — frequency of vibraimage change;
T_m — averaged period of vibraimage frequency variation;
T — vibraimage period measuring.

Inhibition parameter ($E9$) is defined as the average period of the F1 parameter, measured by default for 100 frames. The value of the Braking parameter in the region of 10% (which reflects the reaction time of 0.1s) indicates that the graph of the vestibulogram of the center of gravity displacement of the human head makes about 10 periodic oscillations per second. Naturally, this parameter is determined by the maximum possible frame rate and, in accordance with the Nyquist-Shannon-Kotelnikov theorem (Akimov et al., 2019), the frame processing frequency for calculating this parameter should be at least 25 fps. It is known that Pavlov considered the Inhibition-Arousal parameters to be the defining characteristics

of the human physiological system (Pavlov, 1951) and assumed all other emotional parameters to be dependent on the Inhibiting-Arousing characteristic.

Figure 20 shows the distribution of the measured values of Inhibition parameter over the united database of 10 266 tests.

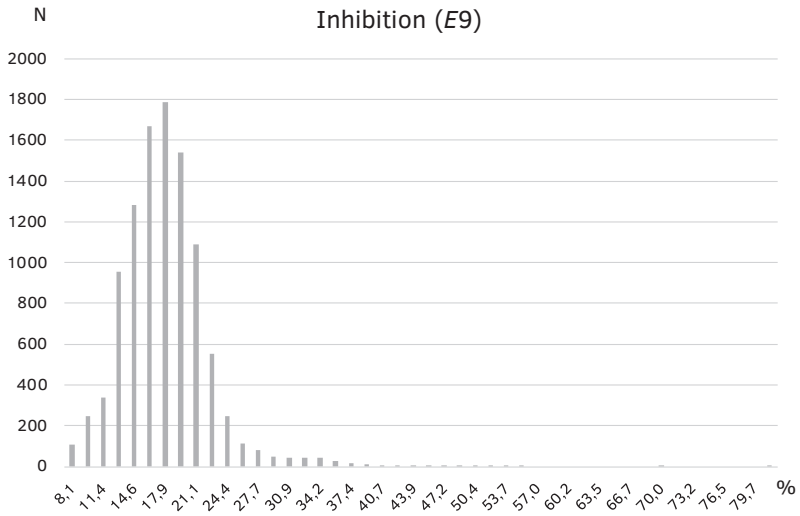

Fig. 20. Distribution of Inhibition parameter (united database of 10 266 tests)

The distribution of Inhibition parameter is quite compact and looks like a normal distribution with slightly asymmetric edges (Table 15). The scatter of numerical values and the shape of the distributions is insignificant, which shows a weak effect of various external conditions on Inhibition parameter.

The parameter having the maximum correlation with the level of Inhibition is Neuroticism. The Pearson correlation coefficient between the Inhibition and Neuroticism parameters was 0.52 based on the results of an available sample of 10 266 tests. The correlation statistical relationship between the Inhibition and Neuroticism parameters shown in Figure 21.

Table 15

Numerical analysis of the distribution of Inhibition parameter

Designations of mathematical characteristics for Inhibition state	Parameter value,%				The number of counts beyond the specified range,%				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	17,85	17,65	18,39	17,34					
SD	4,59	5,68	3,30	2,97					
M + SD	22,44	23,33	21,69	20,30	10,10	11,29	13,12	14,22	15,8
M – SD	13,25	11,96	15,09	14,37	12,10	8,01	13,83	13,82	15,8
M + 2SD	27,04	29,01	24,99	23,27	3,19	4,63	1,19	2,28	2,2
M – 2SD	8,66	6,28	11,78	11,40	0,79	0,00	4,35	2,63	2,2
M + 3SD	31,63	34,69	28,30	26,24	1,68	1,70	0,28	0,57	0,1
M – 3SD	4,07	0,60	8,48	8,43	0,00	0,00	0,34	0,00	0,1

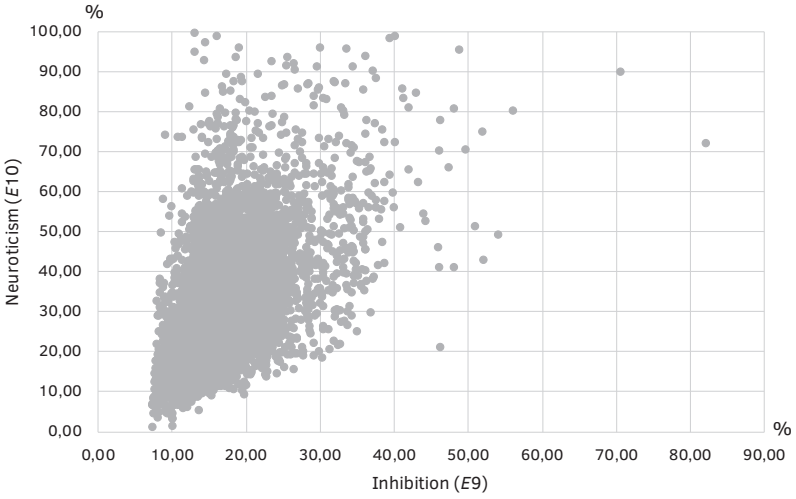

Fig. 21. Correlation dependence between Inhibition and Neuroticism parameters (united database of 10 266 tests)

Inhibition has a positive correlation with Neuroticism according to the results of the general sample, which is explainable psychologically, since a high level of Inhibition can be increased Neuroticism. It is difficult to guess which parameter is primary in this pair, an increased level of Neuroticism leads to an increase in the level of Inhibition, or an increased level of Inhibition causes a high level of Neuroticism. This is a question of the origin of emotions, which is reflected in several theories, the most famous of which is the James-Lange theory (Cannon, 1927). The complexity of determining the mechanisms of emotions emergence is also confirmed by the fact that for all the similarity of the parameters of Inhibition distribution in groups, there is a different maximum correlation of this parameter depending on external conditions. This follows from a comparison of the maximum correlations for Inhibition parameter given in Tables 1, 3, 4 and 5.

If the maximum correlation of Inhibition parameter in a free state of a person occurs with the Neuroticism parameter, then when testing with questionnaires, the maximum correlation of Inhibition parameter is detected with Tension parameter. Thus, the significance of the correlation between emotional parameters depends not only on the parameters themselves, but also on external conditions that affect the mechanism by which these parameters arise. To confirm this thesis, in Figure 22 presented the correlation dependence between Inhibition parameter on Tension parameter by VibraMI testing.

The Pearson correlation coefficient between Inhibition and Tension parameters was –0.69 for the database of 3521 tests by VibraMI program according to the correlation dependence shown in Figure 22. This correlation is higher than maximum correlation of Inhibition parameter calculated by united databased and presented on Figure 21. The binding of the Inhibition parameter to physical quantities (seconds) has led to the fact that Figures 21 and 22 clearly show the limitation

of a person's physical abilities along the border of 10% (0.1s) for Inhibition parameter. Several counts of the Inhibition parameter were recorded even slightly below this border, and in the range of limiting (low and high) values of the Inhibition parameter, the correlation of Inhibition with Tension is much lower than in the middle of Inhibition range.

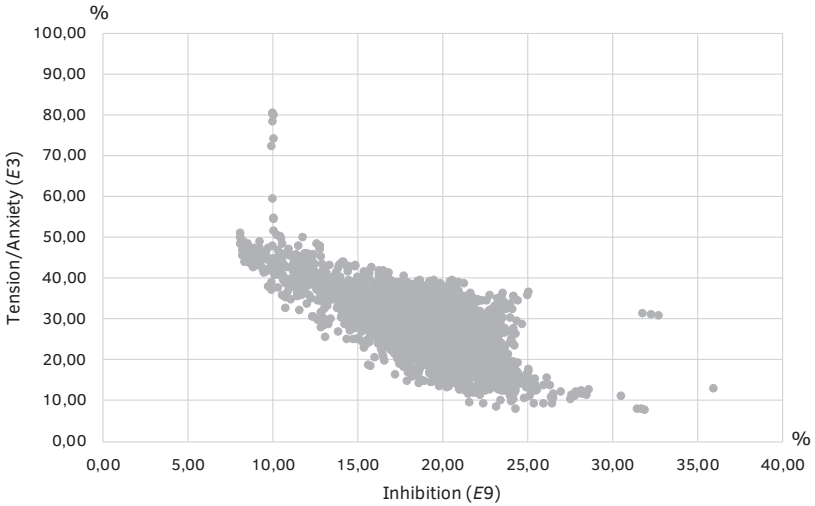

Fig. 22. Correlation dependence between Inhibition and Tension parameters (VibraMI database of 3521 tests)

4.10 Neuroticism

The Neuroticism parameter is often used to characterize a personality, starting with the founders of analytical psychology Jung (Jung, 2016), Eysenck (Eysenck, 1970) and is actively used now, including by the followers of the Big Five or the five-factor personality model (Rothmann & Coetzer, 2003; DeYoung, 2014). However, most representatives of analytical psychology used the parameter neuroticism as a qualitative

characteristic, avoiding quantitative estimates. The quantitative assessment of Neuroticism was used only in psychological questionnaires as a function of a person's conscious reaction to the questions presented to him — stimuli (Eysenck, 1970). At the same time, many researchers emphasized the physiological mechanism of the Neuroticism parameter (Carver & Scheier, 1990), and since it was previously established that there is no correlation between a person's conscious and unconscious response to stimuli (Minkin, 2019e), we proceeded from the need to measure Neuroticism (VibraStat, 2019), as a physiological parameter.

It was proposed to measure Neuroticism ($E10$) as the standard deviation of the Inhibition parameter (12), therefore, the dimension of this parameter in per-units should coincide with the physical dimension in seconds:

$$E10 = Nr = 10\sigma(E9) \tag{12}$$

where $\sigma(E9)$ — SD for the $E9$ (Inhibition) value.

The content of equation (12) shows that the obtained values of Neuroticism parameter are unreduced and theoretically can exceed 100%, which sometimes scares users of vibraimage systems. However, exceeding the value of 100% can occur only in case of incorrect operation of the system (with a 60-second measurement, obtaining a result above 100% only in case of head movements with a period of more than 10 seconds). This is approximately 100 times higher than the normal frequency of the vestibular system, so we did not introduce artificial mathematical constraints into the equation (12) for limitation by 100%. The physical dimension of Neuroticism parameter (as well as the Inhibition parameter) is a second, but for the joint processing of all emotional parameters, we transfer it into relative units or percent.

Figure 23 shows the distribution of the measured values of the Neuroticism parameter over the united database from 10 266 tests.

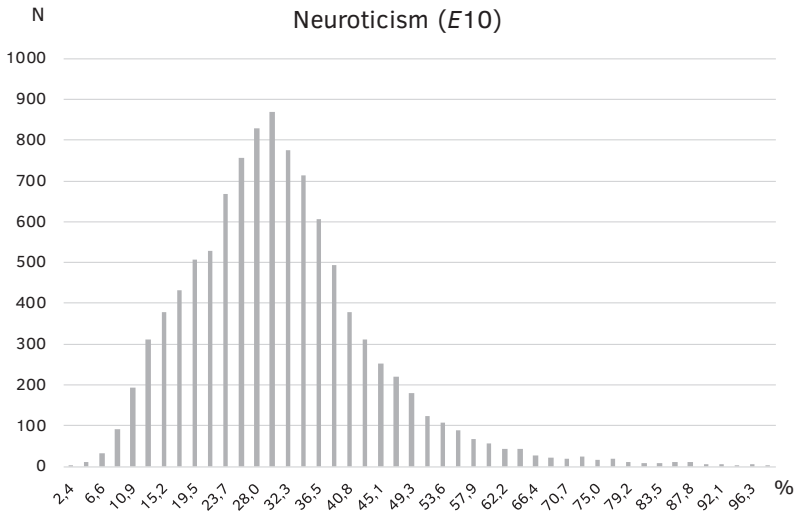

Fig. 23. Distribution of Neuroticism parameter (united database of 10 266 tests)

The distribution of the Neuroticism parameter resembles a normal distribution with a wider right border. It is interesting to note that the average value of Neuroticism parameter measured during testing by VibraMI program has a maximum value (Table 16), and the maximum scatter is recorded when testing in a free state by VibraMed program.

The parameter having the maximum correlation with the level of Neuroticism (according to united database) is Tension. The Pearson correlation coefficient between the Neuroticism and Tension parameters was –0.53 according to the results of the available sample of 10 266 testing. The correlation statistical dependence between the parameters Neuroticism and Tension is shown in Figure 24.

Table 16

Numerical analysis of Neuroticism parameter distribution

Designations of mathematical characteristics for Neuroticism state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	31,34	29,59	33,64	31,67					
SD	12,80	15,10	9,90	9,68					
M + SD	44,13	44,69	43,54	41,34	13,28	14,60	13,60	14,05	15,8
M – SD	18,54	14,49	23,75	21,99	14,37	12,13	10,65	12,28	15,8
M + 2SD	56,93	59,79	53,44	51,02	3,88	4,53	3,55	2,97	2,2
M – 2SD	5,74	–0,61	13,85	12,32	0,14	0,00	1,45	1,14	2,2
M + 3SD	69,73	74,89	63,33	60,69	1,42	1,50	1,19	1,09	0,1
M – 3SD	–7,06	–15,71	3,96	2,64	0,00	0,00	0,09	0,00	0,1

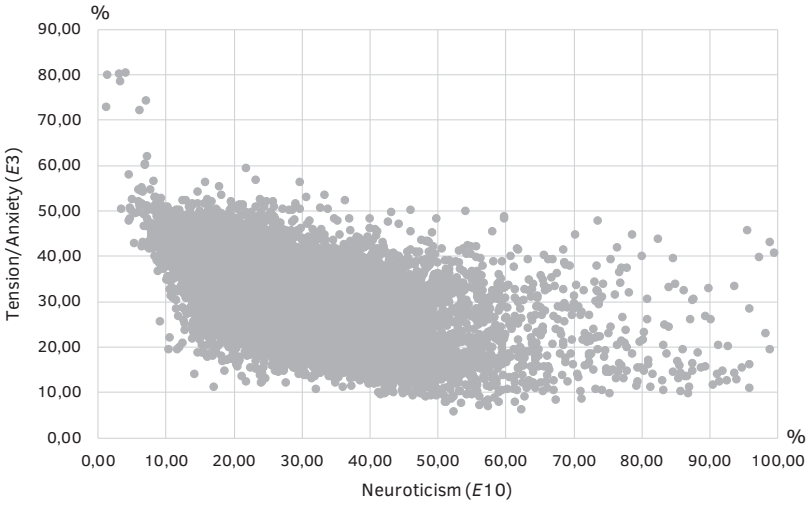

Fig. 24. Correlation dependence between Neuroticism and Tension parameters (united database of 10 266 tests)

According to Table 1, Neuroticism has a slightly less correlation with the level of Inhibition (0.523) (Figure 21) than with the level of Anxiety (–0.526). Moreover, despite the physical restrictions for the Inhibition parameter (it is always more than 0.1 s, and Neuroticism is proportional to the standard deviation from Inhibition), these restrictions do not affect to the Neuroticism parameter distribution. It is interesting to note that according to the data in Figure 24, the extremely low level of Neuroticism is characteristic of states with a high level of Tension, which is not obvious for modern psychology.

4.11 Depression

For a long time, the set of emotional parameters in vibraimage system was limited to 10 parameters, of which only two belonged to the group of physiological parameters, while the groups of positive and negative parameters included four parameters. This asymmetry and neglect of physiological parameters was eliminated in mid–2019 with the introduction of the Depression and Happiness parameters (Vibraimage PRO, 2019) in the group of physiological parameters. This immediately raised questions from users of vibraimage systems, first, why did Depression belong to the group of physiological parameters, and not negative emotional parameters? Once again, I emphasize that the division of parameters into groups is rather arbitrary, each behavioral characteristics is determined primarily by nature mechanism coordinated with calculated equation, and not by the name and membership of the group. Historically, negative parameters in psychology most often characterized as emotions, while physiological parameters, including the term Depression, traditionally used in medicine. The cybernetic approach to a person does not see the fundamental

difference between emotions and physiological characteristics of a person, and both of them represent the informational and physical characteristics of the studied object. However, for an interdisciplinary understanding of the proposed system of parameters, we considered it more appropriate to attribute the Depression to the group of physiological parameters of emotions.

Most of Depression level psychometrics is associated with conducting self-tests using psychological questionnaires (Beck et al., 1961). The ability to self-diagnose mental illness causes legitimate doubts, so we had a natural desire to determine depressive states using objective physical measurements. We have proposed the following equation (13) for determining the level of Depression (VibraStat, 2019):

$$E11 = Dl = \frac{\sigma}{\left(0{,}5 - M\right)} \cdot 100\% \qquad (13)$$

where σ — SD of the vibration frequency in the frequency histogram;

M — mean of vibration frequency in the frequency histogram.

Usually we introducing a minimum number of additional coefficients (without physical sense) in the formulas for determining the parameters of emotions. However, we entered a coefficient of 0.5 Hz in the denominator of the calculation, as a threshold value of vibration frequency SD, values above which can indicate various types of psychophysiological pathology. Many of the emotional parameters described previously use the calculation of M and SD, the main technical parameters characterizing the frequency distribution in the frequency histogram. This is not surprising, since the

frequency histogram of head vibrations and micromotion is one of the most informative behavioral characteristics, and the mathematical expectation parameters (M) and standard deviation (SD) are the main characteristics of any mathematical distribution.

Figure 25 shows the distribution of Depression measured values over the united database of 10 266 tests.

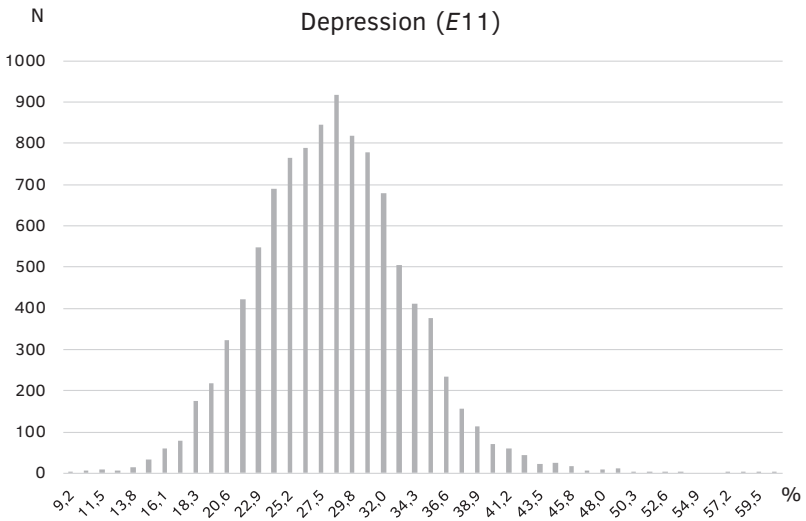

Fig. 25. Distribution of Depression parameter (united database of 10 266 tests)

The distribution of the Depression parameter is relatively symmetrical and close to the normal distribution (Table 17). The average values of the Depression parameter are almost identical for different testing options, although, like for most other emotional parameters, the scatter (SD) of Depression during VibraMed free testing is maximum.

The parameter having the maximum correlation with the Depression level is Energy, and these parameters have a negative

correlation. The Pearson correlation coefficient between Depression and Energy parameters was –0.77 according to the results of the united database of 10 266 tests. This is one of the highest correlation values between parameters. It is quite explainable from the point of view of classical psychology, since depressive states are associated primarily with a lack of energy.

Table 17

Numerical analysis of Depression parameter distribution

Designations of mathematical characteristics for Depression state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	28,35	28,29	28,18	28,88					
SD	5,59	6,35	4,75	4,76					
M + SD	33,94	34,63	32,93	33,64	14,63	14,90	14,97	16,22	15,8
M – SD	22,76	21,94	23,43	24,12	14,86	15,36	15,36	16,85	15,8
M + 2SD	39,53	40,98	37,68	38,41	2,72	2,78	2,70	2,63	2,2
M – 2SD	17,17	15,60	18,68	19,35	1,56	1,46	1,90	1,37	2,2
M + 3SD	45,12	47,32	42,43	43,17	0,63	0,72	0,51	0,17	0,1
M – 3SD	11,58	9,25	13,93	14,59	0,15	0,04	0,00	0,00	0,1

The correlation statistical dependence between Depression and Energy parameters shown in Figure 26.

Depression has a negative correlation with the level of Energy, judging by Figure 26, this correlation decreases slightly with a decrease in the level of Energy, i.e. low Energy is pos-

sible with a different level of Depression, but a low level of Depression is possible only for highly energetic conditions.

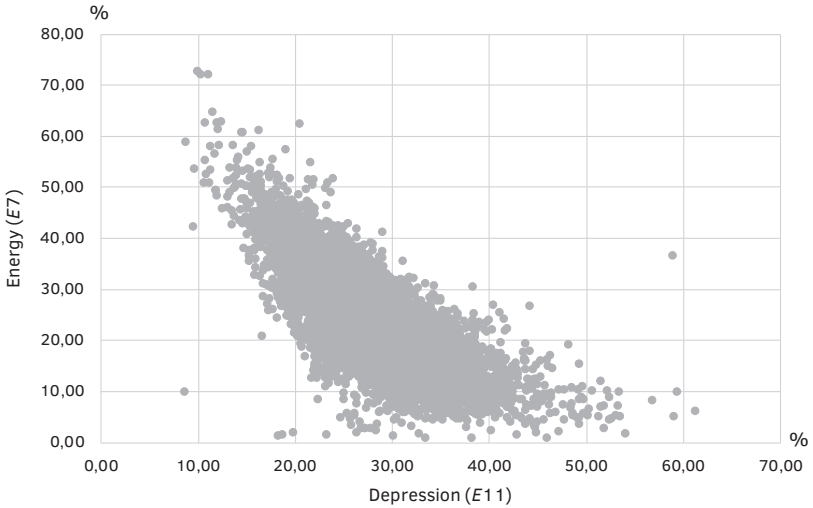

Fig. 26. Correlation dependence between Depression and Energy parameters (united database of 10 266 tests)

4.12 Happiness

Lately, there have been many studies devoted to measuring the level of happiness (Lambert & Pasha-Zaidi, 2015), although earlier the level of happiness seemed to be a qualitative and subjective characteristic of the emotional and psychophysiological state of a person. The logic of representing the level of Happiness as a physiological parameter is similar to the logic of determining the Depression parameter, so I will not repeat why we attributed Happiness to the group of physiological parameters of emotions, especially since I emphasize once again the conditionality

of dividing emotional parameters into groups. Further, I will slightly modify the established sequence of presentation of the parameters when describing the level of Happiness and dwell in more detail on the relationship of the last two psychophysiological parameters, since previously there were no publications on the correlation dependencies between these parameters. Many researchers expect that the level of Happiness should be significantly opposite to the level of Depression, i.e. parameters should have a significant negative correlation.

However, the principle of the meaninglessness of the characteristics of an object with the help of parameters with significant correlation (Polonnikov, 2013) requires that mathematical algorithms that artificially create this correlation be not included in the calculation formulas. We have proposed (VibraStaff, 2019) the following equation (14) for calculating the level of Happiness (HL):

$$E12 = Hl = \frac{I}{I + E + \mathrm{d}T + \mathrm{d}E} \cdot 100\% \qquad (14)$$

where I — information effectiveness of psychophysiological state;

$\mathrm{d}I$ — changes of information effectiveness of psychophysiological state;

E — reduced energy characteristics of psychophysiological state;

$\mathrm{d}E$ — changes of energy characteristics of psychophysiological state;

The equation for determining the level of Happiness is based on the calculation of two basic technical characteristics of PPS, information efficiency and energy expenditure. Its physical

meaning is that any biological object strives to achieve maximum information efficiency with a minimum amount of energy costs.

For a person, such a psychophysiological state is characterized by high level of Happiness. A direct calculation of information efficiency is quite complicated, since the information flows passing inside a person can be estimated only by external manifestations. Earlier, it was proposed to evaluate information efficiency as a function of inversely proportional to the standard deviation of the frequency component of vibraimage (Minkin, 2019a).

Figure 27 shows the distribution of Happiness measured values of the united database of 10 266 tests.

The distribution of Happiness parameter is single-mode and has a flatter right border, slightly wider than the normal distribution by the numerical values given in Table 18.

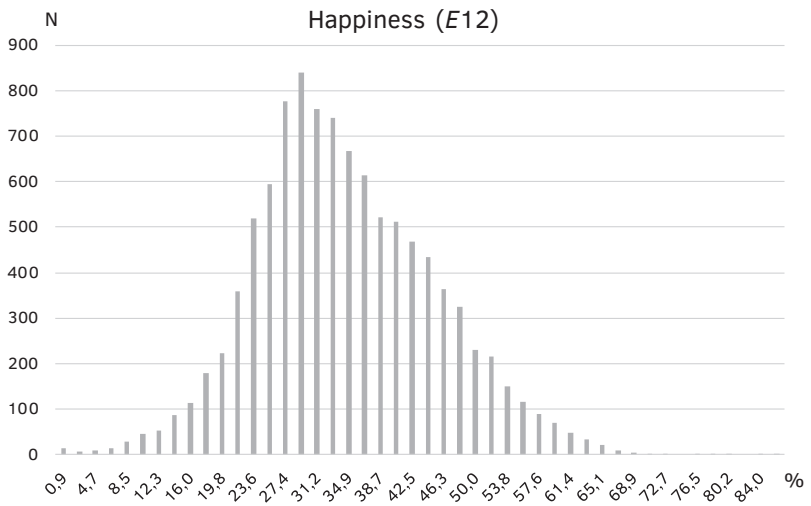

Fig. 27. Distribution of Happiness parameter (united database of 10 266 tests)

Table 18

Numerical analysis of Happiness parameter distribution

Designations of mathematical characteristics for Happiness state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	34,59	40,32	29,44	28,57					
SD	10,75	11,29	6,48	6,81					
M + SD	45,34	51,61	35,92	35,39	16,47	13,72	15,02	13,88	15,8
M – SD	23,84	29,04	22,96	21,76	14,07	14,04	14,68	13,65	15,8
M + 2SD	56,09	62,90	42,40	42,20	3,17	1,46	2,13	2,97	2,2
M – 2SD	13,09	17,75	16,48	14,95	1,61	4,27	2,61	2,51	2,2
M + 3SD	66,83	74,18	48,88	49,01	0,26	0,22	0,34	0,63	0,1
M – 3SD	2,34	6,46	10,00	8,14	0,14	0,50	0,26	0,29	0,1

We especially note the maximum scatter of the average values of the Happiness parameter under various testing conditions; it follows from the results in Table 18 that testing with VibraMI and PsyAccent questionnaires clearly makes people less happy with respect to their free state (VibraMed, 2019).

We will separately consider the correlation between the last two parameters Depression and Happiness, since statistics on the correlation of these parameters have not been previously studied. The correlation statistical dependence

between the Depression and Happiness parameters shown on Figure 28.

From Figure 28 it follows that the task to minimize the correlation between the Happiness and Depression parameters is quite successful, the existing negative correlation is only –0.16.

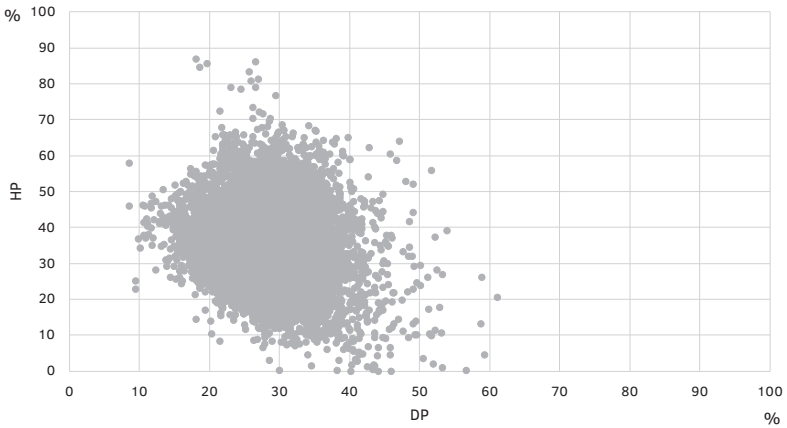

Fig. 28. The correlation dependence of Depression and Happiness parameters in the united database of 10 266 people

The parameter with the maximum correlation with the level of Happiness is Aggression, and these parameters have a negative correlation. The Pearson correlation coefficient between the Happiness and Aggression parameters was –0.79 according to the results of the united database of 10 266 tests. This is one of the highest correlation values between parameters. It is quite explainable from the point of view of classical psychology, since happiness and aggressiveness are opposite psychophysiological states.

The correlation statistical relationship between the Happiness and Aggression parameters shown on Figure 29.

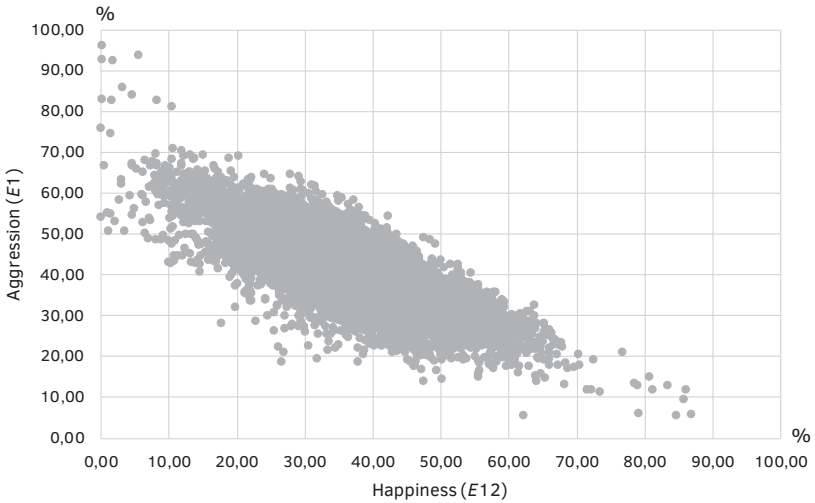

Fig. 29. Correlation dependence of Happiness and Aggression parameters (united database of 10 266 tests)

Happiness has a negative correlation with the level of Aggression, judging by Figure 29, this correlation is little dependent on the level of Happiness, a slightly larger spread of correlation values is observed at a minimum level of Happiness.

5. PSYCHOPHYSIOLOGICAL PARAMETERS

All the emotional parameters described earlier had a mutual correlation between themselves of more than 0.4 in absolute value of Pearson coefficient, i.e. are behavioral characteristics of personality with significant correlation between each other. In this chapter, we consider psychophysiological parameters with a lower level of correlation between each other, less than the level of 0.4 in absolute value of Pearson coefficient.

In the future, various options and algorithms for assessing the degree of correlation between behavioral characteristics should be discussed, for example, a different threshold value separating emotional and psychophysiological parameters. The proposed solution does not pretend to be absolute; it is more important to adopt a general concept for determining an objective and unambiguous method for classifying the behavioral characteristics of a person.

5.1 Extraversion

The parameters of extraversion / introversion were proposed by Jung more than 100 years ago (Jung, 2016) and now they are one of the most informative characteristics of a personality. Jung suggested that the extrovert and introvert differ, including also in the directions of energy distribution.

This genius assumption by Jung was confirmed by vibra-image technology (Minkin & Myasnikova, 2018b) and the equation was proposed for calculating the level of extraversion taking into account PPS direction in the axes of information-energy parameters (15):

$$P13 = Ex = \frac{R_{IE} + 1}{2} \cdot 100\% \qquad (15)$$

where R_{IE} — Pearson correlation coefficient between information efficiency (I) and energy costs (E).

The calculation of the level of extraversion according to equation (15) is based on the assumption that when chronobiological regulation of the equilibrium psychophysiological state of the extrovert, the vectors of changes in information efficiency and energy costs coincide in direction, and for introvert they occur in the perpendicular direction (Minkin & Myasnikova, 2018b).

Figure 30 shows the distribution of the measured values of Extraversion parameter over the united base of 10 266 tests.

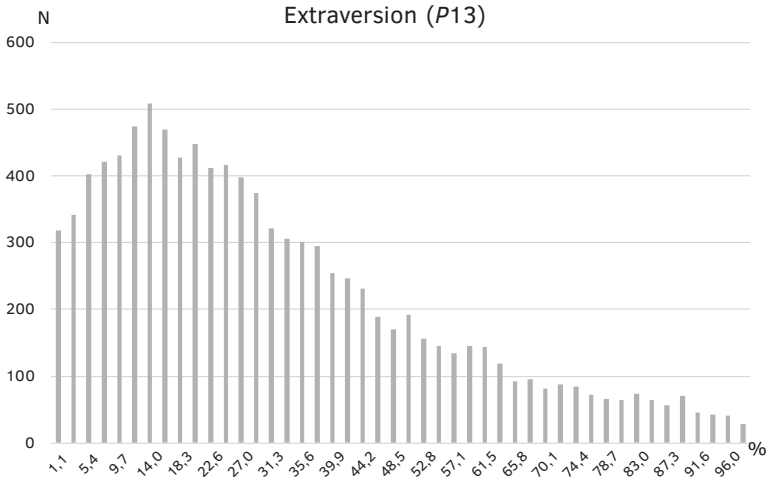

Fig. 30. Distribution of Extraversion parameter (united database of 10 266 tests)

The distribution of Extraversion parameter shown in Figure 30 is relatively close to a uniform distribution (it covers the range of values from 0 to 100%), in contrast to the parameters described earlier, whose distributions were close to the normal distribution. For the uniform distribution, in principle,

it is incorrect to talk about the norms for this parameter, since any value within the specified range is valid. Considering the obtained dependence, we will pay attention to the fact that according to the results of the measurements, the number of people with a low level of extraversion (introverts) is slightly higher than the number of people with a high level of extraversion (extraverts). This may be an evolutionarily justified function of the actual distribution of the level of extraversion among people. Although it is possible that the testing method slightly influenced the result and the need to answer questions and stimuli, presented by VibraMI and PsyAccent programs moved distribution into introvert direction. Perhaps, when conducting tests using questionnaires, the subject closes which leads to an increase in the level of introversion and affects the distribution result. In the future, we plan to clarify the nature of the distribution obtained by testing on one sample by various programs with and without stimuli.

The numerical values of extroversion parameter distribution given in Table 19.

From Table 19 it follows that conducting surveys in a more stressful situation (PsyAccent questionnaire) leads to a decrease in the average level of Extraversion relatively to more neutral questionnaire (VibraMI) or a person's free state (VibraMed). Moreover, as usual for emotional parameters, the spread (SD) of the Extroversion parameter in VibraMed group turned out to be maximum and exceeded the spread in VibraMI and PsyAccent groups by almost two times.

Naturally, a certain value of the correlation between emotional parameters exists even for relatively independent parameters with minimal correlation (Table 2). The maximum correlation level between Extraversion parameter and Depression parameter was detected (Pearson coefficient –0.27) based on united database of 10266 measurements processing. The correlation dependence between the parameters Extraversion and Depression shown on Figure 31.

Table 19

Numerical analysis of Extraversion parameter distribution

Designations of mathematical characteristics for Extraversion state	Parameter value,%				The number of counts beyond the specified range,%				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	31,46	32,99	30,51	28,99					
SD	22,77	27,61	16,91	16,64					
M + SD	54,23	60,59	47,42	45,63	16,96	20,06	16,56	16,05	15,8
M – SD	8,68	5,38	13,60	12,35	14,62	15,26	15,14	15,82	15,8
M + 2SD	77,00	88,20	64,33	62,27	5,61	4,49	3,64	4,80	2,2
M – 2SD	–14,09	–22,22	–3,31	–4,29	0,00	0,00	0,00	0,00	2,2
M + 3SD	99,77	115,80	81,24	78,92	0,00	0,00	0,88	0,51	0,1
M – 3SD	19,80	17,62	22,58	22,37	0,06	0,00	0,03	0,00	0,1

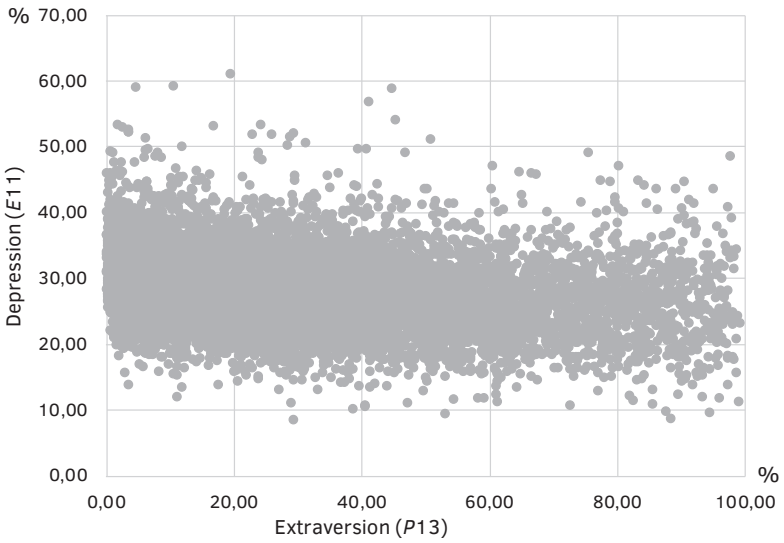

Fig. 31. Correlation dependence between Extraversion and Depression parameters (united database of 10 266 tests)

For VibraMed program testing, a similar maximum correlation was determined between Extraversion and Depression parameters (Pearson's correlation coefficient is –0.24). For VibraMI testing the maximum correlation was determined between Extraversion and Charm parameters (0.33), and for PsyAccent testing the maximum correlation was determined between Extraversion and Depression parameter (–0.43). Such a spread in the correlation between behavioral characteristics confirms our assumption that parameters of consciousness affect emotions and psychophysiological parameters and their use in the calculation leads to the appearance of systematic and random errors (Novitsky, 1975). This is especially noticeable on the dependences of psychophysiological parameters, since the correlation between them is small and more subject to the influence of external factors.

5.2 Stability

The stability of subject's psychophysiological state is one of the main characteristics of the personality in classical psychology. Along with the extroversion parameter, Eysenck (Eysenck, 1970) used the stability scale (the inverse characteristic of neuroticism) in his two-dimensional and three-dimensional coordinate systems to determine the psychological type of personality from questionnaires. In the theory of information and metrology, complex processes are generally considered stable, the distribution of parameters of which corresponds to the normal distribution law, since this indicates the absence of significant systematic and methodological errors in the studied processes (Novitsky, 1975; Polonnikov, 2013).

The cybernetic approach to humans distinguishes precisely the normal distribution of the frequency component of micromotion, as one of the most important parameters, which

determines, among other things, the psychophysiological stability of the state, so equation (16) was proposed for calculating the Stability parameter (VibraStat, 2019).

$$P14 = Sb = \frac{\sum\left[y(x)\cdot K - y'(x)\right]^2}{\sum\left[y'(x)\right]^2} \tag{16}$$

where K — normalization coefficient of the obtained frequency histogram:

$$K = \frac{\sum y'(x)}{\sum y(x)},$$

y' — normal distribution density:

$$y' = \frac{1}{\sqrt{2\pi}} e^{-\frac{(x-M)^2}{2\sigma^2}}$$

Stability parameter is determined by the frequency histogram and characterizes the level of similarity of the current frequency histogram to the normal distribution law. A high level of similarity of the frequency histogram to the normal law is characterized by a high level of stability of all emotional and psychophysiological parameters, and a significant deviation from the normal distribution law is characterized by a low level of the Stability parameter.

Mentally balanced stable state of a person characterized by head vibrations and movements distribution close to the normal distribution, and the resulting distribution of vibraimage frequency is not related to the spatial characteristics of the movements. For example, the movements in one area of the head (eyes) have high vibration frequencies. In the other area (mouth) the vibrations have an average frequency, and the third region (hair) has a low frequency of movements.

Therefore, the form of the total distribution will depend on the contribution of each area to the total distribution and under certain conditions may correspond to the normal distribution law. The mathematical approach used to calculate the Stability parameter was not used in the calculation of previous emotional parameters, therefore, the mathematical correlation between the Stability parameter and emotional parameters should be minimal.

Figure 32 shows Stability parameter distribution from the measured values of the united database of 10 266 tests.

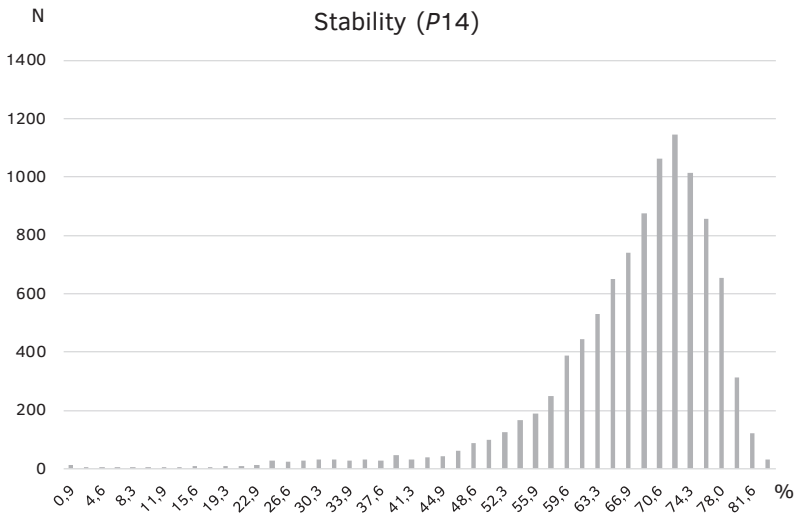

Fig. 32. Distribution of Stability parameter (united database of 10 266 tests)

The distribution of Stability is an asymmetric single-mode distribution with a significantly stretched left boundary. By the level of M = SD, it is near to normal distribution, and by the level of M – SD and M – 2SD it is already noticeably wider than the normal distribution. The numerical characteristics of distribution for Stability parameter given in Table 20.

Table 20

Numerical analysis of the distribution for Stability

Designations of mathematical characteristics for Stability state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	67,33	64,15	70,80	69,41					
SD	10,54	12,27	7,29	7,63					
M + SD	77,87	76,42	78,09	77,04	7,65	7,69	11,25	11,82	15,8
M – SD	56,78	51,88	63,51	61,78	11,44	12,31	14,26	13,48	15,8
M + 2SD	88,42	88,69	85,38	84,67	0,00	0,00	0,00	0,00	2,2
M – 2SD	46,24	39,61	56,21	54,15	4,47	5,73	4,03	3,77	2,2
M + 3SD	98,96	100,96	92,67	92,30	0,00	0,00	0,00	0,00	0,1
M – 3SD	35,69	27,34	48,92	46,52	2,42	2,22	1,39	1,26	0,1

The maximum average value of the Stability parameter corresponds to the testing conditions in VibraMI group, and the minimum Stability is observed in the free testing state by VibraMed program.

The maximum value of the correlation between the parameters Stability and Depression (–0.32). The correlation statistical relationship between the parameters Stability and Depression shown on Figure 33.

Like the previous parameter, the Stability level has practically no correlation with other psychophysiological parameters in the studied sample, the Pearson negative correlation coefficient between the Stability and Depression parameters is –0.32. We draw attention to the fact that the minimal correlation of psychophysiological parameters Extroversion

and Stability with other emotional and psychophysiological parameters confirms the possibility of using these parameters by Eysenck as the main axes in determining the psychological type (Eysenck, 1970).

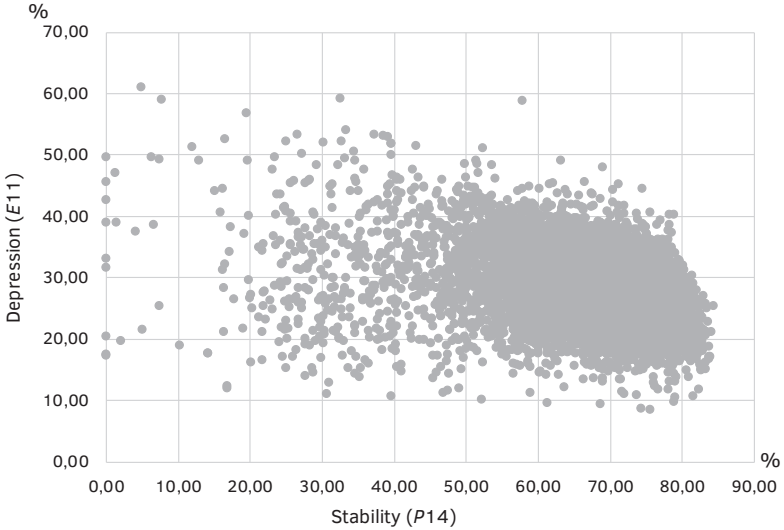

Fig. 33. Correlation dependence between Stability and Depression parameters (united database of 10 266 tests)

5.3 Satisfaction

To understand the changes in the psychophysiological state of a person under the influence of certain stimuli, is necessary to group the changes in each psychophysiological parameter into a single trend that characterizes the positivity or negativity of the psychophysiological changes that have occurred (Mauss & Robinson, 2009; Mesurado et al., 2018). The most general approach to assessing PPS changes is in measuring changes in information efficiency and energy costs. An increase in information efficiency and a decrease in energy costs cause positive changes in the PPS (Minkin, 2019d).

At the same time, a decrease in information efficiency and an increase in energy costs indicate negative changes in PPS, since from the point of view of evolution, any complex cybernetic system should drive to effectively perform of functions with minimal energy costs. In the paper (Minkin, 2019d) was proposed equation for assessing the level of satisfaction, showing the degree of negativity or positivity in the perception to any stimulus (17):

$$P15 = dP = \overline{P2} - \overline{P1} \tag{17}$$

where $\overline{P2}$ — PPS after exposure of stimulus;

$\overline{P1}$ — PPS before stimulus.

Figure 34 shows the distribution of Satisfaction parameter by measured values of the united database of 10 266 tests.

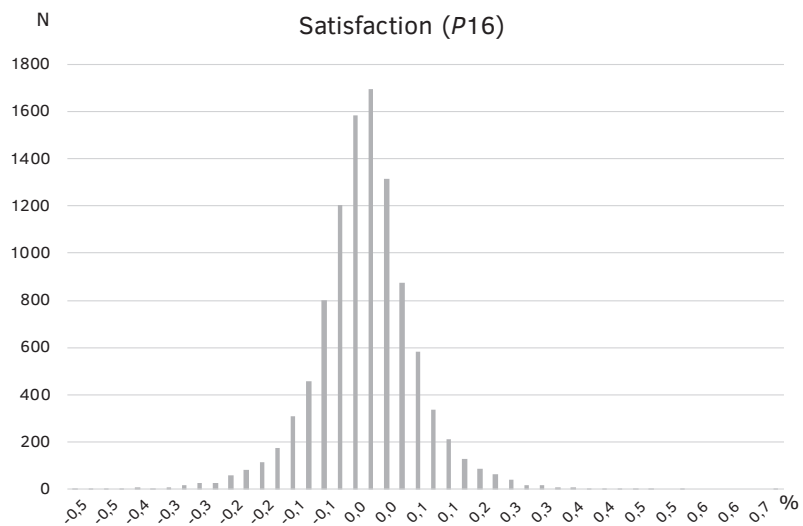

Fig. 34. Distribution of Satisfaction parameter (united database of 10 266 tests)

Unlike all the previously described parameters, the range of the parameter Satisfaction is approximately symmetrically distributed in both directions from zero. The Satisfaction parameter can have negative values, which compares the mathematical meaning of this parameter with the psychological meaning and I see no need to enter this psychophysiological parameter into the standard range for emotional parameters from zero to one or from zero to 100%. Note that a small statistical dissatisfaction (–0.01) is observed when testing with questionnaires (VibraMI, PsyAccent), and a free state does not affect the shift of the Satisfaction parameter towards negative or positive values (Table 21).

Table 21

Numerical analysis of Satisfaction parameter distribution

Designations of mathematical characteristics for Satisfaction state	Parameter value, %			The number of counts beyond the specified range, %					
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	0,00	0,00	–0,01	–0,01					
SD	0,09	0,11	0,06	0,06					
M + SD	0,09	0,12	0,05	0,06	12,29	12,72	13,86	14,05	15,8
M – SD	–0,09	–0,11	–0,06	–0,07	11,90	13,78	14,17	13,99	15,8
M + 2SD	0,18	0,23	0,11	0,12	2,87	2,60	2,64	2,57	2,2
M – 2SD	–0,18	–0,22	–0,12	–0,13	2,91	3,12	2,50	2,51	2,2
M + 3SD	0,27	0,34	0,17	0,18	0,66	0,52	0,28	0,46	0,1
M – 3SD	–0,27	–0,33	–0,18	–0,19	0,73	0,48	0,26	0,34	0,1

Happiness has the maximum correlation with the Satisfaction parameter; this correlation is quite small (Pearson coefficient 0.15) and has a positive character.

The correlation statistical dependence between the Satisfaction and Happiness parameters shown on Figure 35.

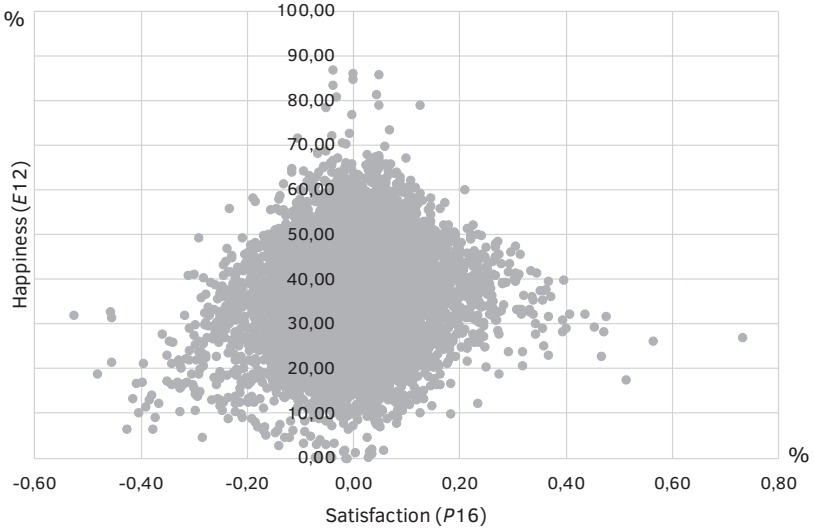

Fig. 35. Correlation dependence between Satisfaction and Happiness parameters (united database of 10 266 tests)

The symmetrical around zero distribution of Satisfaction level in Figure 35 should be understood in such a way that it is impossible to have high values of the Happiness level with a low level of Satisfaction. Likely a high level of happiness means a stable psychophysiological state that does not change during testing, or the probability of a change in the level of Happiness is random and depends from external factors.

5.4 Brain activity period

In modern psychology, there are many approaches and terms designed to assess the effectiveness of human performance (Medvedev et al., 2015), for example, concentration, mindfulness, attention, etc.

The proposed approaches are based on a qualitative and subjective perception of a person and his consciousness, as a unique and inimitable system that is difficult to measure.

At the same time, there are objective criteria for evaluating the functioning of any system, including consciousness. One of such objective criteria is the period or frequency of activity of any physiological or chronobiological process (Halberg, 1987; Baevsky et al., 2001) and many frequency and periodic characteristics of brain activity are known (Trenité et al., 2012). However, most of the determined frequency characteristics of brain activity are related with the current work of consciousness or are determined by external factors (Reddy, P. et al., 1984; Halberg, 1987). It was necessary to find frequency response of the brain, similar to the pulse rate, which is used as an objective measure of the physical load on the human body (Fleishman, 2014).

An objective measure of the processes of activity in the physiology of consciousness was proposed to consider the brain activity period further as BAP (Minkin & Blank, 2019; Minkin & Kachalin, 2019) fixed in the very low frequency range (VLF; 0,016–0,03 Hz), which is determined by the Fast Fourier Transformation (FFT) of the current PPS (18). The period of brain activity in the range of 30–60 seconds was previously singled out as determining in the formation of the psychophysiological state of a person (Minkin & Blank, 2019).

$$P16 = Tb = FFT\ (P_i) \tag{18}$$

Measurement of brain activity period is possible only with a test duration of at least 180 seconds, so the data on this parameter provided only for testing by VibraMI and Psy-Accent programs, since the standard testing time by VibraMed program is only 60 seconds.

Figure 36 shows the distribution of BAP parameter over united database of 5272 tests.

Different discreteness of BAP distribution for the left and right borders accounts is associated with the method of BAP calculating using FFT. Given the uneven discreteness, the

distribution is quite symmetrical (about 3 counts on both sides of the maximum) and close to the normal distribution.

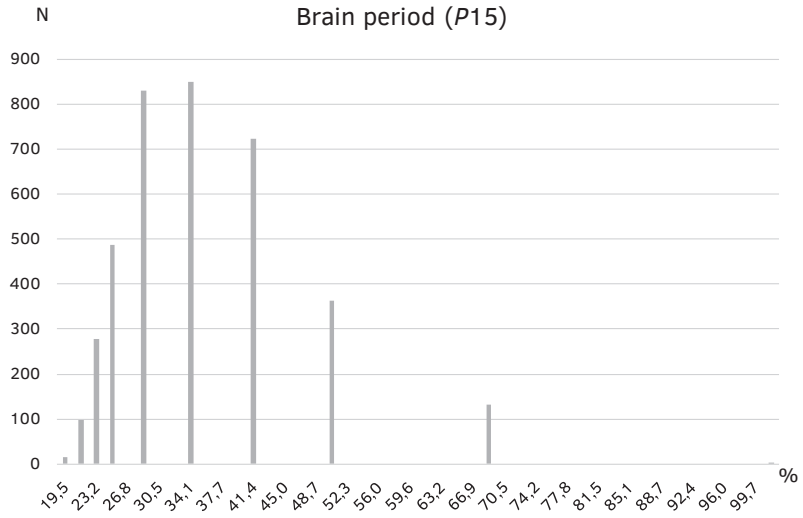

Fig. 36. Distribution of BAP parameter (database of 5272 tests by VibraMI and PsyAccent programs)

BAP distribution resembles the normal distribution with a wider right border, which follows from Table 22. In the works (Minkin & Blank, 2019; Minkin & Kachalin, 2019) it was shown how BAP changes during free testing and depending on the brain load. However, in Table 22, I decided not to add the source data from the other databases in order to maintain the integrity of the measurement of all parameters in this book on the single database of test results.

The correlation statistical dependence between the BAP and Energy parameters shown on Figure 37.

Pearson correlation coefficient between BAP and Energy is quite low and is only –0.11, which confirms the classification of BAP as psychophysiological parameter with minimal correlation with other emotional and psychophysiological parameters.

Table 22

Numerical analysis of BAP distribution

Designations of mathematical characteristics for BAP state	Parameter value, %				The number of counts beyond the specified range, %				
1	2	3	4	5	6	7	8	9	10
	All	Med	MI	PA	All	Med	MI	PA	ND
M	34,91	–	34,72	35,39					
SD	10,53	–	10,07	11,63					
M + SD	45,44	–	44,79	47,01	4,86	–	9,66	9,08	15,8
M – SD	24,38	–	24,65	23,76	3,81	–	7,61	7,02	15,8
M + 2SD	55,96	–	54,86	58,64	1,32	–	2,07	3,60	2,2
M – 2SD	13,85	–	14,58	12,13	0,00	–	0,00	0,00	2,2
M + 3SD	66,49	–	64,93	70,26	1,32	–	2,07	0,00	0,1
M – 3SD	3,32	–	4,51	0,51	0,00	–	0,00	0,00	0,1

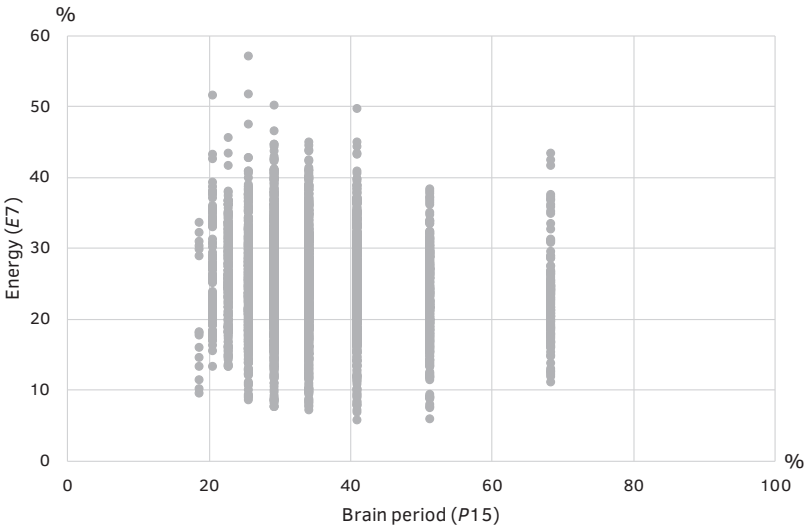

Fig. 37. Correlation dependence between BAP and Energy parameters (database of 5272 MI and PA tests)

6. PSYCHOMETRICS AS THE PART OF METROLOGY

The results of said measurements and studies of the psychophysiological parameters of a person as standard physical quantities show not only the possibility, but also the need to use the proposed cybernetic approach in the study of emotions, psychophysiological parameters, character traits and personality characteristics, i.e. all behavioral characteristics of a person. Moreover, unlike previous developers of the cybernetic approach to personality analysis, limited to the development of theoretical principles (Bernstein, 1967; Wiener, 1948; Anokhin, 1963; Simonov, 1986; Polonnikov, 2013; Van Egeren, 2009) or concentrated on practical research (Hoffman, et al., 2012; Chakraborty & Konar, 2009) vibraimage technology allows combining theoretical modeling with empirical data (Minkin, 2019c). The first Nobel laureate from Russia, Academician Pavlov wrote: "It is often said, and not without reason, that science moves with jerks, depending on the successes made by the technology. With each step of the technique, we seem to go up a step higher, from which a wider horizon opens up, with previously invisible objects" (Pavlov, 1951). Such a technology that allows measuring almost any (as shown in this book) psychophysiological parameters and combining the processing of conscious and unconscious reactions during various experiments is vibraimage technology (Minkin & Shtam, 2004; Minkin & Nikolaenko, 2008b; Minkin, 2017; 2019a). This does not mean at all that vibraimage technology is the only technology of psychophysiological detection that allows obtaining the correct data on the psy-

chophysiological state of a person. On the contrary, if the measurement of emotions and psychophysiological state was carried out by vibraimage technology, then you can probably get similar results using other technologies, for example, when analyzing heart rate variability (Baevsky et al., 2001) or frequency scanning of human tissues (Zhao et al., 2016).

Fundamentally important (to obtain an unambiguous and objective result) is the approach to the emotional and psychophysiological parameters of a person, as to physical quantity. Behavior parameters are various qualities of a physical object (human) under study that have quantitative characteristics. This is the standard metrological approach to measuring physical quantities (JCGM 200) and it need be applied to measuring the emotional characteristics of a person. Psychometrics cannot be a separate science based on an analysis of only the conscious reaction of the subjects, doing by self-testing and self-assessments (Standards, 2014). An analysis of only a person's conscious reaction when testing using questionnaires, even if it is carried out using the most modern mathematical methods (Schiele & Baker & Hathaway, 1943; Standards, 2014), cannot give an objective and complete characterization of a person, since the processes of consciousness and the unconscious do not replace, but complement each other (Minkin, 2019e). At the same time, I do not deny, but confirm that the conscious information obtained by passing the questionnaires can be effectively used to obtain a complete personality profile. The combination of conscious and unconscious information in one test allows determining the character traits of a person, or, for example, his ability and multiple intelligences (Minkin & Nikolaenko, 2017a; 2017b; Minkin & Myasnikova, 2018a). So that the measurement of the emotional and psychophysiological parameters of

a person is objective, it should be carried out based on measuring physical quantities (or physiological parameters). An open algorithm for calculating parameters and statistical processing of measurement results are standard approaches to solving metrological problems. Minimization of behavioral characteristics, measured by the results of a conscious reaction and an increase in human behavioral characteristics, measured as physical parameters, increase the accuracy of determining the general characteristics of a personality, since the physical measurement is more objective than the measurement of the characteristics of consciousness.

The proposed approach brings psychology closer to the natural and exact sciences, and one should begin by agreeing on exact definitions of the personality's behavioral characteristics. As noted earlier, there are currently no clear distinctions between emotions, psychophysiological parameters and personality traits. The separation of the behavioral characteristics of a person according to their stability over time as states-traits (Spielberger et al., 1983) does not be correct, since all behavioral characteristics of a person change under the influence of various factors and time. For an objective characteristic of a physical object, it is necessary to study the physical characteristics of this object, and not the subjective reaction of consciousness to subjective stimuli. Therefore, the inclusion of the results of processing a conscious reaction in the behavioral characteristics of a person should be minimized, and for measuring emotional and psychophysiological it should be excluded, since all the information necessary for measuring emotions and psychophysiological parameters should be obtained on the basis of physical measurements.

What is the advantage of cybernetics, which made it possible to achieve significant scientific and technological progress

in technical fields? First, in an approach that allows to consider any complex phenomenon as a black box, analyzing primarily the input influences and output parameters of a complex object. This approach has made significant progress in the development of modern computer technology and informatics, when developers and users of systems do not need to have complete information about the internal processes occurring in the used object in order to use it and simulate behavior in various situations. The possibility of such an approach to a person, as to a rather complex object in the form of a black box, was demonstrated in this publication. The proposed approach allows psychologists to obtain objective quantitative information about the behavioral characteristics of a person, use it for various applications and move to a new, more accurate level of understanding of a personality.

It seems to me that such an engineering approach to emotions is natural, scientific and objective, is free from the emotional ideology that we get used to throughout our lives, evaluating people and their actions not according to their current state, but according to the established subjective perception of a person. As for the analysis of conscious response to questionnaires and stimuli, the result of consciousness operation is always subjective, perhaps psychology should have passed this stage, but we need to move on in the study of the personality. I imagine how many flattering words I will have to hear from psychologists, so I refused the help of my traditional co-authors in writing this work so as not to expose them to the fire of criticism, possibly partially justified. At the same time, I do not believe that the cybernetic approach to a person is significantly different from what Sechenov, Darwin, Jung, Freud, Pavlov, Bernstein, Wiener, Lorenz, Anokhin or Polonnikov suggested. On the contrary, I am not saying anything new about a person that was not said by these

outstanding scientists. My only advantage in human research is the feedback of vibraimage technology, which allows to measure emotions, psychophysiological parameters and personality traits, receiving these data about a person from the vestibular system due to the vestibular-emotional reflex (Minkin & Nikolaenko, 2008b). This huge amount of vibraimage information makes possible to implement almost any approach to the analysis of human emotions. The use of vibraimage technology as a universal tool in the study of emotions allowed accumulating the united database of psychophysiological parameters and using the resulting database of results of physical measurements of behavioral characteristics for processing using modern mathematical methods.

It should not be imagined that the approach to a person as a black box somehow contradicts studies aimed at elucidating the physiological causes of emotions, these are two different areas of study of human PPS. On the contrary, the information obtained on statistical dependencies between different emotional states should contribute to a better understanding of the psychophysiological processes occurring inside a person. Information about the dependencies between the behavioral characteristics of personality can be used in robotics and the development of artificial intelligence. Measuring the parameters of a person's psychophysiological state, as usual physical quantities, makes psychometrics a standard section of metrology and allows to use the entire reserve, available in the natural and exact sciences, to study a person.

The proposed approach does not limit the study of a person only by vibraimage technology, just by the example of vibraimage I have shown that the study of human emotions is possible by measuring of psychophysiological parameters as physical quantities. It seems to me advisable to develop a discussion on the objective measurement of

emotions and psychophysiological parameters of a person in the following areas:

1. Development and research of technologies to obtain maximum information about the psychophysiological state of a person by measuring physiological parameters and/or physical quantities. The data obtained by vibraimage should be confirmed when measuring the behavioral characteristics of a person with other technologies.
2. Acceptance or adjustment of the proposed methodological and mathematical principles, the separation of the behavioral characteristics into groups — emotions, psychophysiological parameters and character traits. Without the clear definition of the groups of behavioral characteristics, in my opinion, further progress in the study of human psychophysiology is impossible.
3. Testing the mathematical apparatus for determining emotions. For vibraimage technology, this is the adoption or adjustment of the proposed equations as standards for determining emotions and psychophysiological parameters.
4. Consideration of alternative methods for building dependencies between emotional and psychophysiological parameters according to the proposed data processing order. Obtaining a database of alternative psychophysiological detection technologies using open algorithms. Construction of correlation dependencies (or other mathematical characteristics, for example, factor analysis) from the obtained databases of behavioral characteristics.
5. The study of the united database of behavioral characteristics (placed in Open Access) by various methods. Open discussion on the proposed classification of behavioral characteristics. Increasing the size of the existing united database and checking suggested classification by the enlarged database.

Perhaps some readers think that in this book about emotions there are too many technical pictures, graphs and histograms of the distribution of parameters. But in the technical sciences, which include cybernetics, information theory and measurement theory, the construction of distributions for dynamic parameters is one of the main elements of their classification (Novitsky, 1975). The term dynamic parameters used in the technique is largely similar to the term behavioral characteristics used in biometry and psychology. In this book, I tried correctly transfer the natural and naturalistic principles of classification to the behavioral characteristics of a person.

CONCLUSION

This book is not only about vibraimage, cybernetics and emotions. Unlike classical psychology, which considers a person as a unique phenomenon, a natural (naturalistic) approach to the behavioral characteristics of a person as a natural phenomenon is proposed and the actual results of studying this phenomenon are shown. It is not enough to put forward hypotheses and proclaim theoretical approaches to the study of human personality; it is necessary to empirically confirm theoretical assumptions, as Karl Linnaeus did for a unified classification system for the plant and animal world (Linnaeus, 1735), and as is customary in the natural and exact sciences. A large number of pictures and graphs given in this book are similar to the Linnaeus images of plants and animals, only showing human behavioral characteristics.

One of the tasks of cybernetic psychology is the systematization of the basic behavioral characteristics of the personality, similar to the periodic table of chemical elements (Mendeleev, 1872). There are several approaches to constructing a periodic table of elements; according to Mendeleev, the periodicity was determined by the atomic weight of the elements, which were combined into certain groups with approximately the same chemical properties.

The proposed classification of the behavioral characteristics of a person uses correlation as the basis for constructing a table of personality elements similar to atomic weight in a periodic table of chemical elements. Since for each person the significance of every behavioral characteristics is different, one can offer two options for a personal periodic table, static and dynamic. Under the period should be understood the

periodical significance changes of each parameter in the group, more clearly expressed in the dynamic version of the table. In the static version (Table 23), an unambiguous arrangement of the behavior characteristics in each group is fixed. In the dynamic table, the order in which behavioral characteristics are displayed is determined by the significance of these parameters for a given person in current time (the second row of Table 23 allows both a fixed and a varying arrangement of behavioral characteristics). The rightmost column in Table 23 has a reference value; it is given to indicate the general trend of correlation between behavioral characteristics.

In contrast to the well-known personality typologies (Wundt, 1867; Eysenck, 1970; Russel, 1980), dynamic Table 23 is based on the measurement of physical quantities and includes various groups of human behavioral characteristics. For each person at different points in time, measurement value change in accordance with changes in current psychophysiological state.

The top row of the dynamic/static table contains the technical characteristics of the PPS, such as the previously described information efficiency (*I*), energy consumption (*E*), mathematical expectation of the vibration frequency (M) and standard deviation of the vibration frequency (SD). These characteristics are included in many equations for determining emotions and can have a high degree of correlation with emotional characteristics (Pearson's maximum correlation coefficient with emotional states is 0.8–1.0).

The second row of the table contains emotional characteristics that have significant correlation between each other (maximum Pearson correlation coefficient between emotional states is 0.4–0.8). Now, I am not ready to offer a clear algorithm for the dynamic priority of emotions location in this line, but this is a technical issue and subject of study in future. The arrangement of emotions in order of importance can be determined by the absolute value, or the normalized deviation from the average value in the group, this is the technical point, needs to be tested.

Table 23

Table of behavioral characteristics of personality

Name	Behavioral characteristics (BC)												Maximum correlation between BC
BC number or significance	1	2	3	4	5	6	7	8	9	10	11	12	
Information and Energy parameters (IEP) of PPS	*I*	*E*									M	SD	0,8–1,0
Values of IEP PPS													
Emotions	*E*1	*E*2	*E*3	*E*4	*E*5	*E*6	*E*7	*E*8	*E*9	*E*10	*E*11	*E*12	0,4–0,8
Emotion values													
Psychophysiological parameters (PPP)	*P*13	*P*14	*P*15	*P*16									0,1–0,4
PPP values													
Multiple intelligences (MI) types	IA	PH	LM	BM	VS	NL	BK	MR	AS	VL	CR	IE	0–0,1
MI values													
Personality Accentuations (PA)	IV	DT	DB	JM	PD	AL	AE	EX	EM	DM	HT	EV	0–0,1
PA values													
Conscious Independent Parameters (CIP)	1	2	3	4	5	6	7	8	9	10	11	12	0–0,1
CIP values													

The third row of the table contains psychophysiological parameters that have an average correlation between themselves and emotional parameters (the maximum Pearson correlation coefficient between psychophysiological states is 0.1–0.4).

The bottom rows of the table include the behavioral characteristics of a person determined by consciousness and measured by a joint analysis of the parameters of consciousness and the unconscious (Minkin & Nikolaenko, 2017b). The fourth (top) line contains the parameters of multiple intelligences, and the next line contains the parameters of character accentuations (Nikolaenko, 2019). In the following rows of the table, other Conscious Independent Parameters (CIP) may be given if it would be proved that there is no correlation between these new parameters and all the other behavioral characteristics described above.

I think that many readers of this book will take the proposed approach to measuring and classifying a person's behavioral characteristics using some hardware, software, formal methods and mathematical principles, too revolutionary. But for me, as a person who has been involved in measuring various physical quantities and parameters of complex systems for several decades, and for the last 30 years measuring biometric characteristics, this approach seems absolutely normal. Having a certain number of patents and understanding of patent law, I see that the proposed approach to measuring emotions as a person's physical characteristics has the condition of novelty, but does not satisfy patenting by an inventive step. This is only using well-known features for a new object. When Ivan Sechenov in 1863 suggested (Sechenov, 1965) that human emotions in their physiological mechanism of formation are not significantly different from frog emotions, since the physiological systems in

animals and humans work approximately the same, this was a significant step in science. When Charles Darwin showed in 1872 (Darwin, 1872) that emotions in humans and animals are a product of evolution, this was also an outstanding scientific assumption. Then the society, including scientific, was not ready for the adoption of such revolutionary scientific ideas. I hope that for psychological cybernetics and vibra-image technology, the situation is somewhat different and the ideas presented in this book will find support from readers. Moreover, psychology gradually moved to physiology, psychophysiology and psychometrics with the help of psychological testing (James, 1884; Boring, 1933; Schiele & Baker & Hathaway, 1943; Eysenck, 1970; Polonnikov, 2013) and from narrative reasoning is gradually approaching measurements.

Of course, "in the beginning was the word" and in the psychology of the past it was customary to describe and justify scientific concepts using multi-page reasoning. However, in the 21st century, a word has replaced by digit and in our time, it does not surprise anyone that a person's emotions and their psychophysiological or functional state can be measured by various methods (Mauss & Robinson, 2009; Meiselman, 2016; Chernorizov at al., 2016; Gunavan et al., 2018). However, digital enthusiasm should not deprive researchers of general concepts possessed by outstanding researchers of the past. Digit should contribute to the formation of common concepts, and not hinder it. The empirical measurement results should confirm or refute the proposed theories (feedback is the main element of cybernetics), but for this we must first propose a theory and concept. I hope that the proposed cybernetic approach to determining the behavioral characteristics of a personality will become generally accepted and will allow a higher level of understanding of conscious, unconscious and physiological processes in the human body.

Quantitative analysis and measurement of human characteristics does not contradict, but rather contributes to the development of psychology, medicine, biology and combines them into one science about a person, for example, cybernetic psychology or psychophysiology.

In science, mathematical logic should rule emotions, especially if this science is about emotions. Therefore, it is not logical to spend so much effort on determining emotions by a conscious reaction (questionnaires) if it was proved that conscious and unconscious responses do not have a mathematical correlation between themselves (Minkin, 2019e), which is confirmed by the above statistics (Table 6). The study of emotions and psychophysiological parameters should be based on the measurement of physical quantities and physiological characteristics of a person. The work of human consciousness should be studied separately and used for analysis of independent personality characteristics (bottom lines of Table 23). The study of the parameters of these groups is carried out using psychological questionnaires and a parallel physical measurement of the psychophysiological response to stimuli (Minkin & Nikolaenko, 2017b).

Of course, any person always has a mutual influence of consciousness on unconscious characteristics and uncoscious characteristics influenced on consciousness. The results presented in this paper confirm this. However, this does not mean that emotions cannot be measured using physical measurements, but, on the contrary, differentiates approaches to measuring conscious and unconscious characteristics of a person. In this paper, I paid more attention to the unconscious characteristics of a person, since they are closer to physical measurements (Penrose, 1994).

The attachment provides links to the investigated databases of emotional and psychophysiological parameters. The united

database includes 10 266 tests of behavioral characteristics measurements (file 10266All.xlsm). The database for measuring of person free state by VibraMed (file 4994MED.xlsm). The databases of behavioral characteristics by VibraMI and PsyAccent testing are placed in corresponding files (3521MI.xlsm and 1751PA.xlsm). I invite researchers of emotions and psychophysiological parameters to conduct their own study and develop their theories based on the said databases.

Attachment

Database of emotional and psychophysiological parameters measurements are given in the files on the link http://www.psymaker.com/downloads/CyberVibra.zip

TERMS AND DEFINITIONS

(In development of JCGM 200 and ISO/IEC 2382-37:2017)

Behavioral characteristics of a person — a set of qualitative physical characteristics that determine the behavior and personality of a person, including emotional parameters, psychophysiological parameters and parameters of consciousness (personality traits).

Emotional parameters are the behavioral characteristics of a person, having a significant correlation between themselves. Emotional parameters could be determined by measuring behavioral processes, physical quantities (characterizing a person) and/or physiological parameters of a person.

Psychophysiological parameters are the behavioral characteristics of a person, having low correlation between themselves. Psychophysiological parameters could be determined by measuring behavioral processes, physical quantities (characterizing a person) and/or physiological parameters of a person.

Parameters of consciousness (personality traits) are the behavioral characteristics of a person, determined by joint measurement of physiological (physical) parameters and conscious response to stimuli of a person. The parameters of consciousness are independent and have no correlation with emotions, psychophysiological parameters and among themselves.

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