Integration and Disintegration of Auditory Images Perception

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Abstract. Defects of sensory perception are one of essential features in structure of psychopathological frustration. The conscious mental activity includes components of perception, construction of an image, memory and thought processes. The perception is formed on the basis of synthesis of three kinds of the information flows: sensory, taken from memory and coming from the centers of motivation. The sensory information defines communication of cognition with an external world. Purpose of present research was aimed for studying character and a degree of disorders of mechanisms of perception and integration of auditory figurative information at depressive psychopathological states. Outcomes of present research, including EEG coherent analysis, represent convincing acknowledgement of brain decomposition at perception of the auditory information at patients with psychopathological frustration.

Keywords: Sensory perception · Auditory images (AI) · EEG · Decision-making

1 Introduction

We are surrounded by world of our sensations, but we live in world of our consciousness, our sensations, ideas and feelings. The real world and perceived by us world not always completely correspond. Our life is a life of our consciousness. Therefore so problem of consciousness' research is important. For neurosciences it is necessary to understand a problem how on basis of movement of nervous impulses there is that we feel inside of ourselves – world of our ideas and feelings [6].

Interest for analysis of information – substantial side of brain work on basis of its physiological parameters sometimes has explosive character. Irrespective from the purposes and tasks in many laboratories brain bioelectric activity is used. Quite often this problem is designated as "reading of a brain" by analogy to how human comprehends the text on alphabetic symbols. It is a new stage in the decision of a global problem "a brain and mentality" as such investigations integrate technology of brain processes and their results in form of mental functions [7].

Besides theoretical value this problem has also practical outputs – at creation of more perfect generation of interfaces between brain and computer. The understanding

D.D. Schmorrow and C.M. Fidopiastis (Eds.): AC 2015, LNAI 9183, pp. 470–480, 2015.
DOI: 10.1007/978-3-319-20816-9_45

of a thinking brain is solving at creation of devices of an artificial intellect and new generations of computers [11].

There is a representation [3] that problem "consciousness and a brain" includes two main tasks. The first problem – to find out how on basis brain work, or on basis of movement of electric nervous impulses a subjective experience, a private person world are formed. The second problem is to specify what brain mechanisms underlie certain cognitive actions [1, 6].

One of explanations of how on basis of brain processes there is a subjective experience belongs to I.P.Pavlov who has assumed, that "consciousness is a result of activity of that cortex area which is in a condition of optimum excitability" [12]. I.P.Pavlov wrote, "if we could see through a cranium would observe the freakish form a light spot moving on a cortex which reflects the area connected with consciousness". Modern methods of brain research allow looking very similar – EEG-mapping, ERPs-mapping, MEG-mapping, fMRI, PET-scan, near infrared sources, etc. [8, 14, 16].

One of key brain structure responsible for support of status "consciousness – wakefulness" formation reticular has acts [11]. It receives collaterals from sensory and from motor paths of a brainstem. This approach by the theory of centrencephalic Penfild's system is presented [13].

Purpose of present research was aimed for studying character and a degree of disorders of mechanisms of perception and integration of auditory figurative information at depressive psychopathological states.

2 Methods

Healthy examinees (40 persons) and 72 patients with homogeneous psychopathological frustration of depressive character (middle age 34 ± 3.4 years) by means of standard and original techniques have been surveyed. Individually-psychological characteristics and a degree of expressiveness for cognitive defect estimated according to clinical interview, research of the auditory-speech memory, traditional techniques of an estimation of situational and personal uneasiness, differential diagnostics of depressions.

Auditory cognitive system by means of original technique "recognition of auditory images (AI)" was investigated. Examinees have listened and identified a continuous series of AI. Further a level of an identification of AI, speed of perception and accuracy of a semantic estimation of the acoustical nonverbal information were defined. Multichannel EEG until stimulation and also synchronously with AI perception was registered.

The instruction and tasks for all patients were clear. For patients AI were offered to listen and identify. For strengthening intensity of process of listening AI not separated were showed. The images a uniform continuous series by general duration of 10 min have represented (20 AI for 30 s) (Table 1).

The interval between AI has made 3 s. AI have been saved on the digital memory and have submitted binaural. The level of sound pressure was comfortable and made 80 dB above a threshold of audibility.

Table 1. EEG registration with presentation of auditory images

Background EEG	Awake rest
EEG with AI presentation	Acoustical images
Presentation of pure AI	Call of phone
	Shout of the cock
	Crying of the child
	Sound of a moving train
	Shooting from a gun
Presentation of noise AI	Noise of a thunder-storm
	Noise of a sea surf
	Noise of a mountain stream with singing birds
	Roar of the engine of the take off plane
	Noise of city

For EEG analysis software WIN-EEG from N.Bechtereva Institute of Human Brain was applied. Also coherent EEG analysis was applied, chose non artifact epochs which duration was established experimentally. Reliability of the received results was estimated by t-criterion. EEG data in the form of individual coherent-grams and diagrams were represented.

The present investigation by local ethical committee is approved.

3 Results

Base coherence for persons with psychopathology before stimulation is characterized by impoverished functional communications (Table 2) by comparison with healthy examinees. The difference varies within the limits of 18.8–42.7 % (Fig. 1).

Inside of each hemisphere at healthy examinees in a condition of rest all cortex zones – occipital, parietal, central and frontal were characterized by precise communications. Besides, each of these zones in one hemisphere in pairs with symmetric area in other hemisphere is connected.

At schizophrenia generalized decomposition inter-and-intra hemispheric coherent communications was registered. Infringements of intercentral attitudes complicate carrying out of nervous impulses on inter- and intra- hemispheric brain communications. It promotes infringement of perception and AI identification, difficulty of integration of the information and formation of the cognitive decrease. At patients impoverished intra- hemispheric communications were registered. However, inter hemispheric interaction almost completely was absent or has been weakened.

During task performance at healthy examinees the set inter- and intra- hemispheric communications is registered. The pattern, characteristic for a condition of rest, at thinking varies. Communications start to converge to the certain fields of an associative cortex. Such centers of communication have been named by “focuses of interaction” which were formed at healthy examinees (Fig. 2).

Table 2. Variants of perception of auditory images

NN п\п	Variants of perception	Recognition, n (%)	
		Patients	Healthy
1	Correct recognition	0 (0)[d]	30 (75)[d]
2	Unreasonably certain character and-or occurrence of affective illusions	6 (8.3)[a]	0 (0)[a]
3	Absence of associations (guessing)	6 (8.3)[a]	0 (0)[a]
4	Prolonged recognition of acoustical image	11 (15.3)[b]	2 (5)[a]
5	Splitting of perception	9 (12.5)[c]	0 (0)[c]
6	Late recognition	10 (13.8)[c]	1 (2.5)[c]
7	Propensity to jamming the same images	6 (8.3)[a]	0 (0)[a]
8	False recognition	16 (22.2)[b]	2 (5)[b]
9	Easy illegibility of an identification, scarcity and monotony of hypotheses	8 (11.1)[a]	5 (12.5 %)[a]

Note. [a]– $p > 0.05$; [b]– $p < 0.005$; [c] – $p < 0.05$; [d]– $p < 0.001$.

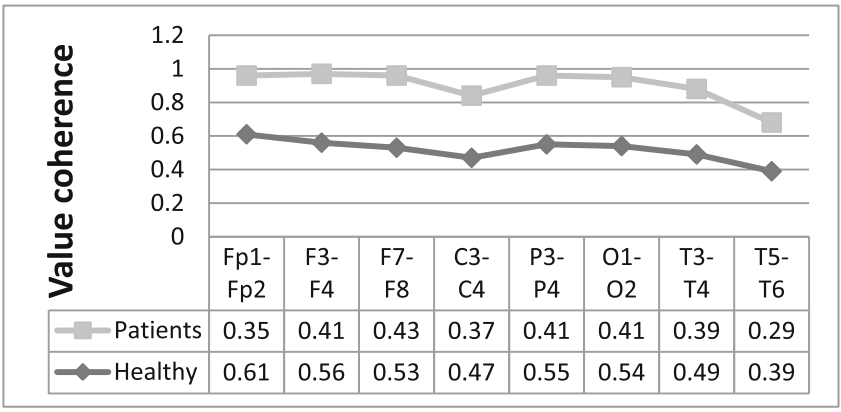

Fig. 1. Parameters of coherence before auditory stimulation at healthy and at psychopathology

The tasks of brain are perceive, processing and transfer the information by excitation of the certain structures and establishment of communications, including cortex. Transfer of the information is possible only at occurrence of interrelations between participating structures.

At psychopathology number of communications (Fig. 3) considerably below was registered. Inside of hemispheres their quantity increased in comparison with a condition of rest. But main mechanism testifies that hemispheres have been completely "separated". Thus, disintegration and breakage neural networks forming inter- hemispheric

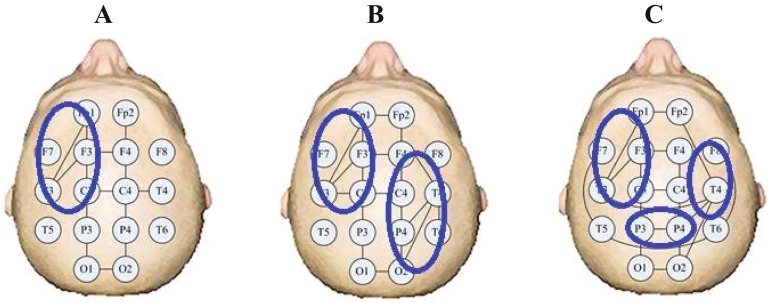

Fig. 2. Dynamics of a beta-rhythm before stimulation (A), at perception pure (B) and noise (C) acoustic images at healthy examinees.

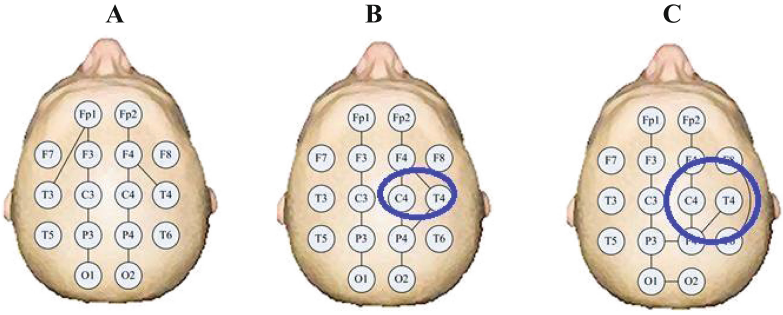

Fig. 3. Dynamics of a beta-rhythm before stimulation (A), at perception pure (B) and noise (C) auditory images at schizophrenia.

communications are main difference of a brain in psychopathology from brain healthy (Fig. 2, 3 and 4).

For background neurophysiologic changes infringement of nonverbal acoustical perception at psychopathology on qualitative (Table 2) and quantitative (Table 3) parameters is marked. At healthy examinees during 30 s presentation of each acoustic fragment the AI on mechanisms of the subsequent change of hypotheses was formed. The quantity is correct AI at schizophrenia considerably below has appeared. In comparison with control group high reliability of distinctions ($p < 0.001$) is marked (Table 2).

At patients more often tendency of association with professionally habitual or actual sounds in personal interests is observed. Perception in this case has unreasonably concrete and/or affective-illusory character. The person hears “crying of familiar human”, instead of crying of person in general, “noise of a familiar place”, instead of abstract noise of street, etc. Instead of habitual sounds patients hear flick a shutter of a gun, shots, steps and breath of persecutors, dying groans and shouts of people familiar to them. Such frustration of perception is noted in 8.3 % of cases at patients and was absent at healthy (Table 2).

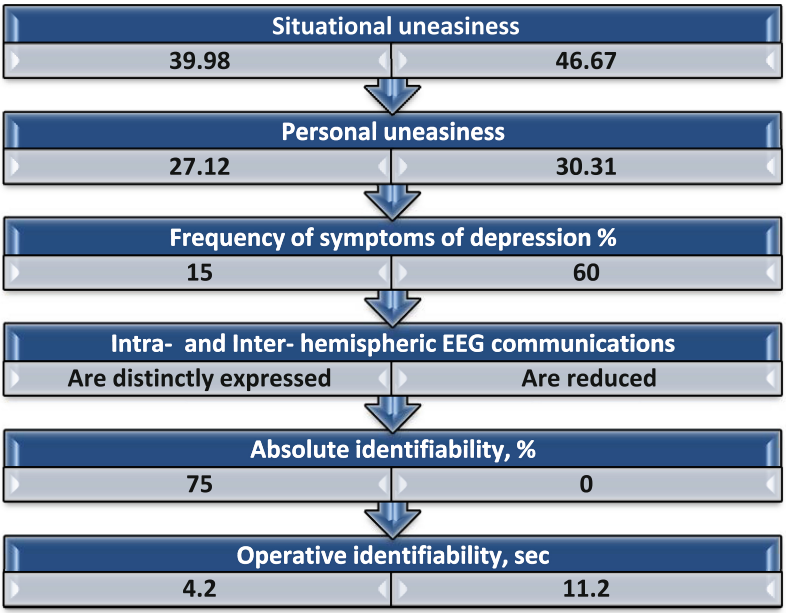

Fig. 4. Parameters of healthy examinees (left) and persons with psychopathology (right) at identification of acoustical images.

In 8.3 % of cases at schizophrenia associations did not arise. The identification had guessing character. At healthy such features of perception AI did not registered (Table 2).

Long identification of AI in 15.3 % of cases at mentally sick was marked. In control group such feature only in 5 % of cases was observed. At patients it was quite often observed "prolonged identification of AI". "Ideal standards" already are stored in memory of images and examinees are capable to find conformity between them and the acting deformed images (Table 2).

Splitting of perception (loss of ability to form a complete image) in 12.5 % of cases at schizophrenia was registered. Patients could perceive correctly separate details of AI, but could not connect them in uniform structure. They heard sounds, marked their start and finish, gave them the characteristic, but could not recognize AI as a whole. The perception in such cases was characterized by "the split identification". The patient speaks: "something turns", but during 30 s does not identify AI (for example, a sound of "helicopter' helicopter take off"). Other patient speaks: "it is clear such sound with shine", but does not learn a sound of a mountain stream (Table 2).

Late recognition at schizophrenia marked in 13.8 % of cases (2.5 % in control group, $p < 0.05$). To speak about full loss of subject perception it is impossible. Patients could not during the necessary moment recognize AI, but in further the braked association as reaction to another stimulus was formed (Table 2).

Typical feature of acoustical perception for patients is the expressed inertness, propensity to "jamming of the same images" (Table 2).

False recognition AI on a background agnosia of subject sounds it is established in 22.2 % of cases at patients (at healthy persons of cases of 5 %, $p < 0.005$). Patients have supposed gross blunders in the assumptions (for example, accepted crying the child for cat's miaow). More often they could not associate with AI. They painfully searched "with what for it to compare", but did not find, though is thin enough caught shades of sounding (Table 2).

The easy illegibility of an identification, scarcity and monotony of hypotheses met in 11.1 % at patients (12. 5 % at healthy) (Table 3).

Efficiency of recognition pure and noise AI by quantity of correctly distinguished images (P, %) and on time of decision-making (T, sec) was estimated. Healthy examinees successfully coped put with cognitive task (95 %) on average for 4.2 s. Difficulties have fixed only in 5 % of cases at an identification of AI "noise of city". At perception of the noise AI healthy examinees successfully have coped with cognitive task in 80 % of cases. Time of identification has risen in 2 times by comparison with pure AI (Table 3).

An outcome of perception at schizophrenia essentially was below. Pure AI have recognized in 75 % of cases and time of an identification exceeded in 2.6 times of healthy examinees.

At an identification of noise AI patients with the task have consulted in 40 % of cases and time of recognition has increased up to 24.3 s. It exceeds in 2.9 times period of identification in comparison with healthy examinees. Time of a correct identification of noise AI at patients has increased in 2 times by comparison with an identification pure AI (Table 3).

Thus, level of AI identification on qualitative and to quantity indicators is lowered in patients with psychopathology by comparison with identification in control group of healthy people. From presented data (Fig. 4) it is visible that healthy examinees successfully coped with AI identification on average for 4.2 s. Patients have identified AI in 2.7 times more slowly (aver. for 11.2 s). Quality indicators of recognition also were much worse at patients with psychopathology. Absolutely correct identification of AI in patients did not meet.

At successful perception of AI by healthy examinees on EEG data coherence focus was formed. At patients with psychopathology coherence focuses either were not formed or have been weakened.

Depression at healthy met much less often (in 15 % of cases) unlike patients (in 60 % of cases). Parameters of situational and personal uneasiness were below in group healthy, unlike patients with psychopathology.

Table 3. Pure and noise auditory images recognition

Acoustic Images	Healthy		Patients	
	P	T	P	T
Pure AI	38 (95 %)	4.2	54 (75 %)	11.2
Noise AI	32 (80 %)	8.4	29 (40 %)	24.3

Note. P – quantity of correctly identified images, T – time of decision-making.

4 Discussion

Transition of physiological process to psychic level is provided by ring movement of impulses (Fig. 5) with activation of memory centers, including hippocampus and motivational structures with subsequent return of excitation to a projective cortex. Such mechanism has provides an opportunity of comparison and synthesis of the information on physical and signal properties of stimulus that underlies sensations [2, 15].

Return of sensory impulses to points of initial projections after inquiry in other structures allows comparing the new information with last experience. It allows a basis to lead its updating [4].

Human consciousness consists not only of consecutive images. It also is capable to manipulate these images and symbols forming thought process. These points of view are close to "cinema theory of perception" [5].

Focus consists from neuron's groups, each of which is connected by flexible communications with peripheral neurons (Fig. 6). Neuron' groups work on same frequency and are incorporated in uniform neural network on the basis of isosynchronous principle. Inside of the focus neurons are incorporated by rigid communications. It enables to integrate information circulating in separate neural networks. Thus, information synthesis includes three basic components: the sensory information, the data from long term memory and data from the motivation centers. At psychopathology in all components deficiency (Fig. 7) is marked that leads to infringement of perception of AI [1, 6].

Processes of perception and integration of the auditory information in norm occur instantly and are accompanied by increase both intra- and inter- hemispheric coherent communications. It is marked precise lateralization of the focus coherence in a temporal-frontal cortex over again in the right hemisphere, responsible for an identification of physical, spatial and semantic AI characteristics, and then in a

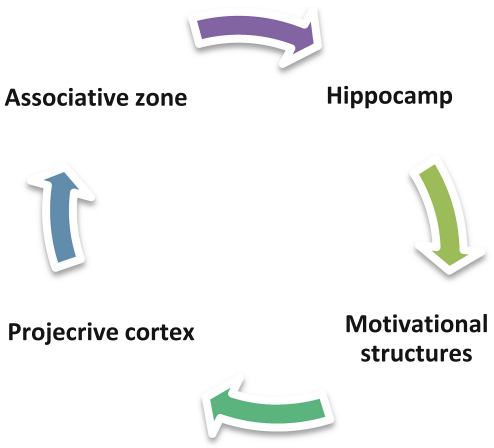

Fig. 5. Cyclic movement of impulses and information synthesis at an identification of auditory images.

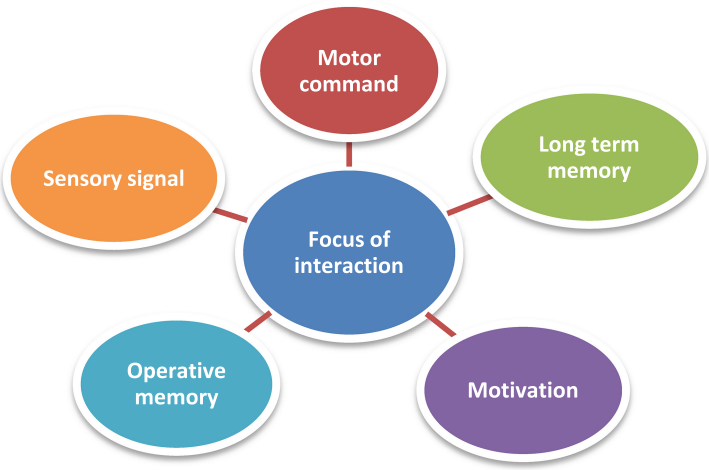

Fig. 6. The scheme of focus of interaction which is carrying out synthesis of the information during perception of auditory image.

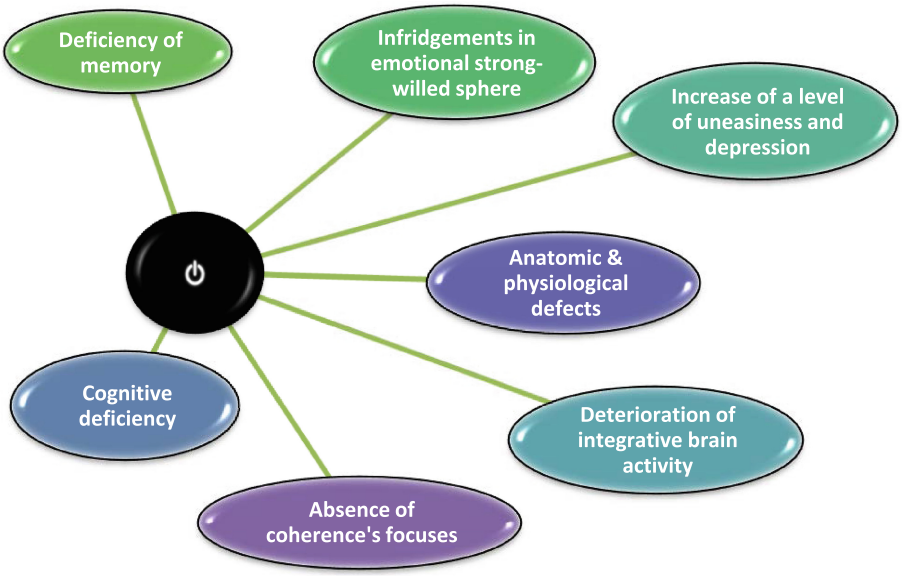

Fig. 7. Deficiency of basic segments for auditory images identification

frontal-temporal region of the left hemisphere responsible for verbalization and conceptual judgment of the perceived information on the basis of individual experience. At successful perception of the AI in a brain cortex the behavioral dominant that finds reflection in dynamics of coherent communications is formed. Inter central attitudes undergo respective alterations. The pattern of coherent communications in the form of

the strengthened combination of potentials of frontal and temporal areas of the right hemisphere in a high-frequency range is formed. Bioelectric activity has correlates with cognition dominant at a behavioral level [1, 6, 9, 10].

At psychopathology before stimulation comes to light essential decrease inter- and intra- hemispheric EEG synchronization. It is the objective certificate of infringement of the inter central attitudes, decrease in a degree of functional coherence between temporal, frontal and parietal structures of the left and right and left hemispheres of a brain.

Remedial changes of initially lowered level of integration processes at audio-cognitive activity carry at schizophrenia torpid character. Characteristic for norm asymmetry of the coherence focuses at perception of integration of the mono- modal information, at schizophrenia or completely was absent, or in separate supervision had the expressed tendency.

5 Conclusion

1. In norm the perception pure and noise AI has high recognition (up to 95 %) and efficiency with the latent period 4.2–8.4 s. In view of time for verbalization and decision-making on biologically significant action such time interval corresponds to physiological norm. Productivity of AI perception at psychopathology is within the limits of 40–75 %, and the latent period – within the limits of 11.2–24.3 s, that in 2.6–2.9 times exceeds a standard time of identification.

2. At psychopathology before stimulation reveal essential decrease of inter- and intra- hemispheric EEG synchronization. It is the objective certificate of infringement of the intercentral attitudes, decrease in a degree of functional coherence between temporal, frontal and parietal structures of left and right and left hemispheres of brain.

An infringement of functional interaction in basic frequency EEG ranges at psychopathology specifies steady infringements of neurons functioning. Infringement of synchronization of the basic rhythms shows, that this mechanism can define infringement of AI recognition.

3. At successful AI perception in a brain cortex the behavioral dominant that finds reflection in dynamics of coherent communications is formed. The intercentral attitudes undergo respective alterations; the pattern of coherent communications in the form of the strengthened combination of potentials of frontal and temporal areas of the right hemisphere in a high-frequency range is formed. Bioelectric activity has correlates with recognition dominant at a behavioral level.

4. At psychopathology authentic infringement of a holistic and segmental way of processing of the acoustical information is marked. In the first case synthesis of the acting information with the ready standards stored memory, and in the second is carried out, on the basis of a principle of likelihood forecasting – from separate fragments of a signal the person on the basis of the experience hypotheses about a possible subject accessory of an image has builds.

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