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МОДЕЛИРОВАНИЕ ПСИХОЭМОЦИОНАЛЬНОГО НАПРЯЖЕНИЯ И ПОМЕХОУСТОЙЧИВОСТИ ПРИ СЛУХОВОМ ВОСПРИЯТИИ

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РЕЗЮМЕ. Для моделирования функционального состояния при восприятии релевантных и нерелевантных слуховых сигналов регистрировали слуховые вызванные потенциалы (СВП). Кроме того, предъявляли эмоционально нейтральную информацию и значимое информационно-психологическое воздействие с регистрацией ЭЭГ и анализом фрактальной динамики (АФД). Наибольшие различия СВП при предъявлении релевантной стимуляции отмечены в левой фронтальной области на отрезке 16–18 мс с момента подачи сигнала. Эмоционально-нейтральные и эмоционально-значимые воздействия убедительно характеризуются при АФД данных ЭЭГ. Установлено, что личностная тревожность повышается, если субъект воспринимает ситуацию как угрожающую его чувству собственного достоинства и самооценки. Лица с высоким уровнем тревожности склонны воспринимать широкий круг ситуаций в качестве угрожающих. Их реакция соответствует тому, что они думают в условиях диктующей ситуации.

КЛЮЧЕВЫЕ СЛОВА: слуховые вызванные потенциалы (СВП), картирование мозга, ЭЭГ, информационно-психологическое воздействие.

MODELING OF THE FRUSTRATION STATUS AND NOISE PROOF FEATURE DURING AUDITORY PERCEPTION

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ABSTRACT: Tests for modeling of the human status at recognition of target and non target stimulus with auditory evoked potentials (AEPs) registration; emotional neutral and significant information-psychological influences with EEG registration and analysis of fractal dynamics (AFD) were applied. From the moment of signal presentation the greatest difference of AEPs at target stimulation is marked in frontal areas of the left hemisphere through 16–18 ms. Emotionally-neutral and emotionally-significant psycho-informational influences provided the most conclusive AFD EEG data. Essentially, personal frustration is activated when the subject perceives situations to be threatening to his or her self-esteem and self-evaluation. Individuals with high levels of frustration are inclined to perceive a wide range of situations as threatening and therefore, will respond according to what they think the situation dictates.

KEY WORDS: Auditory Evoked Potentials (AEPs), Brain Mapping, EEG, Information-Psychological Influences.

INTRODUCTION

During last more than 100 years human brain is classical model of "the black box". We can estimate parameters of acoustic signals acting to the brain. From other side it is possible to register some target data of the acoustic information analysis. Development of means and algorithms of multivariate dynamic biological measurements creates predictors for expansion of a circle of problems for biometric systems [4, 5]. One of perspective directions of development biometrics is the analysis of a human functional status in remote research. For example, in such context the problem of remote recognition of a human mental condition and like-

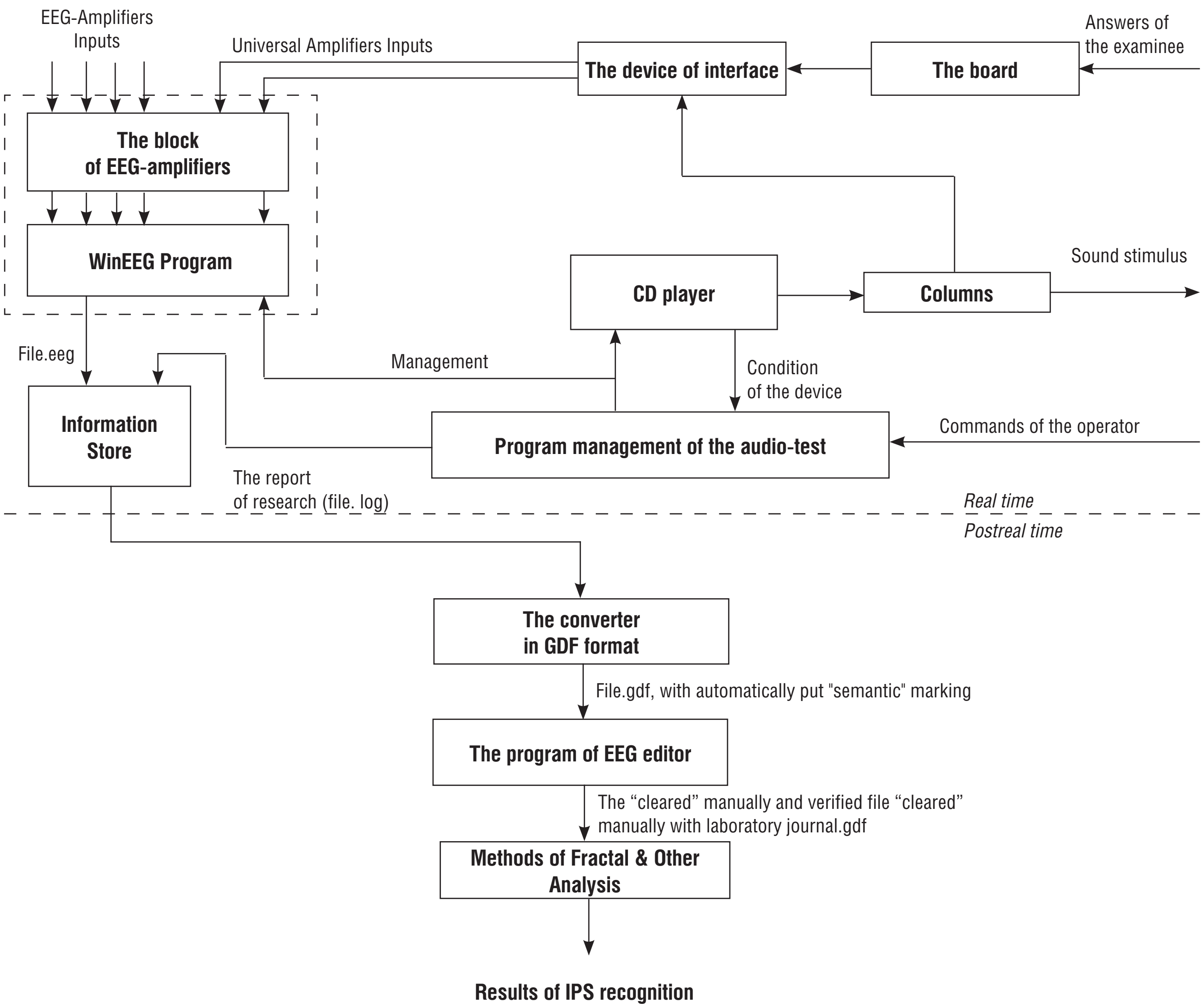


Fig. 1. Software and hardware complex for support of audio test

lihood forecasting is solved at processing the acoustical information [5, 8, 9].

The answer reactions of the brain, namely, auditory evoked potentials (AEPs) (event-related potentials) are the target data. The modern methods of brain mapping allow to investigate the spatial-temporary characteristics of reactions of the brain in reply to acoustic signals and also to estimate mechanisms of processing of the auditory information [2, 3, 9, 10].

The present research was aimed for modeling of human frustration status and noise proof feature at perception of the auditory images.

METHODS

86 healthy examinees (man, age 20–27 years) were surveyed. Audio tests were performed with using an original hardware-software complex with neurosystems for auditory evoked potentials (AEPs) and EEG registration. Tests for modeling of the human status at recognition of target and non target stimulus with AEPs registration; emotional neutral and significant information-psychological influences (IPI) with EEG registration and analysis of fractal dynamics (AFD); recognition of homogeneous verbal significant and insignificant stimulus (with EEG); with the compelled reaction to verbal stimulus, overcoming steady stereotypes (with EEG) and psychological testing were applied.

For realization of audio of testing the hardware-software complex has been created. Hardware devices are allocated by shading (fig. 1). The complex contains in the structure standard electroencephalograph with regular software (in fig. are led round by a dotted rectangular) and also originally programs and the devices developed by us especially for realization of the test. These are programs of management of the audio test, devices of interface and for processing data of research in a post real time. Fragments of presentation of information-psychological influences at simultaneous EEG registration are presented in tab. 1.

Table 1

Text codes of EEG fragments

Code	Fragment
1	Background prior to the beginning of presentation of stimulus
20	The incoherent text
21	The neutral intelligent text
22	The incoherent text after the neutral text
23	The prevention of painful stimulus
24	The incoherent text up to stimulus
25	The incoherent text after stimulus
26	The disturbing text-attitude
27	The incoherent text after the disturbing text

RESULTS

The data of the brainstem (short-latency) auditory evoked potentials registration testify that the acoustic signal is involved in processing by brain structures in 3 ms from moment of its presentation. Usually on this analyzed epoch (3–10 ms) different authors allocate 6–8 components [6, 7], in our case — 6 waves (fig. 2).

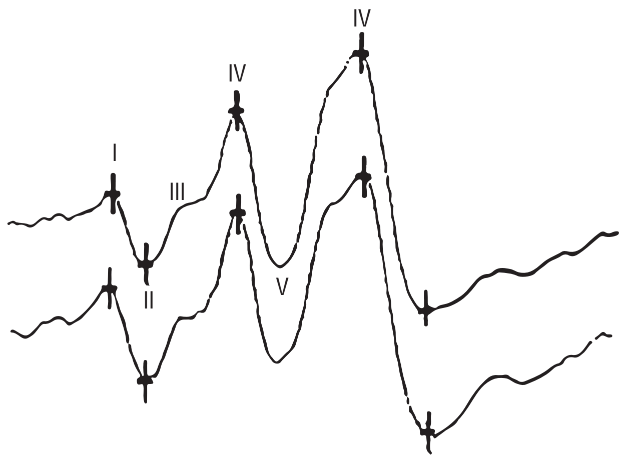


Fig. 2. The components of the BSAEPs, I–VI. Epoch of the analysis — 10 ms; the ordinate's line — in 1 cm 1 uV

Brain mapping was performed on the analyzed epoch from 10 to 400 msec. From the moment of signal presentation the greatest difference of potentials at target stimulation is marked in frontal areas of the left hemisphere through 16–18 msec, while in occipital and parietal sites the insignificant symmetric activation is marked.

On the diagram the statistics of peak-time characteristics of potentials are presented at target and non-target stimulation (fig. 3).

Among middle-latency auditory evoked potentials the most stable in both tests are 4 waves — P_{16}, N_{30}, P_{40} and $N_{60.}$ The amplitude-temporary characteristics of the Pa/Nb complex don't differ significantly in variants of testing. Some features are observed in formation of waves Po and Na at relevant stimulation. The amplitude of Po in the parietal (P_3 and P_4), and also in the left hemispheric C_3 and F_3 sites (F>4.0) grows significantly. The similar tendency is kept and on the time interval of formation of a wave Na in left (P_3 and F_3, F>4.0) points of registration.

The temporary parameters of late waves (200–400 ms) are leveled in both tests. Only peak latency of the wave P_{250} is significantly lower at action of the relevant signals (F>4.0). Simultaneously the amplitude of this component in conditions of a target task is reduced. Significant differences are observed in left P_3 and C_3 sites and in vertex (fig. 3).

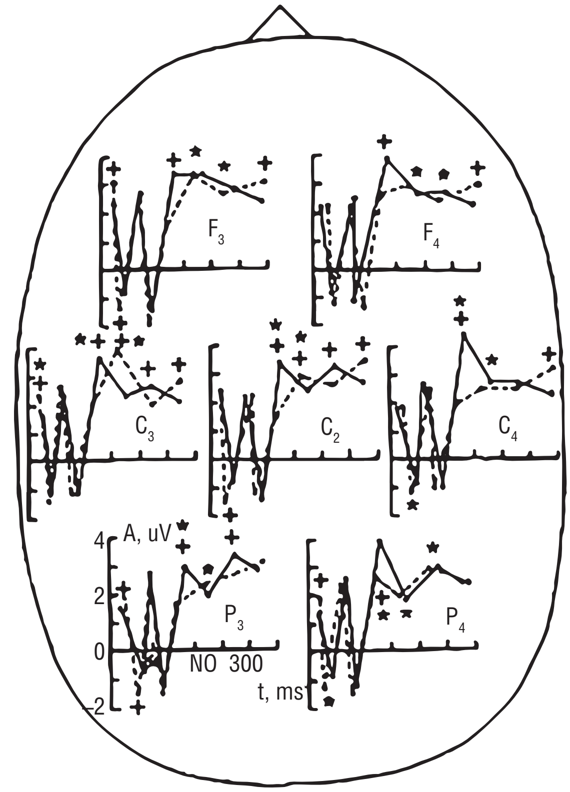


Fig. 3. The average meanings of amplitudes and of PL AEPs waves at non-target (continuous) and target (dotted line) stimulation. Badges (+) and (*) — significant (F > 4.0) accordingly for amplitudes and PL. P_4, P_3, ..., F_3 — sites on system 10/20. The marked facts are reflected in the brain mapping images (a, 220 ms; b, 226 ms). At performance of the target task the hemispheric symmetry of processes of excitation pays attention appreciable.

In this research healthy subjects and also persons with boundary frustration were investigated. For subjects with a high level of personal and situational frustration low percent of identification of acoustical images was characteristic. 8.3% did not have associations. The identification had guessing character. The long identification of an auditory image was marked in 15.3% of cases. If the average duration of the latent period of an identification of healthy subjects was 3–5 sec, persons with

Table 2

Recognition of Auditory Images Depending on a Level of Situational and Personal Frustration

Features of Auditory Images Perception	N, (% from total)	Level of situational frustration (Points)	Level of personal frustration (Points)
False recognition	16 (22,2%)	49	33
Illegibility of the recognition	8 (11,1%)	30,5	28,75
Unreasonably certain identification and/or affective illusions	6 (8,3%)	50	37,5
Late recognition	10 (13,8%)	48,6	31
The prolonged recognition	11 (15,3%)	45, 6	28,4

high levels of frustration took 10 to 30 sec. to recognize the acoustical images (tab. 2).

The splitting of perception, i. e. loss of the ability to form a complete image of object was registered in 12.5% of cases. Some examinees correctly perceived separate details of an acoustical image, but could not connect them into a complete structure. Late recognition was marked in 13.8% of cases, false recognition an acoustical image — in 22% and unreasonably certain character of identification — in 8.3% (tab. 2).

Affective illusions are established in 8.3% of cases. Such subjects instead of traditional sounds heard a shutter, a gun, shots, steps and the breath of persecutors, agonizing groans and shouts of people familiar to them. These features of perception correlate with a high level situational and an average level of personal frustration. The long identification of an acoustical image (15.3%), propensity to jam the same images (8.3%) met at high situational and low personal frustration (tab. 2).

In conditions of strong white noise healthy subjects correctly identified 82% of acoustical images and people with a high level of frustration — 52% of all masked acoustical images (fig. 4). Overall, 30 acoustical images were shown in random order over a period of 20 sec. Simultaneously EEG was registered.

With a decrease in the level of white noise the distinction between examinees was reduced. However parameters of an identification of acoustical images at healthy were approximately 10% higher in comparison with to subjects' high level of frustration (fig. 4).

We have applied 3 variants of subtests at EEG registration.

Subtest 1 simulates steady human status during the presentation of emotionally-neutral and emotionally-significant information-psychological influences. To emotionally-neutral influence carried the incoherent text (a casual set of neutral words) and the neutral intelligent text on the abstract topic. For emotionally-significant influences we have used texts that force the subject to listen and induce feelings of alarm.

Subtest 2 simulates the human status at recognition of a line of homogeneous verbal audio stimulus. One of the stimuli was more significant for the subject.

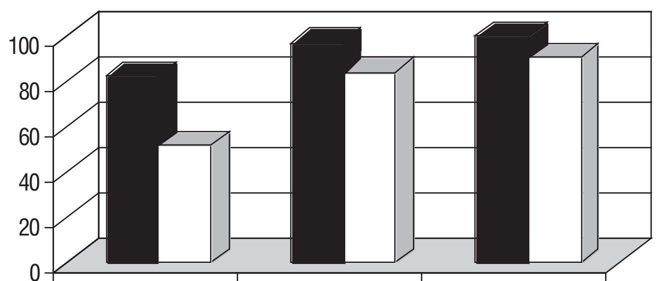
Subtest 3 simulates the status of human reaction on a verbal stimulus in an unusual image, overcoming stereotypes. When the subject during conversation intentionally deforms true, which to it for a long time and well-known, similar status take place.

The registered EEG has divided into patterns corresponding with fragments from the audio test. To each fragment a code is assigned. EEG fragment codes and variants of their sequences are presented in the table 1.

Further EEG processing was carried out in post real time after the removal of artifacts from each file. This is a manual procedure.

In the EEG files, software has allocated analyzed epoch according to semantics of the subtest. For each of epoch are settled an invoice a vector from 79 informative attributes. It is automatic procedure.

For the analysis and recognition of the EEG patterns were automatically allocated of values of informative attributes. Thus values of attributes of fragments of different EEG type



	Strong noise	Middle noise	n/a
■ Control	82	97	100
□ Boundary frustration	52	84	90

Fig. 4. Recognition of Images on a Background of Acoustic Noise

minimally depend on specific EEG features and mainly reflect the EEG change at transition from a fragment to a fragment. That is they reflect transition from one test to another.

The subsequent automatic processing of EEG patterns was carried out from complex to simple — for allocation of the most significant parameters with a reduction of less significant results.

CONCLUSION

Brain mapping images of middle latency AEPs (26 ms) during target stimulation show distinct symmetry with maximum activation of the occipital-parietal areas, to a lesser degree — the central departments and, practically no electrical dipoles in the frontal areas of the cortex.

A higher level of symmetric excitation with a latent period ranging from 300 to 350 ms was observed when the components of the experiment were mapped. The analysis of the spatial–temporary characteristics in this task marks significant simplification of amplitude of this wave in all sites, except for the parietal.

In the first case, it is a question of activating unrealized attention processes, in the second — a question of indicating the decision-making process.

Subjects with high levels of personal and situational frustration respond differently to the acoustic images when compared to healthy individuals.

It was characteristic for subjects with high levels of personal and situational frustration, to achieve low percentage scores when attempting to identify acoustic images. Their responses to the images differed as well, when compared to healthy individuals. These responses include: making no association; guessing; taking an extended period of time to respond; the splitting of perception; incorrect identification; and affect illusions.

High emotional intensity, anxiety, concern and propensity to test alarm, fears, fear even in habitual for them to conditions were observed in individuals with higher levels of personal frustration.

Emotionally-neutral and emotionally-significant psycho-informational influences provided the most conclusive ADF EEG data (subtest 1). Decreased, or a complete absence of motivation and emotionally neutrality account for the low recognition scores in subtest 2.

This demands the formulation of an action plan (the reply) and simultaneously, an initial cognitive analysis of the information received, regardless of the individual's attitude towards the question or situation.

Essentially, personal frustration is activated when the subject perceives situations to be threatening to his or her self-esteem and self-evaluation. Individuals with high levels of frustration are inclined to perceive a wide range of situations as threatening and therefore, will respond according to what they think the situation dictates.

Unlike personal frustration, the reactive (situational) alarm is dynamical, changes over time and influences how one would react to a potentially stressful situation.

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