

# COMBINATION OF NEUROFEEDBACK TECHNIQUE WITH MUSIC THERAPY FOR EFFECTIVE CORRECTION OF STRESS-INDUCED DISORDERS

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**The aim of the investigation** was to evaluate the applicability and efficacy of music presentations controlled by feedback signals from the narrow-band electroencephalographic (EEG) oscillators of a patient to correct functional stress-induced disturbances.

**Materials and Methods.** We revealed dominant narrow-band (0.4–0.6 Hz) oscillators in the theta (4–8 Hz) and alpha (8–13 Hz) EEG bands in 18 volunteers suffering from stress-induced disorders. During two examinations the subjects were presented with classical music. However, the music was interrupted for 3 s if the current amplitude of subject's theta EEG oscillator exceeded the initial level, or if the current amplitude of subject's alpha EEG oscillator did not reach the initial level. The subjects were asked to find and maintain the functional state in which the music was played continuously. Music playing time, the changes in EEG rhythm power, and the shifts in subjective estimations of health, activity and mood from the beginning to the end of each session were recorded.

**Results.** Marked EEG normalization, reduction of stress sensations and positive shifts in mental and emotional state of the patient were found under the influence of music controlled by a feedback from theta or alpha EEG oscillators of a patient as early as by the end of the first treatment procedure.

**Conclusion.** Improved efficiency of applied music therapy caused by its interaction with the relevant individual characteristics of the bioelectrical brain activity suggests the possibility for a successful use of such effects in a wide range of medical rehabilitation procedures.

**Key words:** narrow-band EEG oscillators; neurofeedback; stress-induced functional disorders; musical therapy effects.

From the standpoint of science a human body is considered as a set of multiple information-controlled systems, malfunction of which results in homeostasis disorder and formation of a pathological state or a disease [1]. The cause of such malfunctions is often plenty of conflicting and extreme situations in the modern world, as well as experiencing stress due to terroristic actions, economic crises, natural and technogenic disasters, traffic accidents, violence, and other factors [2]. The enumerated factors form multiple functional disturbances or the so-called discomfort syndromes [3], and in chronic complex action they may lead to the impairment of adaptation mechanisms, failure of the protective bodily systems, and, finally, to a disease. According to the recent investigations [4], it is the negative effect of psycho-social stress-factors that becomes the main cause of industrial morbidity in Europe. Efficacy of drug therapy in this case is rather doubtful due to its primary orientation to the suppression of certain morbid symptoms, presence of side-effects and phenomenon of drug resistance. That is why in great demand there are information-controlling interventions directed to the timely return of the organism to its optimal condition and cognitive rehabilitation of an individual [5].

Two approaches seem to be rather well-developed nowadays: adaptive function biofeedback (BFB) using electroencephalogram (EEG) and music therapy (MT). In EEG-BFB technique the current amplitude of this or that EEG-rhythm is reflected in the parameters of sound or light feedback signals, presented to the patient for a conscious control of intensity of his own rhythmic EEG components to achieve the required medical effects [6]. MT is a system of psychosomatic regulation of the bodily functions by means of musical and acoustic effects [7].

Though there are quite evident advantages of the both methods — noninvasiveness, lack of contraindications and orientation to the central regulatory mechanisms of the brain — they have also serious limitations. Thus, maximum individual orientation of EEG-BFB technique is combined with the difficulty of awareness and active use of feedback signals from the brain biopotentials which evolutionally are not designed for voluntary control. Besides, a serious drawback of EEG-BFB method is an application of preset traditional EEG-rhythms (theta-, alpha-, beta- and so on), which are functionally heterogeneous and individual [8]. At the same time, the advantage of unconscious perception of musical effects in MT method is combined with the

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difficulty of individual selection of music corresponding to the psycho-physiological features of the patient, which is necessary to achieve the efficacy of the therapeutic procedures [9].

Here, an original technique of musical EEG-biofeedback, combining maximum individuality of EEG-BFB with unconscious perception of MT, is presented. To correct unfavorable functional conditions the suggested technique uses musical therapeutic effects, which are controlled by biopotentials of the patient's brain using the principle of a feedback. In this case, automatically revealed in real time narrow-band EEG oscillators typical and significant for the individual are used instead of the preset excessively wide-band, traditional EEG-rhythms.

**The aim of the investigation** is to assess the possibility of application and efficacy of musical effects controlled by feedback signals from patient's EEG-oscillators for the correction of stress-induced functional disorders.

**Materials and Methods.** 18 workers of Pushchino Scientific Center of the Russian Academy of Sciences at the age of 18–60 years visited the psychological relaxation unit complaining of psycho-emotional tension and stress conditions. They readily volunteered to participate in two examinations. At the beginning of the examinations dominating narrow-band (0.4–0.6 Hz) EEG-oscillators in the range of theta- (4–8 Hz) and alpha- (8–13 Hz) rhythms were identified in each subject. In the course of the therapeutic sessions patients were presented with classical music, but in one of the sessions music was interrupted for 3 s if initial intensity of theta EEG-oscillator was exceeded, while in the other — if initial intensity of alpha EEG-oscillator decreased. The tested subjects were suggested to find and maintain the condition, in which the melody sounded continuously using their own individual strategies. In the first case it was achieved by suppression of theta EEG-oscillator, in the second case — by activation of alpha EEG-oscillator. Details of registering and analyzing EEG, as well as determining individual EEG-oscillators have been described in our previous work [10].

The study complies with the Declaration of Helsinki (the Declaration was passed in Helsinki, Finland, June, 1964,

and revised in October, 2000, Edinburg, Scotland) and was performed following approval by the ethic committee of the Institute of Cell Biophysics of Russian Academy of Sciences. Written informed consent was obtained from every patient.

In order to assess the efficacy of the effects two objective criteria were used: the time of music playing (in % from the total session duration), and the degree of changing the intensity of regulated EEG-range in the course of the therapeutic procedure. Changes in the assessment of health, activity and mood, recorded at the beginning and at the end of each examination using the HAM-test (health, activity, and mood) served as subjective indices.

Statistical processing of the results was performed by the software package Origin 6.0. Mean values (M) for the group of the tested subjects, standard errors (m), and Student criterion t were calculated.

**Results and Discussion.** The analysis showed that the tested persons coped successfully enough with the given task — to achieve continuous music playing by randomly regulating their own biopotentials. So, the time of music playing in the sessions with suppression of theta EEG-oscillator was, in the average, 77.8±2.7%, and in the sessions with activation of alpha EEG-oscillator — 75.3±2.7%, i.e. the duration of music interruptions did not exceed 25% of the total examination time.

Quantitative data, obtained during the correction of stress-induced disorders by musical effects directed to the suppression of theta EEG-oscillator or activation of alpha EEG-oscillator of the patient (See the Table), demonstrate that in both sessions the power of EEG theta-rhythm decreased to the end of the therapeutic procedure, while the power of alpha-rhythm increased. And the most marked and statistically significant (p<0.05) changes of the EEG power occurred in the direction required by the procedure protocol: the power of theta-rhythm reliably reduced in the sessions with the suppression of theta EEG-oscillator, and the power of alpha-rhythm reliably grew in the sessions with activation of alpha EEG-oscillator.

According to the findings of HAM test performed prior and following the applied musical therapy effects,

**Objective and subjective indices recorded before the beginning and at the end of the two sessions of correcting stress-induced disorders**

Indices	Session for suppression of theta EEG-oscillator		Session for activation of alpha EEG-oscillator	
	beginning	end	beginning	end
Power of EEG theta-rhythm, standard units	7.7±0.3	6.8±0.3*	7.5±0.4	7.2±0.4
Power of EEG alpha-rhythm, standard units	16.4±0.5	16.9±0.6	16.1±0.6	18.2±0.5*
HAM test: health assessment, scores	37.0±1.5	39.2±1.6	35.9±1.5	37.9±1.6
HAM test: assessment of activity, scores	35.5±1.7	37.3±1.8	34.1±1.7	35.2±2.2
HAM test: assessment of mood, scores	36.7±1.6	38.2±1.9	36.7±1.4	39.3±1.7

\* — p<0.05 compared to the values at the beginning of the session.

positive shifts in the subjective assessments of health, activity and mood of the patients were revealed.

Thus, under the influence of the applied procedures of musical EEG-biofeedback positive shifts both in objective and subjective characteristics of the functional condition took place in the tested patients. Besides, according to the subjective reports, positive attitude of the patients to the conducted therapeutic sessions, reduction of the stress level and improvement of psycho-emotional condition were noted.

Notably, that the results of the investigation are of the preliminary character and need further analysis. As it is known from the literature, correction of the stress-induced disorders may be achieved by means of both techniques — MT [12] and EEG-BFB [13], therefore to find the contribution of each of the technologies to the effects, obtained by us when the combination of their main elements was used, require further studies with the conduction of control series of experiments. However, it is important to underline that positive therapeutic effects are usually achieved after 10–12 therapeutic sessions of MT [9] or EEG-BFB [6], but in our investigation almost the same results were observed already after 1–2 procedures.

A high efficiency of the applied musical effects and their positive influence on the functional condition of the patients is likely to be explained by presenting music in a strict accordance with the significant bioelectrical characteristics of the individual's brain. As it has been shown previously [10], in this case optimal conditions are created for involving integrating, adaptive and resonance mechanisms of central nervous system activity into complex reactions of the organism to the action of the environmental low-intensity factors.

**Conclusion.** In case of musical effects, controlled by the patient's EEG-oscillators on the principles of feedback, decrease of the stress level, normalization of EEG-characteristics, and positive changes of the psycho-emotional condition are observed. Interaction of music with the regulatory systems of the brain which develops when it is presented in strict accordance with bioelectrical characteristics of the individual, lies in the basis of the effects observed. Optimal condition for such effects is the application of narrow-frequency oscillators from EEG theta- and alpha-ranges. Indicating to the importance of further studies in this direction, the acquired data show the possibility of successful application of musical EEG-biofeedback technique in a wide spectrum of medical rehabilitation procedures.

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