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CHAPTER 3

DIAGNOSIS AND MONITORING OF THE FUNCTIONING OF THE HUMAN NERVOUS SYSTEM

ABSTRACT

The significance of the study of the main nervous processes and typological combinations for deepening the general idea of the state of the body, as well as the possibility of using their indicators in the diagnosis and monitoring of the nervous system of young people, is analyzed. Various contingents of the population were examined: students, athletes, mobile operators, people with deprivation of auditory function, post-COVID syndrome and psychophysiological lability developed under martial law.

It was found that when performing real activity, individual typological properties are manifested, which determine the current psycho-emotional background, the speed and efficiency of sensorimotor reactivity, and the effectiveness of mental performance. The features of information processing by subjects with different gradations of functional mobility of nervous processes are reflected. It was found that the deprivation of the auditory function, post-COVID syndrome, psychophysiological lability, developed in a state of war, significantly reduce the level of the course of nervous processes and the possibility of processing information.

The evaluation scales of neurodynamic and sensorimotor functions proposed for use in the medical field can be used to optimize the diagnosis and increase the effectiveness of monitoring neurological morbidity, including in people with special needs.

Taking into account the peculiarities of neurodynamic and sensorimotor functions, they will also be useful in the physiology of labor, the professional selection of healthy people and the individualization of educational trajectories in higher education.

KEYWORDS

Monitoring, diagnostics, nervous system, basic nervous processes, individual typological properties, functional mobility, central nervous system, higher nervous activity, sensorimotor reactivity.

Health is not everything, but everything is nothing without health
Socrates

At all times, the problem of preserving human health has been and remains an urgent task of medicine. Due to its complexity of solution, it cannot be limited only to clarifying its biological or medical aspects. In modern conditions, human health should be considered in conjunction with its clinical, theoretical and methodological factors.

At present, there is an extensive arsenal of accumulated scientific biomedical information devoted to both elucidating the very concept of health and its physiological, psychological, social, and other components. Equally important is the experience of various ways of maintaining and improving health: clinical methods, rehabilitation practices, innovative habilitation technologies, the results of recreational activities, etc. At the same time, theoretical and methodological developments are still rather limited, few in number, and fragmented [1, 2].

Scientific and technical, social and medical and technological achievements of versatile studies of the human body should contribute to the digitalization of society, leveling various risks, maintaining and developing the health of the nation. A special priority is given to research to elucidate the fundamental foundations of individual health, concerning a comprehensive study of its mechanisms, factors of influence, diagnostics of intermediate states, creation of physiological information bases, predictive models, experimental intelligence and expert systems for evaluating and monitoring functional systems, intersystem interaction to ensure health-preservation.

From the point of view of a systematic approach, any functional state (FS) is regarded as a reflection by the human body of the consequences of exposure to environmental factors. Each FS is always an integral result of certain parameters, functions, characteristics of an organism and, at the same time, an indirect indicator of its adaptive strategies, reserve capabilities, etc. Therefore, FS should be considered as a complex of uncoupled interrelated reactions of the body to ensure its adequate functioning in accordance with the existing environmental conditions.

To understand all the risks of exposure to the body and ways to adapt to them, the task arises of diagnosing complexes of physiological reactions, numerous functional indicators, understanding of heterogeneous processes and their physiological mechanisms.

In recent decades, scientists around the world have been focusing society's attention on the disappointing dynamics and exponential growth in the incidence of neurotic disorders, neurological diseases among young people, the main reasons for which are called the acceleration of the pace of life, the introduction of new technologies in education and production, the reassessment of priorities and values, environmental, social and etc. aspects of human life [4].

Modern researchers are increasingly turning to the consideration of functional relationships between sensory and motor areas of the cerebral cortex, various morphological and functional systems of the body [5]. At the same time, in the literature there are few works performed on modern equipment that concern the study of the role of individual and typological properties of higher nervous activity (HNA), awareness of their significance in identifying predictors of various mental and autonomic disorders.

So, the issue of diagnosing and monitoring the functional state of the human nervous system, the need to return to physiological truths, understanding the mechanisms of regulation of functions, recognizing the role of the coordinating, regulating and integrating functions of the central nervous system and its importance in the occurrence of pathological disorders and the development of diseases.

Based on the concept of modulating brain systems, the reticular formation (ascending excitatory subcortical influences) belongs to the leading regulatory and integrating systems that determine the formation of a certain functional state. Having a grid-like structure hidden in the depths of the brain stem, and in contact with adjacent afferent sensory fibers, the reticular formation has an activating effect on the cortical structures of the brain at their slightest excitation, causing global shifts in the overall level of functioning, generalized.

An important contribution to the development of the functional state of the nervous system and the organism as a whole is made by the activity of the thalamic part of the diencephalon, which receives the flow of sensory afferentation, generates rhythmic activity, and synchronizes local effects on the cortex. The emergence of a functional state is also impossible without the participation of the limbic system, which has both activating and inactivating components, the coordinated work of which ensures the flow of cognitive functions and the activity of the emotional structures of the brain.

The leading place among the most influential regulatory structures, on which the formation of functional states depends and have a powerful downward influence, is occupied by the frontal areas of the cerebral cortex. They control the activity and reticular formation of the brainstem and thalamic part of the diencephalon, as well as the formation of a modulation vector corresponding to the current needs.

At the same time, in our opinion, equally important in this sense should be given to understanding the universality of the significance of the main nervous processes, their typological features in the development, deployment and maintenance of the functional state of the body. In this case, the functional state can be considered a synergy of both the modulating systems of the brain, the higher parts of the central nervous system of the cerebral cortex, and the support systems, which include the main nervous processes: strength, balance and mobility.

The next step, which leads to ensuring the state of health, is an attentive attitude to monitoring the vital signs of the body and, first of all, the functional state of the nervous system, and, if necessary, the use of psychophysiological diagnostics.

Among the sensitive indicators of the functional state of the central nervous system (CNS), which can be used to judge the dynamics of brain activation levels, the parameters of the electrical activity of the brain are of paramount importance. These include indicators of the rhythmic components of the EEG, their spatiotemporal characteristics, the value of the coherence of biocurrents, etc. It is known that the dynamics of the FS of a healthy person is manifested by the transformation of spatio-temporal relationships of the electrical activity of the brain, demonstrating connections between its individual sections or spectral indicators of a different nature. Most authors emphasize that in response to the complication of the task being performed, the intensity of interregional ties, for the most part, is growing.

Indicators of the cardiovascular and respiratory systems of the body obtained by electrocardiography, echocardiography, rheography, magnetic resonance imaging, which are at the intersection of medicine and physiology (heart rate, force, minute volume of the heart, blood pressure, regional circulation, tidal volumes, 3D reconstructions of the coronary arteries). They are indispensable for diagnosing the course of processes that occur in the body during the development of emergency conditions, in particular acute coronary syndrome, cardiac arrhythmias and conduction disorders, myocardial infarction, treatment of strokes, hypertension, diseases of the bronchopulmonary apparatus, etc.

At the same time, it should be noted that there is an urgent need for modern inexpensive express methods, mobile innovative methods for studying the functional state of the nervous system, including those developed using the neurodynamic approach. Recently, there has been a growing interest in such innovative methods of studying the body, the results of which would have both high efficiency, objectivity, ease and speed of obtaining, etc. From our point of view, such needs can only be satisfied by a research methodology based on genetically determined properties of the nervous system of the human body.

Scientists note that the features of HNA should be considered as a biological basis for the formation of possible vectors of adaptive behavioral reactions, further manifestation in the functions of the autonomic nervous system, and primarily the activity of the heart. Diagnostics and monitoring of the functional state of the nervous system, its characteristics in different conditions of existence in people with different levels of development of the main nervous processes will expand the criteria base for the sphere of career guidance and selection, prediction and prevention of neuropsychiatric pathology.

The aim of this study is to analyze the significance of the study of the characteristics of the main nervous processes and typological combinations for a general idea of the state of the body, as well as the possibility of their application in the diagnosis and monitoring of the nervous system of young people. The work used neurodynamic and sensorimotor hardware-test methods, analytical and statistical analysis.

3.1 MODERN IDEAS ABOUT THE PROPERTIES OF THE MAIN NERVOUS PROCESSES AND THEIR ROLE IN THE FORMATION OF FUNCTIONAL STATES

It is known that the main processes of nervous activity are excitation and inhibition. The leading properties of the main nervous processes are recognized as their strength, balance and mobility.

More than one century has already passed since Ivan Pavlov at the XIV International Medical Congress in Madrid made his famous report on the basics of higher nervous activity, intriguing the world scientific community with a new look at the existence of biological disagreements between people, at the same time basing their study and the need for diagnostics. Today, an extremely large number of works have already been accumulated devoted to the study of the property of the mobility of human nervous processes, as one of the leading ones, but to this day its problem remains unresolved [3].

The possibility of a rapid transition from one nervous process to another, depending on the conditions of the external environment, as well as the rate of occurrence, flow and termination of nervous processes, is the basis of Pavlov's idea of the concept of mobility. Later, the concept of mobility was divided into the understanding of mobility itself according to Ivan Pavlov, the rate of onset and termination of excitation according to Nikolai Vvedensky, and the ability of nervous processes to process an associative pair of conditioned reflexes according to Alexei Ukhtomsky.

Although the history of the study of mobility did not end there, but was enriched by the discovery of a new property by Mykola Makarenko – the functional mobility of nervous processes. According to the author, it is an integral speed characteristic of the whole functional system in which the signal is perceived, analyzed, decision is made, and a command is issued to the effector, taking into account the peculiarities of the work of the higher parts of the central nervous system – cortical structures [6].

It should be noted that the new discovered property not only does not contradict Pavlovian ideas about mobility, but also agrees with them in taking into account both the rapid switching of actions to discriminate positive signals and the frequent change in the process of inhibition by excitation and vice versa.

No less important properties of the main nervous processes are their strength and balance. According to the views of Ivan Pavlov, balance is the relationship that exists between the absolute values of the processes of excitation and inhibition. In other works, this property is understood as a balance between the rate of formation of conditioned reflexes and differentiations, the number of positive and inhibitory reactions, the rate of extinction and reinforcement of conditioned reflexes, etc.

The property of the strength of the main nervous processes lies in the ability of ensembles of nerve cells to withstand prolonged or frequently repeated excitation that does not cause the development of foreign inhibition [6]. Strength characteristics include resistance to external stimuli, concentration and irradiation of the excitation process, absolute sensory sensitivity and various manifestations of the law of strength.

Both reflex (actually nervous) and mental activity of a person are inextricably linked with the environment and are the result of the interaction of an infinite number of receptor, central and effector circuits. The carriers of the psyche are the processes of organizing physiological processes, that is, systemic interactions.

The concept of the properties of the main nervous processes in the Pavlovian understanding is today the leading one in the presentation of the biological foundations of individual behavior, response strategies, etc. According to the teachings of Ivan Pavlov about HNA, it is the properties of the nervous system that are the neurophysiological basis of heterogeneous manifestations, reactions and their individual behavioral strategies.

At present, the genetic nature of the properties of the main nervous processes, and first of all, the mobility of nervous processes, is no longer in doubt. The external environment, constantly influencing the body, forms new qualities of HNA. Modern studies of the higher nervous activity of a person have established a highly genetically determined property of nervous processes – their functional mobility (FMNP).

According to the research results, the reflection of the main properties of the human nervous system in the patterns of the electroencephalogram (EEG recorded at rest and under various functional loads) is genotypically determined. The Holzinger coefficient, which expresses the degree of genetic determination of FMNP, as well as the latent period of a simple sensorimotor reaction of visual and auditory modality, was in the range of 0.6–0.86.

Therefore, it should be noted that the diagnosis of individual indicators of FMNP is an important objective criterion for assessing the functional state of the nervous system [6].

It should also be noted that the range of various characteristics of the body's activity, its functions, properties, and, first of all, the indicators of the course of the main nervous processes are the result of the constant interaction of the human body with the environment, an indicator of its functional state. It does not matter what role in the creation of a certain functional state is played by the HNA properties, the initial level of activation of the nervous system, sensory systems, as well as numerous factors associated with the emotional background, motivations, and the type of activity performed.

Factors such as reactivity and lability are among the defining characteristics of the functional state.

Distinguish between the concept of normal, disturbed and pathological functional state of the body, where the neurophysiological component is given a leading role. The normal functional state of the nervous system is associated with the establishment of a relative dynamic balance between the main nervous processes, intersystem interaction in the body and external environmental influences, when the use and restoration of the body's functional resources is within its capabilities.

The signs of disturbed and pathological functional states include disturbances in reflex activity, disorganization of intersystem interaction, imbalance, discoordination of functions, depletion of nerve centers, an increase in inhibitory nervous processes, etc. The danger of a disturbed state is manifested by an exacerbation of neuro-emotional stress, the appearance of fatigue, the development of irritability, the spread of negative emotions that serve as the basis for psychosomatic disorders and their transformation into a pathological functional state. It is the pathological functional state of the body that is characterized by signs of shifts in nervous activity, the development of crisis physiological states, and cardio-respiratory insufficiency.

Among the modern technologies for studying the functional state in terms of the parameters of the main nervous processes, the psychophysiological hardware-computer method "Diagnost-1M", which is constantly developing and updated in our scientific school, has recently become the most popular in scientific laboratories of many educational, industrial, military institutions of Ukraine. A large body of research has already been accumulated, proving the essential importance of taking into account the functional indicators of the nervous system, established by neurodynamic characteristics, in order to optimize educational, labor operations, develop health-preserving principles of life for workers in various sectors of the national economy.

Psychophysiological studies of certain examined contingents (in normal and pathological conditions) open up opportunities for the practical application of the results of applied developments, for example, scientifically based proposals for the use of neurodynamic methods as diagnostic, screening for the possibility of monitoring (or treating or correcting) the functioning of the nervous system in the medical field, to which the present work is dedicated.

3.2 HARDWARE-COMPUTER METHOD FOR STUDYING THE FUNCTIONAL INDICATORS OF THE HUMAN NERVOUS SYSTEM "DIAGNOST-1M"

The "reverse side of the medal" of the current level of scientific and technological progress requires a person to exert high stress on many systems of its body, including the nervous one. Both the performance of many professional tasks and the everyday realities of communications in modern society constantly place ever greater demands on the nervous system, often causing overstrain of the main nervous processes, exacerbation of psycho-emotional personality disorders, the development of premature fatigue and asthenia of its functions.

The work of the nervous system under conditions of time limit is accompanied by excessive activation of cerebral processes, emotional zones of the brain, an imbalance in the processes of excitation and inhibition, and other shifts in the central and autonomic nervous system. There is a need to conduct monitoring examinations, develop and apply a differentiated approach in the diagnosis of neuropathology, which is designed to enrich the understanding of the neurological level of "safe" life activity, to contribute to updating the theoretical and methodological foundations of prevention and medical selection especially those that are based on non-invasive, but objective methods, which include psychophysiological developments.

To assess sensorimotor reactivity, let's determine the individual neurodynamic properties of HNA, create appropriate neurodynamic scales, with a detailed assessment of the functional quantitative and qualitative individual neurodynamic characteristics of certain contingents of subjects, in our opinion, the most suitable is the latest hardware-computer complex created by Mykola Makarenko and Volodymyr Lizogub and is constantly being improved by their scientific school [7].

Studies can be carried out in three main modes (in optimal, feedback, imposed rhythm) and the sub-mode "reaction to a moving object" using signals of various modalities and specifics: figurative (geometric shapes square, circle, triangle), auditory and visual (green, red, yellow colors of rectangles; pure tones in low, medium and high keys, described by a regular curve), associative (names of animals, plants, inanimate objects). In the optimal mode, the hardware-diagnostic computer complex allows to determine the indicators of a simple visual-motor or auditory-motor reaction, as well as to identify the characteristics of the reaction of choosing one signal from three proposed ones or to select and differentiate two signals from three.

When determining the indicators of a simple sensorimotor reaction (various modalities), at the beginning of the examination, familiarization with the rules for performing the task is carried out.

In particular, it is emphasized that when a certain type of signal (announced on the eve of the examination) appears on the monitor screen – geometric shapes, words, colors or sound tones, press and release the right button of the device as quickly as possible with the right (or left) hand. The task must be completed before the message about its completion appears on the screen. For a better acquaintance of the subject with the performance of the task, it is desirable to demonstrate the technique of its implementation by the researcher on a small number of presentation of signals.

The significance of identifying the characteristics of simple sensorimotor reactivity lies in the fact that they reflect the rate of the excitatory process in all links of the reflex ring (from the receptor to the higher centers of the central nervous system, analytical and synthetic processes in it and propagation in the opposite direction to the effector), including taking into account the time spent on perception, decoding, signal transformation into a nerve impulse, etc. This allows to regard a simple sensorimotor reaction as an indicator of the excitability of the central nervous system, giving the status of its latent period as an objective indicator of the functional state in which, it is under these conditions.

The performance of the sensorimotor task of choosing one signal out of the three proposed is also carried out with one hand: right (or left). Under these conditions, the subject is told that, for example, when a high-pitched sound tone (square, red, etc.) appears, it should press and release the right (or left) button as quickly as possible and not respond to other signals by pressing.

As in the previous task, the response must continue until the message about its completion appears on the screen. The content of this sensorimotor reaction is to find out how accurately (clearly) and quickly the subject is able to select only one signal from the three proposed. As a result, the number of erroneous reactions made by the subject during the performance of the task makes it possible to judge the accuracy of its performance, and the duration of the latent period indicates the speed of the operation of choosing one stimulus among others.

The implementation by the subject of the sensorimotor reaction of choice and the differentiation of two signals from the three proposed requires the use of both hands. So, the appearance of a signal (as in the previous tasks, its certain modality can be selected) requires the subject to quickly press and release the right button on the signals: a square, a red rectangle, a high-pitched sound, the names of animals. With the left hand, it is necessary to quickly respond to the figures of circles (names of plants, sound tones of low pitch or green rectangles) by pressing and releasing the button of the device as quickly as possible. Negative signals, which include: the shape of a triangle, the name of an inanimate object, a mid-tone sound tone, a yellow rectangle, should not be reacted to.

In the case of performing such a sensorimotor task, in addition to the operation of choosing a stimulus (carried out in the optimal mode), it is also complicated by the need to process information on the differentiation of positive and inhibitory signals, which occurs in the imposed rhythm mode and in the feedback mode, when the speed of signal presentation, and the number of stimuli used in the study. At the same time, since the task is as complex as possible, its implementation requires the participation not only of the peripheral departments and lower nervous levels of control, but also requires the inclusion of the highest cortical coordinating and integrating centers of the nervous system.

Consequently, the value of the indicator of the rate of a complex reaction lies in its informativeness regarding the ability of the central nervous system to ensure the flow of a complex reaction and at the same time demonstrates the criteriality of this characteristic of the nervous system in relation to the development of individual typological properties of the human HNA.

Statistical processing of indicators is carried out automatically with the calculation of the average value of the latent period of the sensorimotor reaction, the error of the arithmetic mean, the standard deviation, the coefficient of variation, the number of errors; the average value of the motor reaction, which objectifies the obtained individual and group data. Thus, highlighting the values of sensorimotor reactions of different complexity, it should be stated that simple sensorimotor reactivity is an important measure for assessing the functional state of the nervous system, while complex sensorimotor activity is an indicator of the activity of many brain structures: neuronal networks, ensembles, columns of modules, and their inside-system and intersystem interactions.

The hardware-computer complex "Diagnost-1M" makes it possible to actually evaluate to a certain extent those processes that occur directly in the higher parts of the central nervous system, diagnosing the ability of the nervous system to provide sensorimotor reactivity of varying degrees of complexity. This becomes a possible means of studying both simple and complex sensorimotor reactions of selection and differentiation of stimuli.

To do this, on the basis of this examined device, a certain number of stimuli are presented with the determination of the average values of the latent periods of a simple sensorimotor reaction, then a certain number of stimuli are presented with the determination of the average values of the latencies of a complex sensorimotor reaction of selection and differentiation of two stimuli out of three, obtaining the speed of the central processing of information by the higher parts of the central nervous system. It is determined by the difference between the average latencies of a complex sensorimotor reaction and a simple sensorimotor reaction and is based on the fact that the average latency of a complex sensorimotor reaction is defined as the average value of the response time to stimuli presented in the "feedback" mode [8].

It is known that the time interval between sensory perception and the onset of motor wear reflects the total duration of the sensorimotor response. The procedure for applying at least three times consciously quickly pressing and releasing an unrestricted button of the measuring device and averaging the time spent on such movements makes it possible to identify the motor component of reactivity. This possibility can be useful in medicine as an express diagnostic of paresis, neurotic disorders, depressive states, etc.

After determining the latent period of a simple sensorimotor reaction and the motor component, it becomes possible to evaluate the sensory component of reactivity by calculating the difference between these obtained values. As a screening technique, such a procedure can be offered when determining the diagnosis of sensory disorders (visual dysfunction, deprivation of auditory function), the development of post-COVID syndrome, etc.

The study of the time (speed) of the central processing of information by the brain makes it possible to find out at what level (quantitatively and qualitatively) its analytical and synthetic activity can be carried out, which involves the participation of numerous and heterogeneous cerebral structures in the performance of any sensorimotor task of differentiating stimuli. With an increase in the complexity of the task (from a simple sensorimotor reaction to a reaction of choice and differentiation), the need to expand intersynaptic interactions also increases, proving the importance of the main nervous processes in their provision and the course of brain activity.

Studies of the brain functions of people with congenital deafness have revealed excellent characteristics of information processing by the brain compared to their healthy peers, which makes it possible to propose such a technique for monitoring the dynamics of nervous processes associated with dementia of various pathogenesis.

The "feedback" mode is used to directly determine the levels of properties of the main nervous processes: functional mobility and strength. It is possible to select the required number of signals (in the range from 120 to 360), as well as the duration of the study series (1–5 minutes). In this mode, the speed of signaling directly depends on the progress of the task by the subject: an error-free reaction causes a reduction in the next signal (no more than 20 ms), and an erroneous reaction is accompanied by its delay by the same amount of time. Signal exposures range from 20 to 900 ms.

To complete the task in the "feedback" mode, the subject is required to strictly follow the instructions that it read at the beginning of the study. Namely, the appearance of, for example, a square (or the name of an animal, a red rectangle, a high-pitched sound) requires the immediate pressing and releasing of the right button with the right hand. On the contrary, the appearance of a circle (or the name of a plant, a green rectangle or a low-pitched sound) is the reaction of pressing and releasing the left hand on the left button of the device. Shapes of triangles (or names of inanimate objects, yellow rectangles, mid-pitched sound tone) are inhibitory and do not require any response to them. If the task is executed without errors, the signaling rate will increase and decrease with an erroneous response.

The essential point is the execution of the task at the highest possible speed for the examined person, while making the least number of errors. To do this, the subject must respond to the signals as accurately as possible and maintain the acquired high pace for as long as possible. Of course, errors will inevitably occur during the reaction, but stopping tasks in the middle of its execution is not acceptable. As in the previous cases, the task must be completed before the completion message appears on the screen.

Important indicators of statistically processed and visualized on the computer display FMNP are: the number of signals proposed for selection / or selection and differentiation, the duration of the proposed task, the processing time of the proposed number of signals, the initial and minimum signal exposure time and the time to reach the minimum signal exposure.

The indicator of FMNP is the time of task execution as demonstrating the ability of the CNS to maintain the fastest possible rate of error-free sensorimotor response to successive positive and inhibitory signals. It should be noted that the time to complete the task depends entirely on the characteristics of both the process of excitation and inhibition, therefore, is the resulting value of their functional mobility.

The main indicators that can be determined to characterize the strength of nervous processes (SNP) include the number of processed stimuli during the task, the minimum time and time to reach the minimum signal exposure, the ratio of signals that should be responded to the total number of proposed signals, the degree of growth exposure.

In the imposed rhythm mode, it is possible to study in detail the characteristics of FMNP and SNP with preliminary training, which can last from 30 to 60 s. The peculiarity of this mode is to change the speed of presentation of the signals displayed in the range from 30 to 150 per minute. For the optimal degree of gain applied in determining the FMNP and SNP in this mode, it is recommended to select 10 waveforms that will be attached to the waveform demo for processing per minute. For example, 40, 50, 60, and so on up to 150. When completing the task, the subject should press and release the right button as quickly as possible with the right hand when a square figure (or the names of animals, a red rectangle or a high-pitched sound) appears.

The appearance of a circle figure (or the name of a plant, a green rectangle, or a low-pitched sound) requires a quick press and release of the instrument's left button with the left hand. The shape of a triangle (as well as the names of inanimate objects, yellow rectangles, or a mid-tone sound) does not require pressing buttons. The execution of the task is terminated only when an inscription appears on the screen about its completion and in no case is interrupted if an error is made.

After carrying out the examination modes mentioned above, the levels of FMNP and SNP can be judged by the indicators that appear on the display: the rate of presentation of signals per minute, the total number of admitted false reactions, correctly processed signals, etc. The indicator of FMNP is the maximum possible rate of presentation of signals at the highest speed, when the subject allows up to 5.5 % of erroneous responses.

SNP is evaluated by the total number of erroneous reactions (as a percentage of the sum of all applied signals), which the subject allowed for the entire period of the task. Consequently, the fewer erroneous reactions the subject could make during the selection and differentiation of signals, the higher the level of strength of nervous processes it has (the working capacity of the brain).

The balance of nervous processes (BNP) is studied in the "reaction to a moving object" mode. The device allows to change the time of movement of the object from 500 to 2000 ms. The number of BNP determinations can vary from 10 to 40 with a pause between signal series of 500–2500 ms, necessary to restore the functions of the nervous system. Such an examination makes it possible to determine the ratio of the processes of excitation and inhibition in the cerebral cortex by the accuracy of the sensorimotor response to an object moving at a uniform speed in the place indicated on the monitor.

According to modern concepts, premature motor responses (anticipations) reflect the processes of inhibition, while delayed ones reflect the excitatory process. For medicine, no doubt, the identification of BNP by reaction to a moving object can be useful in the diagnosis of depressive disorders, the development of acute stress, and the determination of the volume of sensory and motor anomalies.

To determine the BNP, the subject should press the right or left button in such a way that it is possible to stop the object moving on the monitor clearly opposite the cursor. Among the evaluation indicators, the number of error-free reactions, the sum of deviations and their average value, as well as the number of reactions ahead and late relative to the exact (error-free) reaction in the attempt that was the most successful, are important.

3.3 SETTING GOALS, ORGANIZATION AND APPLICATION OF THE HARDWARE-COMPUTER TECHNIQUE "DIAGNOST-1M" FOR THE STUDY OF THE NERVOUS SYSTEM OF THE EXAMINED VARIOUS CONTINGENTS

An analysis of modern methods of psychophysiological diagnostics, the practice of using hardware devices in the medical field has shown that an adequate assessment of the functioning of the human nervous system should be based on reliable criteria that can only be distinguished when examining different contingents of people (by age, professions, diseases). It is known that the main driving force, an important factor in socio-economic progress, the bearer of the intellectual potential of each country is the younger generation. The main hopes for the further development of Ukrainian society are pinned. The official age of young people in our state, according to Article 1 of the Law of Ukraine "On the promotion of social formation and development of youth in Ukraine" dated February 5, 1993, is 14–35 years.

It is also noteworthy that recently among the younger generation there has been an increase in neurological pathology. Today in Ukraine, as well as throughout the world, over the past 10 years, there has been a growing trend in the growth of vascular diseases of the brain, infectious and demyelinating lesions of the nervous system (in particular, multiple sclerosis), vegetative dystonia, diseases of the peripheral nervous system [9].

It is noted that 70 % of such patients are people of working age. The prevalence is acquired by chronic fatigue syndrome, which is clinically manifested by headache, weakness, dizziness, memory loss, and performance. Among the reasons are the unfavorable ecological situation, immune deficiency, allergization of the population, and viral neurodiseases. Cases of strokes in young and middle age are rapidly increasing, and they are increasingly being diagnosed in children. In this regard, the main emphasis should be placed on preventive treatment, and priority in the fight against neurological morbidity should belong to the development and application of methods for diagnosing and monitoring the state of the nervous system [10, 11].

Given the above, in recent years we have conducted studies of the functional parameters of the nervous system of the population of different categories: students, athletes, people of operator professions, people with pathologies of the auditory system, as well as post-COVID syndrome, psychophysiological lability, developed military condition. In order to clarify the characteristics of the main nervous processes and their typological manifestations in terms of neurodynamic and sensorimotor parameters in young people aged 17–28 years.

The survey was conducted on 168 boys and girls who made up groups: students, athletes, mobile operators, people with deprivation of auditory function (congenital deafness), people with post-COVID syndrome, people with an unstable psychophysiological status, formed as a result of the declaration of martial law in the country. The examinations were carried out in accordance with the norms of bioethics and in compliance with the provisions of the Ministry of Health of Ukraine dated March 13, 2006, No. 66 and the Declaration of Helsinki (1975, later editions of 1996–2013).

The functional characteristics of the nervous system were studied using the hardware-computer method of Mykola Makarenko "Diagnost-1M". Sensorimotor reactivity was studied in terms of latent periods (ms) during reactions to stimuli of varying degrees of complexity: a simple sensorimotor reaction, a reaction of choosing one stimulus out of three, and a reaction of choosing and differentiating two stimuli out of three (stimuli used visual and auditory modality). Lower rates of latent periods indicated better sensorimotor reactivity.

The study of the neurodynamic individual typological properties of HNA was carried out in terms of functional mobility (FMNP), strength (SNP) and balance (BNP) of nervous processes. To determine the individual FMNP, the "feedback" mode was used to obtain results on the selection and differentiation of positive and inhibitory stimuli. The level of FMNP was judged by the time of the completed task: a shorter time corresponded to a higher level of the studied typological property.

The strength of nervous processes (SNP) was evaluated in terms of the total number of processed stimuli per 5 min of computer work. The highest level of SNP corresponded to a greater amount of processed information.

The time/speed of the central processing of information by the brain (CPI) was calculated [11]. To do this, we determined the latencies of a simple visual-motor (SVMR) or simple auditory-motor (SAMR) reaction and the reaction of selection and differentiation of two stimuli out of three (RC_{2-3}), taking into account the FMNP level.

The determination of the BNP was carried out in the "reaction to a moving object" submode with the evaluation of the results, which included taking into account the total number of advanced or delayed responses. A smaller sum of response deviations (ms) indicated a higher BNP.

Additional methods for examining indicators related to the activity of the nervous system were research methods:

– the level of personal anxiety (PA) and reactive anxiety (RA) according to the method of self-assessment by Charles D. Spielberg adapted by Yuriy Khanin;

– the level of self-assessment of well-being, activity and mood (WAM) according to the method of Valery Doskin [12];

– assessment of student learning in terms of semester performance (the number of positive and negative exams and tests passed, their quality, the existence of academic debt, its volume).

The results were processed by conventional methods of parametric and nonparametric statistics. Comparison between independent samples that did not fall under the normal distribution law was carried out by the Mann-Whitney method, between dependent samples – by the Wilcoxon method. When the data fell under the normal distribution law, Student's t-test was used for dependent and independent samples, respectively.

3.4 THE MAIN RESULTS OF THE STUDY OF FUNCTIONAL INDICATORS OF THE HUMAN NERVOUS SYSTEM

According to the tasks set in the work, the characteristics of the main nervous processes were studied. We found out the significance of the properties of the main nervous processes for assessing the functional states and general well-being of a person. The work used neurodynamic and sensorimotor methods of the hardware-computer system "Diagnost-1M", described in Paragraph 3.2.

The study of the parameters of sensorimotor reactivity included the determination of indicators of latent periods of simple sensorimotor reactions of visual and auditory modality (LPSVMR/LPSAMR), reactions of choosing one of three stimuli ($LPRC_{1-3}$) and reactions of selecting two stimuli out of three ($LPRC_{2-3}$).

The results of studies of the sensorimotor functions of a group of students (on the example of the processing of visual modality stimuli) are presented in **Table 3.1**.

Table 3.1 Average indicators of latent periods of visual-motor reactions of varying degrees of complexity among students

Age (years)	Latent periods (M ± m, ms)		
	LPSVMR	$LPRC_{1-3}$	$LPRC_{2-3}$
17–18	234.5 ± 5.1	353.8 ± 4.7	434.6 ± 6.7
19–20	233.5 ± 5.3	345.5 ± 6.8	416.3 ± 6.8
21–22	231.5 ± 5.4	342.3 ± 5.7	400.8 ± 5.8
23–24	243.4 ± 6.4	344.1 ± 6.0	403.2 ± 6.2
25–26	252.1 ± 6.6	346.2 ± 6.5	413.7 ± 6.5
27–28	256.2 ± 6.8	347.3 ± 7.2	417.2 ± 7.7

As can be seen from the Table, with the complication of the sensorimotor task, the time of perception, processing and response increased. The shortest latent periods of SVMR are typical for students aged 17–22; for RC_{1-3}, similar results were obtained from students aged 19–28, with the lowest values at 21–22 years; and for RC_{2-3}, the shortest latencies were observed at 21–24 years. Subjects aged 21–22 had the lowest latencies, regardless of the degree of their complexity, both relatively younger (17–20 years old) and older participants (23–28 years old). Such remittance of indicators demonstrates the age periods of development and stabilization of simple and complex sensorimotor functions of a person.

Indicators of sensorimotor reactions of varying degrees of complexity of the examined group of athletes did not differ significantly from those of students (**Table 3.2**). It is known that the properties of perception, processing of information, appropriate response to various stimuli are important for a person as an evolutionary and ontogenetic heritage regarding the possibility of adaptation and development of a defense strategy. There is no doubt that the processing of information as an element of almost all types of human life depends on the capabilities of the central nervous system and the current functional state.

Currently, the prevailing majority of professions, to one degree or another, are associated with the implementation of operator functions (from a supermarket seller to a work office or a scientific institution).

Table 3.2 Average indicators of latent periods of visual-motor reactions of varying degrees of complexity in athletes

Age (years)	Latent periods (M ± m, ms)		
	LPSVMR	$LPRC_{1-3}$	$LPRC_{2-3}$
17–18	250.1 ± 6.1	347.1 ± 5.3	411.3 ± 6.9
19–20	240.2 ± 6.2	343.5 ± 5.0	389.7 ± 7.2
21–22	235.4 ± 5.1	337.3 ± 3.1	374.6 ± 6.9
23–24	238.4 ± 5.4	336.1 ± 5.3	372.1 ± 6.1
25–26	244.1 ± 5.8	338.2 ± 5.5	374.4 ± 5.1
27–28	253.2 ± 6.2	341.9 ± 4.3	484.8 ± 5.4

However, the best rates of SVMR were observed in the age range of 21–26 years; for RC_{1-3} and RC_{2-3} they were recorded in athletes aged 21–26. Consequently, athletes have a longer period of stabilization of complex sensorimotor reactions at the highest level compared to students.

There are more and more labor operations associated with the processing of auditory information (communications, dispatchers, military personnel, telephone operators, etc.). We conducted a survey of mobile operators, in whose intellectual activity processes associated with visual and auditory afferentation are activated, requiring quick and responsible decisions. The study of the sensorimotor functions of mobile operators made it possible to identify some features (**Table 3.3**).

Table 3.3 Average indicators of latent periods of visual-motor reactions of varying degrees of complexity in people with different statuses of auditory function by stimulus modality

Latent periods (M ± m, ms)	Stimulus modality	
	Visual	Auditory
LPSAMR	210.9 ± 8.2	181.2 ± 9.6*
$LPRC_{1-3}$	367.9 ± 7.8	331.2 ± 8.3*
$LPRC_{2-3}$	412.6 ± 6.8	430.5 ± 6.1*

*Notes: * – reliability of differences $p < 0.05$ between indicators of different modalities*

The time of latent periods of a simple sensorimotor reaction and a reaction with one choice turned out to be significantly shorter in the case of the application of an auditory modality stimulus. As regards the reaction of selection and differentiation of two stimuli out of three, the latencies recorded on presentation of stimuli of the visual modality were shorter. We are inclined to believe that the significantly shorter latency to auditory modality stimuli obtained by us is explained by the higher sensitivity threshold in this analyzer, as well as by the morphofunctional features of the auditory nerves. In turn, the best performance of a complex sensorimotor reaction of selecting and differentiating visual modality information can be associated with the specificity of the mechanisms of visual and auditory sensory processing.

At the same time, the modality of the stimulus in some cases is of decisive importance, especially for those categories of people who have limited or complete deprivation of certain sensory functions. The sad dynamics of the increase in the number of people with hearing problems requires the study of brain processes that occur in the "deaf" brain when processing information. After all, before making a decision adequate to the situation, information coming from the environment must go from the receptor-receivers to the control centers of the brain, and from them directly to the executive organs.

The brain of a deaf person is a unique model with adaptation mechanisms that have not yet been fully elucidated, allowing it to exist in a changing world. The disclosure of this secret can contribute to the development or at least partial restoration of lost mental, sensory, motor abilities, the development and application of new approaches in the field of microtechnologies of nerve impulses, self-regulation, brain twitching in order to treat and correct the functions of the central nervous system of millions of people suffering from sensory defects.

It should be assumed that the analysis of the principles of the brain with deprivation of analyzer functions on the basis of neurodynamic studies will help to identify the algorithms for the functioning of a number of brain structures, improve the diagnosis of pathology, prediction and monitoring.

To determine the features of the brain mechanisms of differentiation of visual stimuli in subjects with normal hearing and the deaf, sensorimotor characteristics were analyzed (**Table 3.4**).

Table 3.4 Average indicators of latent periods of visual-motor reactions of varying degrees of complexity in people with different statuses of auditory function by examined groups

Latent periods (M ± m, ms)	Examined groups	
	Healthy	Deaf
LPSVMR	230.4 ± 9.1	252.7 ± 9.6
$LPRC_{1-3}$	350.9 ± 10.8	366.1 ± 9.3
$LPRC_{2-3}$	426.6 ± 8.7	497.5 ± 11.2*

*Notes: * – reliability of differences $p < 0.05$ between the indicators of healthy and deaf subjects*

No significant differences were found between the sensorimotor parameters of the SVMR and RC_{1-3} ($p > 0.05$). Comparison of the results of RC_{2-3} indicated the predominance of latencies of a complex sensorimotor reaction in the deaf ($p < 0.05$). These results indicate that the performance of relatively simple sensorimotor reactions (SVMR, RC_{1-3}) does not require the participation of the higher parts of the CNS, but is an important characteristic of the rate of the excitatory process in neuronets, which is important from a medical point of view for assessing the work of the peripheral parts of the nervous system of such patients.

Indicators of a complex visual-motor reaction, reflecting the participation of cerebral neurostructures in the analysis of information, providing synthetic processes of the central nervous system, indicated that such processes in the deaf require much more time than in healthy people.

Consequently, deprivation of auditory afferentation, characterized by a deficit in the neural status, significantly impairs the effectiveness of information processing by the brain.

Each psychophysiological state of a person is a reflection of the interaction of the organism with the environment. It is influenced by the surrounding events of personal and social life, the ability to resist negative situations, the levels of situational and personal anxiety, and the tendency to develop depressive states. This aspect becomes especially acute in the conditions of martial law declared in the country. A survey of men who were engaged in professional duties (university workers), not being in the frontline zone, revealed significant changes in their psychophysiological sphere with a tendency to develop depression (**Fig. 3.1**).

Conducted pilot surveys of 19 men aged 20–25 years to assess the impact of adverse events on the general functional state of the nervous system in terms of sensorimotor functions revealed, on the one hand, the vulnerability of the CNS to the psycho-emotional factors of a military state (which was manifested by a predominant decrease in latencies), the other – testified to a rather high sensitivity of the indicators of sensorimotor reactivity to changes in the psychophysiological status of a person. Undoubtedly, martial law is one of the formative factors in the development of unbalancing of adaptive psychophysiological reactions.

Among other medical problems that need urgent solutions is the fight against the incidence of COVID-19 and, especially, the elimination of its consequences [13]. Today, medical workers are concerned about both the rapid spread of the disease and the awareness of the severe consequences of the disease, manifested by the development of the so-called post-COVID syndrome. The most dangerous of its symptoms and complaints include disorders of the central nervous system.

On the other hand, scientists are optimistic about the opinion that the restoration and normalization of the functions of the central nervous system and GNI are quite possible. In addition, the results of studying the functioning of the brain in post-COVID syndrome can be extremely useful for optimizing preventive, therapeutic and rehabilitative measures.

A study of the sensorimotor functions of the examined 20 male subjects aged 19–26 years who recovered from COVID-19 (mild and moderate severity) at the 6th week after recovery and their comparison with the indicators of healthy peers revealed significantly worse sensorimotor indicators (≤0.05) (**Table 3.5**).

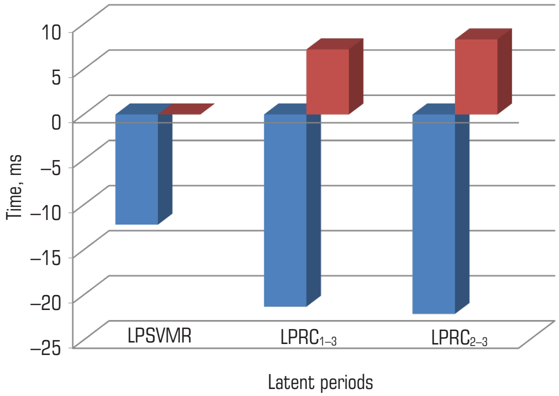

Fig. 3.1 Volumes of increasing and decreasing the time of latent periods of sensorimotor reactions of varying degrees of complexity under martial law

Table 3.5 Average indicators of latent periods of visual-motor reactions of varying degrees of complexity in healthy people with post-COVID syndrome

Latent periods (M ± m, ms)	Examined groups	
	Healthy	Post-COVID syndrome
LPSVMR	230.4 ± 9.1	299.1 ± 6.4*
$LPRC_{1-3}$	350.9 ± 10.8	375.2 ± 8.1
$LPRC_{2-3}$	426.6 ± 8.7	455.7 ± 7.3*

*Note: * – significance of differences p ≤ 0.05 between indicators of healthy people and people with post-COVID syndrome*

Such results may be associated with the existence of residual changes in the walls of blood vessels, disturbances in reverberation processes in neural networks, the development of hypoxic phenomena in the brain tissue, the predominance of inhibitory processes in the cortex, etc.

3.5 FEATURES OF THE FUNCTIONING OF THE NERVOUS SYSTEM IN PEOPLE WITH DIFFERENT LEVELS OF BASIC NERVOUS PROCESSES

According to the tasks set in the work, typological combinations of the main nervous processes were studied. In the presented material, in order to reduce the volume and simplify the presentation of information, the results that illuminate the individual typological properties of HNA are presented only in terms of the functional mobility of nervous processes, as the most scientifically substantiated and studied.

Given that the study of the manifestation of individual typological features in mental activity is still relevant, a study of the neurodynamic properties of human HNA was carried out. Neurodynamic indicators were established (shown on the example of university students) obtained during the processing of information of different modality (**Table 3.6**).

Table 3.6 Neurodynamic parameters of the subjects during the processing of information of different modality

Statistical indicators	**Neurodynamic properties**		
	FMNP, irr/min	**SNP, % of errors**	**BNP, ms**
Visual modality			
max	140	28.5	26.4
min	70	10.3	11.8
X ± m	100.2 ± 3.4	19.1 ± 1.2	19.7 ± 1.3
Auditory modality			
max	110	38.7	–
min	50	15.4	–
X ± m	79.6 ± 1.5	26.8 ± 1.3	–

The distribution of subjects according to the FMNP level using the three-sigma method made it possible to identify the features of sensorimotor reactivity in individuals with its different gradations (**Table 3.7**).

Table 3.7 Sensorimotor parameters of subjects with different FMNP levels during processing of information of different modality (median, upper and lower quartiles)

Tested indicators	Level of functional mobility of nervous processes		
	high, *n* = 38	**medium, *n* = 97**	**low, *n* = 26**
LPSVMR / LPSAMR, ms	182.7 (241.4; 178.9) / 160.1 (180.2; 147.6)	211.4 (234.9; 234.6) / 181.0 (225.1; 154.0)	225.7 (252.1; 215.5) / 188.7 (224.1; 174.1)
$LPSVMR_{1-3}$ / $LPSAMR_{1-3}$, ms	322.1 (370.2; 336.2) / 300.9 (323.9; 286.8)	369.1 (382.2; 347.1) / 329.1 (366.4; 321.9)$^{\wedge}$	377.2 (387.4; 352.6)$^{\#}$ / 374.2 (378.5; 346.1)$^{\#}$
$LPSVMR_{2-3}$ / $LPSAMR_{2-3}$, ms	362.5 (389.2; 353.6)$^{+}$ / 383.2 (401.0; 367.3)$^{+}$	414.1 (468.3; 406.9)$^{\wedge}$ / 434.3 (458.4; 417.5)$^{\wedge}$	462.7 (489.1; 447.5)$^{\#\#}$ / 482.1 (500.3; 467.6)$^{\#\#}$
CPAI / CPVI	173.2 (198.4; 167.9) / 225.2 (258.3; 211.5)	202.8 (236.2; 192.3) / 254.6 (287.1; 223.3)	237.6 (267.1; 211.7)$^{\#\#}$ / 292.9 (337.8; 274.6)$^{\#\#}$

Notes: $^{+}$ – significance of differences in differences $p < 0.05$ between the indices of subjects with high and medium; $^{\#}$ – significance of differences $p < 0.05$; $^{\#\#}$ – $p < 0.01$ between the indices of subjects with high and low; $^{\wedge}$ – with medium and low levels of FMNP

It can be seen from the table that subjects with high and medium FMNP differed in a shorter time of LPSVMR and $LPRC_{1-3}$ compared to its low gradation, although not significantly ($p > 0.05$). Similar results were established when comparing the results of individuals with high and medium levels of FMNP with lower latency in favor of the former ($p > 0.05$). At the same time, the values of $LPRC_{1-3}$ in subjects with low FMNP were probably higher than in those with high levels ($p < 0.05$).

The study of the results of complex sensorimotor activity revealed its significantly lower quantitative values in subjects with high and medium FMNP compared with those with low gradation ($p < 0.05$–0.01). The lowest $LPRC_{2-3}$ were recorded in individuals with high FMNP ($p < 0.05$).

Similar differences were established between the parameters of subjects with different FMNP recorded during the processing of auditory modality information. Except for the fact that the difference between the RC_{1-3} indicators in favor of large latencies in individuals with low FMNP was also established between individuals with its low and medium gradations ($p < 0.05$). This probably indicated an increase in the difficulties of information processing for these subjects.

It is known that the central processing of visual and auditory information (CPVI, CPAI) reflects the speed and quality of the current analytical and synthetic activity of the cerebral cortex and other brain structures, and each specific complex sensorimotor act in the cerebral cortex and subcortex is a consequence of the functioning of departmental spatially excitatory and inhibitory neurons, which is manifested in the individual characteristics of the HNA of the subjects [14].

Comparison of the characteristics of the CPI of visual and auditory modality in subjects with different gradations of FMNP revealed the existence of differences between them. Thus, the time of CPAI, as well as CPVI in individuals with low FMNP, differed significantly in higher values compared to those in subjects with a high level of it ($p < 0.01$). An inverse relationship was established between the number of processed stimuli of both modalities and CPI ($p < 0.05$).

Probably, the faster the processing and differentiation of information took place in the higher parts of the CNS being examined, the greater the number of stimuli they could process. This once again confirms the leading role of the main nervous processes in the functional system to ensure the integrative activity of the brain.

From the point of view of the importance of taking into account scientific results in diagnostics and treatment, it was important to investigate how information is processed by the "deaf brain", because the morphological and functional consequences of hearing defects (congenital and acquired) cause degenerative changes in the receptor hair cells of the organ of Corti, subcortical and cortical auditory centers of the brain and not only [15]. The analysis of quantitative and qualitative indicators of information processing in healthy and deaf people and their comparison made it possible to confirm that subjects with auditory function deprivation achieve a less effective result in 5 minutes of work on the selection and differentiation of stimuli than subjects with normal hearing ($p < 0.05$) (**Table 3.8**).

Table 3.8 Information processing characteristics of people with different levels of auditory function in the "feedback" mode ($M \pm m$)

Tested indicators	**Examined groups**	
	Healthy	**Deaf**
Number of processed stimuli	737.8 ± 39.1	612.2 ± 27.8**
Number of false reactions, %	46.8 ± 4.5	66.2 ± 5.3*
Minimum exposure time, ms	31.3 ± 5.4	48.3 ± 3.5*
Time to reach the minimum exposure, ms	117.9 ± 6.2	268.2 ± 4.5**
Speed of central information processing (CPVI), ms	197.9 ± 7.6	247.8 ± 6.3*

*Notes: * – reliability of differences p < 0.0; ** – p < 0.01 between indicators of healthy and deaf subjects*

This was confirmed by the probably longer time to reach the minimum exposure of the visual stimulus, its minimum exposure compared to the results of healthy individuals ($p < 0.05–0.01$). The CPI indicators of the deaf subjects showed higher values compared to the subjects with normal hearing ($p < 0.05$). This situation indicated a low rate of establishment of intersynaptic contacts in the CNS and reverberation of neuronal impulses.

Thus, it was found that auditory deprivation has a significant impact on the processing of visual information by the brain. The study of neurodynamic parameters obtained during the selection and differentiation of visual stimuli revealed a significantly lower brain performance and insufficient lability of the visual analyzer system in people with congenital deafness.

3.6 PSYCHOPHYSIOLOGY IN THE SERVICE OF HEALTH: PRACTICAL RECOMMENDATIONS, THE IMPORTANCE OF USING THE RESULTS OF THE STUDY OF THE NERVOUS SYSTEM IN MEDICINE

Thanks to the functioning of the nervous system, many current physiological processes are integrated into a functional system that works to adequately adapt the body to changing living conditions. The results of our study of the main nervous processes in terms of the parameters of sensorimotor and neurodynamic functions suggest that the diagnosis and monitoring of the state of the nervous system should be based on genetically determined indicators that reflect the dynamic stability of body functions. These include characteristics of the properties of the main nervous processes, sensorimotor reactions, analyzer systems, which objectively reflect the level of conditioned reflex activity and at the same time allow revealing the state of the analytical and synthetic activity of the brain, memory subsystems, attention, and emotions.

Since FMNP is one of the leading properties of the main nervous processes, it is related to the provision of a certain speed (why exactly there are interindividual differences in the choice and discrimination of stimuli) of the establishment of temporary connections, the formation of intersystem interactions in the CNS.

Persons with low FMNP, in contrast to those who are characterized by its high gradation, can be considered as those in whose brain neurons there are less favorable properties for the formation of axons, synaptic terminals, and more. Their synapses have moderate functional characteristics, are distinguished by lower levels of metabolic and trophic processes in the "neuron-glia" format, slower adaptive and regulatory properties of cerebral cells. This should be taken into account in the programs of preventive, curative, rehabilitation health-preserving design.

Among the practical recommendations, first of all, let's focus on the fact that during the diagnosis, monitoring and treatment of neurogenic diseases, optimization of psychophysiological states, it should be taken into account that human life is based on constant mutual influences of many systems of the whole organism in the conditions of the leading role of the higher parts of the CNS, in particular, the cerebral cortex. Regulatory adaptive mechanisms have individual and typological features that are manifested in the characteristics of the main nervous processes, mental performance, sensorimotor reactivity and are decisive for health and well-being.

The study of the functioning of the brain during mental stress, performed on the computer diagnostic complex "Diagnost-1M" allows to obtain objective information about the individual sensorimotor and neurodynamic characteristics of a person, which should be taken into account to build an individual patient's health trajectory, which will help assess the risk of neurodegenerative disorders, vegetodistonic and psycho-emotional shifts.

Based on the characteristics of the functioning of the brain, its relationship with the properties of psychomotor, emotional components of the personality, as well as its integrating effect on the body as a whole, it is desirable to focus on the current level of various parts of the nervous system in order to optimize the current functional state, predict and manage it, especially in people with shortcomings of analyzer systems. This will make it possible to more confidently predict the first bells at the preclinical stages of the development of pathologies, to apply corrective preventive programs for the prevention of the development of deafness, failures of cognitive processes, and leveling the occurrence of parallel sensory anomalies.

It is proposed to use the psychophysiological scales developed by us on a sufficient number of subjects to identify the degree of latency of sensorimotor reactivity, neurodynamic functions of different categories of the population (**Tables 3.9 – 3.12**).

Table 3.9 Differential scales for evaluating the level of latent periods of sensorimotor reactions of varying degrees of complexity in individuals with normal and deprivation of auditory function

Information processing level	Latent period of visual motor reaction (ms)					
	Healthy			Deaf		
	LPSVMR	$LPRC_{1-3}$	$LPRC_{2-3}$	LPSVMR	$LPRC_{1-3}$	$LPRC_{2-3}$
High	≤ 183	≤ 282	≤ 337	≤ 213	≤ 321	≤ 412
Above medium	180–227	283–325	338–394	242–212	354–322	436–413
Medium	228–294	326–399	395–464	267–243	381–355	452–437
Below the medium	395–332	400–434	465–502	292–268	410–382	474–453
Low	≥ 333	≥ 435	≥ 503	≤ 293	≥ 411	≥ 475

Table 3.10 Scales for evaluating the level of speed, quality and quantity of visual information processing of varying complexity in persons with normal and deprivation of auditory function

Information processing level	Information processing speed		Quality and quantity of information processing	
	Feedback (s)		Feedback (number of signals)	
	Healthy	Deaf	Healthy	Deaf
High	≤ 54.2	≤ 61.3	≥ 851.2	≥ 743.4
Above medium	54.5–61.4	66.9–62.4	785.3–850.2	675.8–742.8
Medium	61.5–69.9	71.6–67.0	677.2–785.2	568.7–675.5
Below the medium	70.1–76.1	76.9–71.7	631.8–677.3	520.2–567.9
Low	≥ 76.2	≥ 77.0	≤ 630.9	≤ 519.5

Table 3.11 Differential scales for evaluating the level of individual neurodynamic and sensorimotor properties of a human mobile operator

№	Indicators	The level of tested property (visual/auditory modality)				
		High	Above medium	medium	Below the medium	low
	Scores	10	8	6	4	2
1	FMNP, c	≤ 54.1 / 66.3	53.9–61.5 / 66.2–70.9	60.8–69.1 / 70.8–75.2	69.2–76.3 / 75.5–80.0	≥ 76.4 / 80.1
2	SVMR/SAMR, ms	≤ 181.5 / 220.4	182.4–226.1 / 220.4–270.7	226.3–292.1 / 200.3–271.4	394.4–330.3 / 374.4–418.1	≥ 332.6 / 426.0
3	RC_{1-3}, ms	≤ 280.3 / 300.0	280.6–322.4 / 300.6–340.1	323.2–398.1 / 340.6–411.0	398.5–432.5 / 411.4–460.3	≥ 433.5 / 471.5
4	RC_{2-3}, ms	≤ 334.5 / 350.0	335–390 / 350.1–420.1	390.1–462.4 / 420.5–490.5	463.3–500.0 / 491.4–560.5	≥ 501.1 / 561.6
5	SNP, frames	≥ 851.5 / 735.8	784.4–848.5 / 700.2–684.5	677.3–783.3 / 680.5–630.4	631.3–676.7 / 633.9–605.2	≤ 630.1 / 604.9
6	BNP, ms	≥ 13.5 / 15.4	19–15 / 24.5–21.4	25.5–20.3 / 29.4–26.5	33.4–28.2 / 34.5–30.2	≤ 34.5 / 35.5

Table 3.12 Differential scales for evaluating the level of individual neurodynamic and sensorimotor functions of students during information processing

№	Indicators	The level of individual neurodynamic and sensorimotor functions				
		I	II	III	IV	V
	Scores	10	8	6	4	2
Visual modality						
1	FMNP, s	≤ 55.9	56.0–61.0	61.1–66.0	66.1–71.0	≥ 71.1
2	SVMR, ms	≤ 207.5	219.3–260.2	208.9–260.4	261.5–310.5	≥ 325.5
3	RC2–3, ms	≤ 360.6	360.5–410.1	410.2–480.5	499.4–570.5	≥ 571.5
4	SNP, frames	≥ 761.4	760.3–741.4	741.5–690.5	690.1–609.0	≤ 611.0
5	BNP, ms	≤ 15.6	16.0–21.0	21.5–30.4	30.5–36.5	≥ 37.4
Auditory modality						
1	FMNP, s	≤ 60.5	60.6–68.1	68.5–71.1	71.0–78.1	≥ 78.5
2	SAMR, ms	≤ 249.4	250.5–279.4	230.3–289.5	291.4–355.5	≥ 370.6
3	RC2–3, ms	≤ 418.2	420.4–449.5	430.1–520.5	524.1–593.2	≥ 595.4
4	SNP, sygnals	≥ 701.1	670.4–651.2	650.5–610.6	609.9–573.5	≤ 512.5
5	BNP, ms	≤ 15.5	15.9–22.3	22.4–30.0	29.6–35.8	≥ 36.6

The evaluation scales of neurodynamic and sensorimotor functions that we propose for use in the medical field can be used to optimize the diagnosis and increase the effectiveness of monitoring neurological morbidity in various segments of the population, including people with special needs.

Taking into account the peculiarities of neurodynamic and sensorimotor functions, they will also be useful in the physiology of labor, the professional selection of healthy people and the individualization of educational trajectories in higher education.

CONCLUSIONS

1. Indicators of the main nervous processes and typological combinations are important characteristics of the functional state of the organism.
2. Parameters of sensorimotor reactions of varying degrees of complexity and functional mobility of nervous processes can be used in the diagnosis and monitoring of the nervous system of young people.
3. Evaluation scales of neurodynamic and sensorimotor functions can serve as an objective basis for optimizing diagnostics and improving the effectiveness of monitoring neurological morbidity, including in people with special needs.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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