

Bioacoustic Correction Application in the Psychologist's Practice

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ABSTRACT

The relevance of the topic is justified by usage of the cutting edge technologies (instrumental approaches to correction) in the psychologist's practice that requires high qualified professional level of psychological and pedagogical competence as well as the other skills for effective correction of psycho-emotional, speech, and cognitive functions of the patient with cerebrovascular disturbance. The objective of the paper is to develop methodical approaches and arrange the psychologist's work employing the state-of -the-art technologies. The leading approach to the research of the topic is the modeling method that allows studying the topic as a direct and organized process of honing the professional skills. The paper structure includes the target, content, organizational and procedural, and effective components. The enhancement of the differentiated approach to speech and psychological recovery of patients with cerebrovascular disturbance by means of "Sinhro-S" bio-acoustic correction (BAC) allows rehabilitating the lost functions efficiently and boosting the experts' professional skills.

KEYWORDS

Bioacoustic correction; methods of "Sinhro-S" BAC; organic brain damage; psycho-emotional condition; reconstructive correction

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Introduction

Urgency of the problem

The topic relevance is defined by the tendency to drug-free approaches in the rehabilitation of the patients with organic brain damage (Konstantinov et al., 2000a). Alongside the approaches there are methods of the psychologist's practice that are successfully used in correction and prevention of the central nervous system functional impairment (Kadykov, Chernikov & Shakhparonova, 2009).

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However, the application of the methods aimed at recovering the cognitive functions is complicated and inefficient. The reason for method inefficiency is that the basic principle of the methods is the paradigm of voluntary self-regulation when a patient is assigned to actively seek psycho-emotional condition. When applying the standard methods, the methodology is hard to implement if a patient with cerebrovascular disturbance suffers from lack of cognition and volition of the psychological activity (Konstantinov, Sizov & Miroshnikov, 2000).

The paper presents the BAC method practical testing in the psychologist's activity; the method is based on the involuntary self-regulation concept of the CNS functional condition. The BAC method is characterized by the fact that a patient is not assigned with any cognitive and volition tasks aimed at the self-condition transformation. The BAC method achieves correction by listening to a sound image of their brain bioelectrical activity that is designed basing on the computer translation of the current electroencephalogram spectrum acoustic range frequencies (Fedotchev, Bondar & Kim, 2002)

Methodological Framework

The research methods: in the course of the research we employed the following methods: the statutory acts and activity analysis, mental experiment, method of forecasting, systematization and generalization of facts and concepts, the diagnostic methods.

The experimental part of the research: the regional vascular center SAPHCI of the RT "Emergency Hospital" in Nabrezhnye Chelny.

The research stages:

The research was carried out in three stages:

- Stage 1 – preparatory stage – investigation of the topic modern state of in psychology theory and practice; the research method plan was developed;

- Stage 2 – the main stage –the psycho-emotional, speech, and cognitive spheres of the patient with cerebrovascular disturbance, priority diagnostic methods were picked out; the experimental work on the BAC method efficiency in the psychologist's practice was carried out;

- Stage 3 – the final stage – the research results were systemized, recognized, and generalized; the theoretical conclusions were specified; the obtained research results were processed and documented.

Results and Discussions

Paper structure and content:

The developed approaches to the psychologist's practice with the BAC method application include the target (objectives, tasks aimed at overcoming the psycho-emotional tension of the patient with organic brain damage); methodological (approaches, principles); content (direct conditions of psychologist's work organization with advanced technology application); organizational and procedure (pedagogic mechanisms, organizational and pedagogic conditions, scientific and method provision), and performance components (performance indicators). Application of the BAC method in the psychologist's practice is aimed at integration of professional and psycho-emotional specialist training and most efficient performance in rehabilitating and preventing emotional and volition, speech, and cognitive disturbance of the patients with cerebrovascular disturbance.

Implementation Stages:

Implementation of the practice required the following experimental work:

- Diagnostics: gnosis, praxis, speech state, emotional state assessment by means of self-assessing test WAM and STAI test, hospital anxiety and depression score, MMSE, physician and psychiatrist scientific assessment. An additional component of patient's psychological state assessment: neurodynamic processes (direction recognition, performance time), attitude towards test fulfillment (diligence, negligence, inactivity, indifference), emotional state, as well as the CNS functional state investigation was performed by the period analysis of electroencephalogram (EEG). The EEG recording was made by means of two bipolar leads - the right and left hemispheres of the frontal and occipital lobes. The analysis of the brain bioelectrical activity frequencies was carried out basing on the EEG data of "Sinhro-S" program. At the stage we were emphasized the psychologist's work peculiarities regarding the advanced technologies required for the further improvement of the experts' practical activity;

- Development and implementation of the methodological framework of the practical basis. The stage presents experimental testing of the work approaches by means of the BAC method in the control and experimental group.

Confirming Stage

At the confirming stage the diagnostic was carried out: 27 patients with the cerebrovascular disturbance were examined for the first 10 days. Furthermore, the control group of 27 people (the identical group) was taken for the result dependability. The accompanying diseases were detected in 98.2 % of patients in both the experimental and control groups. The assessment results of the general emotional state were following: general anxiety: 82% in the control group and 80% in the experimental group. The quantity of the patients complaining of memory impairments is 44% in the control group and 49% in the experimental group respectively. The asthenoneurotic complains were registered by the patients, autonomic regulation of the examined patients was conditioned by the sympathetic dominance. The key data is displayed in table 1

Table 1. The psycho-emotional state at the beginning and end of the trial ($M \pm m$)

Measures	Experimental group(n=27)		Control group (n=27)	
	Before the trial	After the trial	Before the trial	After the trial
Anxiety	45.2±2.1	51.9±2.4**	46.1±2.5	49.3±2.2
Depression	65.4±3.7	76.6±4.1*	66.9±3.5	71.8±4.2
Speech state	55.9±3.6	52.4±4.1	53.9±3.4	52.8±4.2
Feeling state	40.9±2.5	38.6±3.2	41.2±2.4	39.1±2.9
Memory state	176.8±6.4	167.1±5.6	175.6±5.8	170.8±6.1
Activity state	72.6±4.2	66.3±3.7	70.9±3.8	68.5±3,3
Mood	68.2±4.7	90.4±5.1**	67.8±4.3	81.2±4.8*
Motivation	163.9±6.2	194.3±7.1**	160.6±5.7	178.5±6.8*

** - statistical significance ($p < 0.01$), * - statistical significance ($p < 0.05$).

The significant difference of the psycho-emotional state of the control and experimental group was not detected at the beginning of the trial.

Forming Stage

At the forming stage we were developing and implementing the methodological framework with the BAC method and traditional rehabilitation work outlined by the scientific and theoretical (keynotes and layouts for the advanced technology application in the psychologist's practice), content (selection and content structuring of the psychological correction), and methodic level (methodical recommendations).

Scope of the work:

The BAC procedure was carried out by means of the device converting the total brain electrical activity into sounding range for bioacoustic adjustment of "Sinhro-S" psycho-emotional state. The method has been developed by the researches at Physiological Department after I.P. Pavlov, Experimental Medicine Institute, RAMS. Its grounding is EEG depending BFB. EEG signal converting into sound image was fulfilled by a specially designed conversion unit (Konstantinov et al., 2000b). EEG signal converting into the sound image was made by the computer in real time mode with minimal delay that equals to the EEG period registered in the computer memory (Konstantinov, Sizov & Miroshnikov, 2000). It is essential that the method proves to be safe even during ACE. CNS functional state correction means eliminating the deviation between the current and reference data of the brain electrical activity. During the session the patients are listening to their own EEG sound image. When being converted, the sound image of the brain electrical activity has a polyphonic character and acquires the significant emotiogenic qualities that allow noticing the confirming signal features in the obtained sound image. EEG recording was made by 4 channels in points Fp1, Fp2, O1, O2, and was unipolar regarding the joined ear-clip electrode with sampling frequency 250 Hz. The acoustic image was created on the basis of EEG recording by transposing it to the computer as an audio spectrum. The idea of conversion is to create the signal in the audio spectrum that is similar to the EEG signal. The acoustic image acquired by this method was presented to a patient in the real time. During the session a patient was supposed to listen to his "own brain sounds". The patient's eyes were closed. The comfortable volume was chosen for each patient. It is essential that the method proves to be safe even during ACE. The procedure course (in the experimental group) contained 7 sessions in a day for 15-20 minutes each depending on a patient's condition.

Experimental validation of the psychologist's suggested work scope efficiency:

The results of the course of treatment with BAC procedures proved the improvement of the cognitive abilities. MMSE test of the patients receiving the BAC procedures showed the cognitive abilities increased from 25.7 ± 3.1 to 29.5 ± 0.8 ($p < 0.01$). In the control group MMSE showed increase from 24.6 ± 1.7 to 26.9 ± 1.4 ($p < 0.01$). It should be noted that at the end of the treatment course the patients receiving the BAC procedures showed MMSE result was positively higher ($p < 0.01$) than those from the control group. The level of the state anxiety in the group of the patients with BAC has reduced from 31.1 ± 10.2 to 14.8 ± 3.3 scores ($p < 0.01$). In the control group the level of the state anxiety has reduced from 31.3 ± 5.7 to 23.8 ± 4.2 scores ($p < 0.01$). The level of the trait anxiety of the patients receiving the BAC has reduced from 45.2 ± 6.7 to 28.6 ± 5.1 scores ($p < 0.01$), in the control group the level of the trait anxiety has reduced from 36.2 ± 7.3 to 26.3 ± 5.9 scores ($p < 0.01$). Reduction in the state anxiety in the group of the BAC positively surpasses ($p < 0.01$) reduction in

the same measure in the control group. The statistical significance between the levels of trait anxiety in the BAC and control groups was not detected.

Cognitive ability improvement and anxiety level reduction among the patients receiving the BAC procedures were accompanied with the brain bioelectrical activity reconstruction. The marked transformation of the EEG rhythmic structure was observed in alpha-, beta-, and delta-ranges both of frontal and occipital leads. The most significant and proved reconstructions of the brain bioelectrical rhythm is noticed in the frontal lead in the delta activity area. During the course of the BAC procedures the average delta-activity data in points Fp1, Fp2 went down from 6.8 ± 3.8 to $3.7 \pm 2.7\%$ ($p < 0.01$). In the occipital lead the delta-activity went down from 1.7 ± 2.2 to $0.6 \pm 0.9\%$ ($p < 0.05$). In the alpha-rhythm range the significant intensity upsurge was registered in the occipital lead: from 49.9 ± 11.6 to $60.1 \pm 14.3\%$ ($p < 0.05$).

A tiny but proved intensity increase of the alpha-rhythm can be noticed in the frontal lead: from 40.0 ± 8.0 to $45.4 \pm 9.4\%$ ($p < 0.05$). The proved reduction in the beta-activity was recorded only in the occipital lead: from 45.7 ± 15.3 to $33.8 \pm 16.9\%$ ($p < 0.05$). In the theta-rhythm area there was no reconstruction of the EEG rhythmical reconstruction.

Alongside reconstruction of the EEG rhythmical structure of the frontal and occipital lead, decrease in bioelectrical activity asymmetry of the brain right and left hemispheres was not registered. The analysis of the EEG period allocation showed decrease in the rhythm profile asymmetry of the brain bioelectrical activity in the right and left frontal parts from 18.0 ± 9.9 to $10.9 \pm 7.2\%$ ($p < 0.05$) and in the occipital parts from 20.8 ± 12.7 to $11.7 \pm 5.1\%$ ($p < 0.05$).

Hence, our research results pointed out that the rehabilitation steps fulfilled have a positive influence on the regaining the cognitive abilities and psycho-emotional state of the patients with organic brain damage.

It should be noted that the BAC procedure incorporation into the treatment course lead to more significant positive dynamics of the cognitive abilities and significant decrease in the state anxiety. The changes deviated from these measures dynamics in the group of the patients receiving the treatment without the BAC. It is essential that we registered the positive dynamics of the EG rhythmical structure reconstruction accompanying the cognitive ability and psycho-emotional state recovery. The group of the patients receiving the BAC are seen to decrease in slow-wave activity of the frontal lead, increase in the alpha-rhythm and reduction in the beta-activity intensity of the occipital lead and the EEG asymmetry level.

The received results allow us to conclude that the BAC procedures have positive effect on cognitive ability and psycho-emotional state recovery in the patients with the organic brain damage. The patients improve their psycho-emotional state and regain the cognitive abilities. The BAC method can go with the traditional rehabilitation treatment that boosts their efficiency. The application of involuntary self-regulation methodology can be employed to the CNS diseases when cognitive and volition sphere of the psychological activity suffers. The circumstance and the received results allow us to assume that the BAC can be successfully exploited in the integrated medical rehabilitation of the patients with organic brain damage.

Table 2. Dynamics of the patients' emotional disturbance when employing the BAC method to the psychologist's practice, the experimental group

Measures (scores) M±m	Observation Stages			
	Beginning of the trial	Session 3	Session 5	Session 7
Anxiety	12.8 ±1.3	10.1±0.5 *	8.8±0.4 **	8.5±0.8***
Depression	15.1±1.4	12.8±0.4	9.9±0.7*	10.0±0.7**

** - statistic significance ($p < 0.01$), * - statistic significance ($p < 0.05$).

The integral sums of the scores of emotional recovery according to Barthel index and after the course assessment of the patients' emotional state according to the measures above were the best and statistically significant. The rehabilitative treatment facilitated psycho-physiological improvement of the patients with myocardial infarct in the both groups.

In the experimental group there were statistically significant decrease in the state anxiety index (according to STAI) from 48.3 ± 4.1 from 34.5 ± 3.1 ($p < 0.01$), in the control group the state anxiety index from 46.5 ± 5.1 to 39.6 ± 4.3 ($p < 0.05$). The significant change of the trait anxiety was noticed in neither of the groups. The WAM test also proved positive changes by the measures. The patients of the experimental registered the significant improvement of the wellbeing index from 3.2 ± 0.5 to 5.3 ± 0.6 ($p < 0.01$), the activity index from 3.4 ± 0.6 to 5.6 ± 0.7 ($p < 0.05$), the mood index from 3.8 ± 0.7 from 6.3 ± 0.9 ($p < 0.05$). The control group patients' WAM indexes were insignificant, the wellbeing index from 3.2 ± 0.5 to 5.3 ± 0.6 ($p < 0.01$), the index from 3.4 ± 0.6 to 5.6 ± 0.7 ($p < 0.05$), the mood index from 3.8 ± 0.7 to 6.3 ± 0.9 ($p > 0.05$).

When carrying out the EEG assessment, 16 (37.2%) experimental group patients and 19 (44.1%) control group patients showed the EEG polyrhythmical organization that typically occurs with organic brain damage. In the course of the rehabilitation the patient showed the brain bioelectrical activity reorganization. After the bioelectrical session of the psychological correction of the experimental group patients with dominating the EEG alpha-rhythm it was recorded that the alpha-rhythm period increased from $32.4\% \pm 3.2$ to $54.2\% \pm 4.1$ ($p < 0.001$) and the beta-rhythm increased from $55.3\% \pm 6.2$ to $28.5\% \pm 4.5$ ($p < 0.001$). The hemispheric asymmetry index significantly decreased from 0.196 ± 0.3 to 0.105 ± 0.02 ($p < 0.05$). The experimental group patients with the polyrhythmical bioelectrical activity organization and the control group showed the tendency to the alpha-rhythm increase and the beta-rhythm decrease. The hemispheric asymmetry index did not significantly change. The registered changes prove that the BAC method incorporation into the psychologist's practice allows improving the CNS functional state.

Table 3. The dynamics of the emotional disturbances of the control group patients

Measures (scores) M±m	Observation Stages			
	Beginning of the trial	Session 3	Session 5	Session 7
Anxiety	13.3 ±1.2	12.1±0.5	11.8±0.4	10.5±0.8*
Depression	12.1±1.3	11.8±0.4	10.9±0.7	9.8±0.7*

** - statistic significance ($p < 0.01$), * - statistic significance ($p < 0.05$).

The emotional disturbance dynamics according to the hospital anxiety and depression score – by the domain of anxiety ($\chi^2 = 3.386$, $n' = 3$, $p < 0.05$) and depression ($\chi^2 = 4.376$, $n' = 3$, $p < 0.001$). When comparing the scorers in the groups before and after the trial we captured the statistical significance by the both domains: anxiety and depression ($p < 0.05$). The subclinical anxiety was registered and the index was significant. The contrastive analysis of the neuropsychological research scores proves that the patients show the improved ability to regain the lost functions that are statistically significant: the anxiety level ($r = 0.36$) and the depression level ($r = 0.39$). There was no correlative relationship between the stroke and mnemonic factors ($r = -0.19$). Having analyzed the cortex bioelectrical activity of the patients, we noticed that it was nonhomogeneous unlike the investigated comparison group. 73 (69%) patients with ACE had the beta-rhythm dominance in the damaged zone or the hemispheric interaction disturbance (93 % out of the sample). The specific rhythm indicator was $16.9 \pm 1.7\%$ was significantly lower than in the comparison group $17.3 \pm 3.6\%$; ($p < 0.01$). The detected correlative dependence emphasizes the link between the hemodynamical compromise and CNS organic damage by the ischaemic stroke.

According to the research, the increased variability of the general neurologic state depended on the damage zone, individual physical state, and patient's age. The adaptation of the patients also differed significantly depending on the brain bioelectrical activity type. The incomplete adaptation of the 2nd and 3rd degree was often registered among the patients (67.9%) with the EEG polyrhythmic organization, among the patients with beta-rhythm dominance – in 46.8% of the cases.

Hence, the expressed disturbances by the studied measures are registered in the patients with the polyrhythmic type of the brain bioelectrical activity. The results of the rehabilitation course proved that the quantity of the patients with the memory disturbance reduced fivefold in the experimental group and threefold in the control group. The speech disturbance complaints disappeared completely in 86 % of the experimental group patients, and in 32% of the control group patients. The quantity of the experimental group patients with polysymptomatic conditions reduces by two third times. After the rehabilitation course the experimental group estimated the treatment efficiency as “excellent” 66.7%, “good” 22.2%, “satisfying” 6.7%, “unsatisfying” 4.4%; the control group patients: “excellent” 40.0%, “good” 28.9 %, “satisfying” 17.8%, “unsatisfying” 13.3%.

The dynamics of the brain bioelectrical activity and the psychological testing measures in rehabilitation process of the experimental group can be defined as psycho-physiological state recovery.

The BAC method peculiarity is that the patient was not assigned with any cognitive and volition task aimed at his state transformation. The patient was proposed to listen to his own EEG acoustic image that presents the computer converted signals of the current brain bioelectrical activity reflecting in details the physiologically relevant measures of the patient's brain biopotential. It was shown before that the BAC method application facilitates the psycho-emotional recovery of the patients with the neurotic patients with the aesthetic syndrome that is characterized by the reduction in anxiety level, wellbeing, activity, and mood improvement, the EEG index normalization. Considering the results and involuntary self-regulation of the CNS state in the BAC method, it is reasonable to employ the method in the integrated medical rehabilitation of the patients with the

cognitive impairments. The conducted rehabilitation course had a positive influence on the patients' adaptation. The positive dynamics in the patients' adaptation and reactivity were triggered by the psycho-emotional and vegetative regulation improvement. These indicators were outlined by the other researchers. The analyzed spectrum alteration of the cortex bioelectrical activity of the experimental group patients was accompanied by the EEG sound image improvement. It is determined that for the individual – differential approach to the psychological activities choice the patients with cerebrovascular disturbance should be have a complete examination using the psychological methods of the brain bioelectrical activity that allows exposing the index change of the CNS functional state, establishing their interaction with haemodynamic compromise. However, the review of the scientific paper referring to the modern guidance issue is extremely rear and they are of the polemical character.

Conclusion

The high clinical efficiency of the correction of the acute CNS impairment employing the “Sinhro-plus” methods within the cross-disciplinary rehabilitation is proved. The research results allows honing the clinical training of psychologists, enhancing the diagnostic and treatment process at the various levels of the psychologist work, as well as improving the whole rehabilitation process efficiency. It is determined that the advanced technology application, in particular the BAC method in the psychologist's practice allow overcoming the psycho-emotional state disturbance of the patients with the brain impairment efficiently and handling the psychological and pedagogical and organizational and methodological tasks of the rehabilitation period providing the information privacy. The paper materials can be practically helpful for the experts and psychologists in the medical centers, inpatient facilities, and the individual practice. Considering the obtained results, we can point out the range of scientific matters and far-reaching directions requiring the follow-up: extending some aspects specified in the paper related to development and gaining the psychological and pedagogical experience in the BAC method application in the psychologist practice. It is reasonable to employ the data received in the rehabilitation treatment of the patients with brain impairment and achieve efficient recovery of the lost functions.

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No potential conflict of interest was reported by the authors.

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