DEVELOPMENT AND TESTING OF A SOUND SIMULATOR FOR ACTIVE MUSIC THERAPY

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Abstract. the objective of this paper is to substantiate the developed sensory neuropsychological simulator for active music therapy (AMTS), functioning according to the program of the comprehensive author's methodology of systematization of auditory means of influence on the functional state of a person. This is a new psychocorrectional tool used to develop sanogenic thinking and the formation of functional comfort in people with disabilities. From the point of view of the system-structural approach, the theoretical and methodological basis of the correction tool, flow chart of the device and layout manufacture, the interface design of the mobile application from the point of view of UX design are presented. The simulator contains built-in sound samples developed on the basis of the author's method "Profiling of the psychoacoustic effect of musical means of expressiveness", which is based on a system of concepts, models and methods for identifying a person's psychological profile. The reliability of the results is presented by a number of neurobiological studies both in laboratory and in real life conditions.

Keywords: functional comfort, sanogenic thinking, accessible environment, universal design, music therapy, psychoacoustics.

1. Introduction.

The creative aspect of vital activity and its emotional component in the concept of such scientific areas of knowledge as labor psychology, ergonomics, and psychophysiology fully reflect the process of functioning of the higher mental and vegetative properties of the organism [1,2]. Insufficient study of the emotional sphere of the creative aspect of personality is the reason for the predominance of the logical aspect over the emotional in the system-structural study of life activity, which leads to erroneous judgments about the functional states arising in the process of solving mental problems [3, 4]. By optimally building up new neural connections with regard to the individual laterality of brain functions, it is possible to influence the quality of development of cognitive-cognitive, need-motivational, emotional-volitional and interpersonal-social spheres of the personality, and to increase the level of stimulation of sanogenic thinking [4]. The lack of active creative activity in people with disabilities as the main driver of sanogenic thinking leads to extremely straightforward self-management of cognitive activity and, as a result, adversely affects the psychosomatic health of a person [5].

The systemic development of accessible sensory abilities (auditory, visual, tactile) in the process of creative work is the most optimal way to develop higher mental functions if creative activity is available, safe, variable, structurally dynamic and has a connection with life experience. The balanced emotional-volitional regulation of higher mental functions allows making the process of implementing subjective biologically based experiences conscious [6]. Transformation of conscious experiences from the destructive to the constructive field of thinking is possible only through a positive emotional result, which contributes to the productive implementation of vital and personal processes [7], which is an important factor in the formation of functional comfort [8, 9] from the point of view of ergonomics and psychology of work. Analysis of sensory, dynamic and structural properties of personality, typological features of emotional thinking, the specifics of the influence of auditory means of expression on the functional state of a person, taking into account the type of higher nervous activity, allowed us to identify markers of individual response to the sound stimulus and form a stable model of perception of auditory means of expressiveness by different personality types [10, 11, 12].

The obtained theoretical-methodological and experimentally structured knowledge formed the basis of the "Profiling Psychoacoustic Effects of Musical Means of Expressiveness" methodology, which is presented in this study as a musical-acoustic projected audible means of optimizing a person's functional state taking into account psycho-physiological and socio-ergonomic factors [13].

Currently, functional music is represented by a wide range of musical works of various therapeutic orientations, however, listening to functional music is a passive influence method, since it does not involve the user in the process of creating music. The "simulator for active music therapy" is a universal accessible means for involving a healthy person and a person with impaired sensory, mental, vegetative or static-dynamic functions in the creative process. Personal interest and the opportunity to realize oneself as a composer of a music track made up of auditory (musical) means of stimulation that are most appropriate for a personal type of informational metabolism make this product unique, unparalleled in the world [14].

Object of research: the impact of a set of designed audio means of expressiveness (melody, harmony, rhythm) on the functional state of a person, taking into account the individual-typological properties of the personality, presented in the form of the method "Profiling of the psychoacoustic effect of musical means of expression".

Subject of research: the method of "profiling of the psychoacoustic effect of musical means of expression"; mobile application for the AMTS.

Hypothesis of research: the designed AMTS presented in the form of the technique "Profiling of the psychoacoustic effect of musical means of expression", visualized in the form of a developed interface design of a mobile application, is theoretically and methodologically scientifically justified corrective complex providing a stable effect of improving the mental state and autonomic functions of the body.

2 Material And Methods

The purpose of developing the TAMS is to create an effective means of optimizing a person's state that is simultaneously available to all categories of citizens and is capable of ensuring the development of higher mental functions in an exciting way through the process of sensory integration and influencing the formation of functional comfort of a person.

To achieve the set goal the following **tasks** should be solved:

1. Testing of the designed technique "Profiling of the psychoacoustic effect of musical means of expression" using the comprehensive neurobiological fixing of the results obtained.
2. Development of the TAMS design concept; development of the TAMS mobile application; testing of the developed mobile application for the TAMS for its universality, accessibility, and safety.
3. Data processing and selection of actively affecting patterns of audio means of expressiveness for TAMS, providing a stable effect on the functional state of a person, taking into account individual typological characteristics.

The technique "Profiling of the psychoacoustic effect of musical means of expression" is based on a system of concepts, models and methods for identifying a person's psychological profile. Neurocognitive studies were conducted on the basis of the VNIITE Institute of Technical Aesthetics (Department of Ergonomics and Psychophysiology) in the field of psychoacoustic design and functional states. A number of related studies were carried out with the support of the Department of Computer Design of the Physics and Technology Institute of MIREA and the Russian-German Center of the European Academy of Natural Sciences [14]. The development of the design concept and theoretical and methodological basis for TAMS is carried out within the framework of the state assignment of the Ministry of Education and Science of the Russian Federation on the subject: "Application of the principles of universality in the development of industrial design".

In order to develop and test the key methodology, the following empirical methods were used: laboratory and ascertaining experiments, observation, work with focus groups, survey methods, psychoanalysis, expert assessment method; psychophysiological methods: electroencephalography, registration of vegetative parameters: photoplethysmogram, galvanic skin response, electrocardiogram, myogram, and respiratory recursion.

The concept of creating a TAMS design is the convenience, safety and affordability of using the device by people with disabilities, as well as people whose main goal is not to create music, but to improve their mental health [21]. Obviously, the simulator interface should be as simple as possible, since the device is designed for people having no special skills. For comfortable use of the device by visually impaired or blind people, captions will be duplicated in Braille. Elements of the TAMS design correspond to the style of DJ equipment as a musical instrument that has already entered the modern culture, causing enthusiastic and joyful feelings in the majority of respondents. The main elements are: rectangular buttons - pads arranged in rows; neon colors of the pads highlighted when pressed; black control panel; sliders with indicated levels - faders; knobs that switch music tracks or volume; pictures and brief signatures that guide the user; location on the side panels of additional buttons, inputs and outputs for various devices (computer, speakers); rectangular shape of the device.

Plastic was chosen as the main material of the case and buttons for mass production; the most optimal technology for manufacturing plastic products on an industrial scale is plastic injection molding. The base material for most modern electronic devices is a mixture of two synthetic materials: acrylonitrile butadiene styrene and polycarbonate. Short: ABS+PC. The first of the components, ABS plastic, is about half the price of polycarbonate, but its pure form has some drawbacks, to correct which the second component is added to the mixture.

The main internal components of the device are: motherboard and sound cards. C-Media 8738LX with a PCI-Express interface bus for installation in an expansion slot of a PCI-Ex1 motherboard. The card has 6 channels of audio

playback and 2 channels of audio recording. The C-Media 8738LX digital-to-analog converter has a 16-bit resolution and provides a maximum audio playback frequency of 44.1 kHz in 5.1 format [22]. Graphic output device: D-Sub, DVI-D; Integrated 5.1 HD audio (Realtek ALC662 audio codec); Connector CPU Socket FM2+ (AMD); Chipset AMD A68H [30]. Creating a 3D model of the TAMS was carried out in three stages: sketching in a vector program, modeling in Solidworks, visualization in 3ds Max using the V-Ray render program.

In the process of creating a mobile application, the identified characteristics of modern UX design were taken into account. Using the application, the user should receive fast feedback in the form of a created composition from the proposed musical patterns that have a steady number of structural and dynamic signs of coherence with various types of brain information metabolism [21]. The application responds with noticeable changes to the user's action: elements change when the user touches them during operations. When pressing the selected parameters (melody, harmony, rhythm) the pad-imitating buttons are indicated with a thin white line. Thus, the user receives feedback: the design helps to understand which button is currently selected by the user as the active audio element, and does not confuse the user with a variety of colors [23]. The settings block has iOS design. The choice of settings by the user should be clearly shown. To do this, when selecting one of the functions, the line with its name changes color.

To test the designed technique "Profiling of the psychoacoustic effect of musical means of expression" aimed at identifying persistent neurobiological correlators of differentiated perception of auditory means of expressiveness, respondents of the following categories were selected: healthy people (38%), people with mental health disorders of the second and third disability groups (14%), people with limited sensory capabilities of the second and third disability groups (12%), people with impaired static-dynamic functions s (36%). The sample was N=570 respondents aged from 9 to 72 years.

"Profiling of the psychoacoustic effect of musical means of expression" in this technique is presented as a projected ordered set of interrelated musical characteristics that provide in a set stable effects of changes in the functional state of a person recorded using psychophysiological indicators [21].

3 **Results And Discussion**

Processing of the results of a laboratory psychophysiological experiment aimed at studying the effect of auditory means of expressiveness on the functional state of a person, used a set of scientific methods: EEG topographic mapping; EEG descriptive analysis; coherent analysis of brain biorhythms; Spearman's correlation analysis; multivariate analysis of variance with repeated measurements. Data processing was performed using programs: Logic 10.0, Medicom LTD, ANOVA/MANOVA, Statistics 22.0.

The results of testing aimed at identifying stable structural and dynamic features of musical expressiveness, differentiated by the type of higher nervous activity, confirmed the reliability of the methodology, which is a scientifically substantiated base for creating a TAM simulator [21].

The expert group conducted a selection of the most active auditory stimuli, grouped according to the type of means of musical expression: melody, rhythmics, and harmony. The selected sound patterns are the auditory stimulus sensory material and the methodically-corrective basis of the TAMS. These patterns are differentiated by the coherence of the brain activity waves of the respondents, differing in the type of information metabolism and the predominant type of higher nervous activity. Thus, the TAMS consists of mutually compatible musical means of expressiveness, structurally consisting of basic elements of musical expressiveness: melody, rhythmics, and harmony.

The main results of the psychophysiological laboratory research are the following observations: the activity of the frontal upper, frontal central and parietal-occipital region is mainly higher when listening to musical patterns that correlate with the type of respondent's higher nervous activity. When listening to musical patterns that are not compatible with individual typological features, 84% of respondents registered increased activity in the left frontal-frontal lead Fp-1. This activity is responsible for the location of the logical processing of incoming information, while emotional thinking was less active in the alpha and theta rhythms of the brain, and the vegetative indicators indicated the presence of stress when listening to patterns of a different psychotype. When listening to typologically coherent sound patterns, zones P3, P4 are activated, which are responsible for sensory perception and active cognitive activity. Along with sensory activation, when listening to typologically appropriate sound patterns, 79% of respondents used sanogenic thinking, as evidenced by the activation of the alpha-1, alpha-2 frequency ranges in leads F7, F8, responsible for cognitive activity, endogenous mood regulation, emotional expression, verbal perception and processing of the verbal signal.

Thus, it is conclusively presented that the sound content of the TAMS, built on the basis of the technique "Profiling of the psychoacoustic effect of musical means of expression", provides adequate mobilization of neurobiological processes of the body. Audible stimulation material with a subjective preferred choice of the respondent contributes to the optimal functional state and the development of functional comfort. Synchronous activation of the affective and cognitive components of the psyche contributes to the development of sanogenic thinking and regulation of emotional states of a person, regardless of the existing disorders of human health.

During the designing of a mobile application, the most trendy elements were used: blurred and diffuse backgrounds - gradient buttons with inscriptions, hidden navigation - switching to a playlist and track settings, Card

Design (card or tiled design) - buttons that imitate pads on controllers. According to 94% of respondents, when conducting a neurobiological laboratory experiment, the mobile application turned out to be accessible, understandable and did not cause user stress reactions. The intuitive interface is based on the quality interaction of the user and the application [23,24]. This allowed us to create a modern design of the TAMS mobile application, taking into account the principles of universality.

The design of the device allows fitting it in a modern interior. Despite the adaptation of the device for visually impaired and blind people, people without disabilities will be able to freely use it. It is also worth noting that the aesthetic part of the design was not affected due to the addition of Braille, which speaks to the universality of the product.[25].

4 **Summary.** It is conclusively presented that the technique "Profiling of the psychoacoustic effect of musical means of expression" is a sustainable tool for developing sanogenic thinking and correcting the functional state of a person. The TAM simulator can be used to develop higher mental functions and form functional comfort in both healthy and disabled people. The simulator is a universal practical means of application and allows you to diagnose the structural and dynamic qualities of the person, as well as correct the functional state. Satisfactory indicators of criteria for assessing the quality of the technique are presented, and the reliability of the correlation analysis of psycho-physiological parameters is shown. An intuitive mobile application interface was developed based on user and application interaction.

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