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Neurophysiological Features of Perception to Emotional Stimuli in Norm and Patients with Paranoid[1]

A. Y. Arkhipov and V. B. Strelets

Institute of Higher Nervous Activity and Neurophysiology, Russian Academy of Sciences, Moscow, 117485 Russia
e-mail: arhip76@bk.ru

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Abstract—The latencies and amplitudes of the P100 and N170 components of event related potentials (ERPs) upon presentation of neutral and threatening visual stimuli have been studied in healthy persons and patients with schizophrenia. The studied patients had acute psychosis with a predominance of hallucinatory-paranoid syndrome and did not receive antipsychotic therapy, i.e. when the disturbances of sensory perception were mostly pronounced. Analysis of early component P100 and intermediate one N170 of event relative potentials (ERPs) in the control group healthy showed the increase of excitation to emotionally threatening stimuli; at all sites the amplitude increased and the latency shortened. In the group of patients with schizophrenia, the analysis of components P100 and N170, in contrast, showed the increased latency and decreased amplitude. The obtained data point to pathological inhibition underlying the ERPs to emotionally significant stimuli.

Keywords: evoked potentials, schizophrenia, P100, N170, emotion, perception
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Cognitive and emotional disorders, as is known, are the main syndromes of schizophrenia. Disorders of these functions are mainly determined by the clinical picture, as well as psychophysiological correlates. The objective of our study was to determine some physiological factors that are responsible for disturbances of the processes of perception and emotional sphere in patients with schizophrenia. These disorders of mental functions refer to the first rank (top) syndrome in patients with schizophrenia [1].

To date, the vast majority of research in the field of emotional experience in schizophrenia are based on self-report [2]. However, this is not enough. Firstly, the patients themselves can not adequately respond to the questions. Secondly there may be errors of memory and thought disorder associated with delusional symptoms [3].

At present, the study of psychophysiology of emotion, rather actively is used the method of evoked potentials (EP). This method reflects the synchronous activity of neuronal populations in the preparation of any action or in response to a stimulus, the EP considered as a response (its neural reflection) to the stimulus, in this case, the external [4].

In evoked potentials (visual and somatosensory) usually the group of waves with latency to 100 ms is distinguished relatively early, from 100 to 200 ms as intermediate and later. These groups differ in latent period and in the region of localization in the cortical brain structures, temporary reduction cycle, depending on the functional state, the influence of drugs, and others [5].

EP components with a latent period of up to 100 ms have sensory origin and are located within a single analyzer. EP components from 100 to 200 ms—are of mixed origin, in their generation involved brain structures such as the hypothalamic-limbic complex and bark. Basically earlier EP components depend on the physical characteristics of the stimulus [6].

It should be noted that the presentation of emotional words or images, there is an emotional reaction, inducing experience emotions [7].

Most of the studies relating to the definition of psychophysiological differences in reactions to verbal emotional stimulus in normal and in schizophrenia, is dedicated to the late components evoked potential [8], and to a much lesser degree, there are studies that examine the early stages of perception and processing of emotionally-shaped information, particularly in patients with schizophrenia in the acute psychotic period without receiving neuroleptic treatment [9].

In recent studies, the focus is mainly on how emotional stimulus affect the characteristics of the amplitude of the EP components [10], while the analysis of changes in latency, i.e., violation of the temporal characteristics of CAP in patients with schizophrenia is almost unexplored.

In this paper, we tried to find the answer, when and where in the brain integrates disparate neural networks to ensure the process of perception and processing of emotionally significant stimulus normally, and how they are violated when paranoid schizophrenia. To this end, we studied the latency and amplitude of the evoked potential components of P100 (the interval from 60 to 150 ms) and N170 (the interval from 100 to

[1] The article was translated by the authors.

200 ms). Thus, we have identified specific neurophysiological violation underlying the perception of emotionally significant stimuli in schizophrenic patients in an acute psychotic period is neuroleptic therapy.

MATERIAL AND METHODS

Subjects. The study was conducted on the basis of the Psychiatric Hospital "Transfiguration" (Department of acute psychosis). The group of patients included 39 people (21 men and 18 women) with schizophrenia in acute psychotic period prevalence of hallucinatory-paranoid syndrome, aged 18 to 37 years old. The diagnosis was done by a psychiatrist department of acute psychosis, according to the International Classification of ICD-10 category F20.0. Total score of severity of psychopathological symptoms on a scale PANSS, the patients was 96.1 ± 3.1. All patients had the first episode of psychosis and antipsychotic neuroleptic received treatment before and during the experiment. The control group was studied 32 healthy subjects (18 men, 14 women) aged 20 to 35 years. In the study were selected as a control group and in the group of patients with schizophrenia, physical health right-hander with 100% or adjusted to 100% vision. Statistically significant differences by gender, age and level of education between the studied groups were not found ($p > 0.1$).

Stimulus and tasks. All subjects presented stimulus on the screen 14-inch monitor at a distance of 0.75 m from the subject, sitting in a chair in front of a computer in a darkened room. As stimulus material were used neutral and threatening image of IAPS adapted for the Russian sample. Stimulus were presented in a random order. Time of presentation of the stimulus was 500 ms; interstimulus interval was from 1.5 to 3 seconds. The entire series of experiments—Studies differences characteristics of CAP in patients and healthy subjects were conducted in implicit conditions, i.e. the passive perception of stimuli.

The procedure for recording, processing and analysis of data. Electrodes are placed on the international circuit 10–20%. Filtered high frequency were set at 70 Hz, the time constant of—0.3 s. The sampling rate of 200 Hz, the impedance of less than 10 kOhms (in most records <5 kOhms). EP was recorded from 19 leads: Fp1, Fp2, F3, F4, F7, F8, C3, C4, T3, T4, T5, T6, P3, P4, O1, O2, Fz, Cz, Pz at the facility, consisting of 24 channel amplifier company MBN (Russia). Reference electrodes were attached to the left and right lobes of the ears. Posteriori studied recording the EP on the combined ear electrode. From the original recordings manually removed implementation with an amplitude of more than 100 μV. To suppress the EOG, pulse and other artifacts used a method which is a combination of two techniques implemented sequentially filtering and processing of EEG results with varieties of factor analyzers of principal component analysis [11]. For orientation in the film evoked potential first built averaged evoked potentials in groups of subjects, then isolated ERP components P100 and N170. Thereafter, potentials of individual units of 5 ms maximum amplitude extrema found closest to the average waves P100 and N170 in the range from 55 to 150 and from 100 to 250 ms, respectively, and fixed latency between the average amplitude of the three highest peaks of the individual. In cases where the capacities for the individual range latencies were extremum two or more of them selected by the maximum amplitude peak.

Analyzed potentials obtained separately in neutral and threatening images incentives. Measured the latency and amplitude of P100 and N170 components in all 19 leads.

Compared the latency and amplitude of P100 and N170 between groups of subjects (healthy and schizophrenia) separately for threatening and neutral stimuli, as well as the characteristics of EP components to neutral stimuli compared with threatening within each group. Statistical processing was performed program STATISTICA 7.0. Used the nonparametric Mann-Whitney test for intergroup comparisons, as well as a criterion for Wilcoxona—intragroup comparisons.

RESULTS

Comparison of latency and amplitude of P100 and N170 components in the perception of neutral and threatening visual stimulus in implicit conditions in a group of healthy subjects.

In the passive perception of emotional stimuli-shaped images (neutral and threatening) latency component P100, in the group of healthy subjects was significantly shorter threatening stimulus than neutral in the left parietal region (P3) $p < 0.05$ in the right middle temporal region, (T4), $p < 0.05$,

Statistically significant differences P100 amplitude component threatening and neutral stimulus in healthy subjects have not been identified.

N170 latency component in the passive perception of emotionally-shaped stimulus (neutral and threatening images) in a group of healthy subjects was significantly shorter threatening stimulus than neutral in the right central region (C4) $p < 0.05$.

Analysis of the amplitude of the N170 component in the perception of emotional and imaginative incentives implicit conditions in healthy subjects showed significant differences; so that the amplitude at the neutral stimulus was less than threatening in the right inferior temporal (T6), $p < 0.05$, and the central (Cz) $p < 0.05$ areas. Thus, the analysis of the data indicates the excitation threatening stimulus during braking and neutral stimulus in healthy subjects.

Comparison of latency and amplitude of P100 and N170 components in the perception of neutral and threatening visual stimulus in implicit conditions in the group of subjects with schizophrenia.

In the passive perception of emotional stimulus-shaped images (neutral and threatening) latency component P100, in the group of subjects with schizophre-

nia was significantly longer threatening stimulus than neutral in the following areas: the left anterior frontal (Fp1) $p < 0.05$, right front frontal (Fp2) $p < 0.01$, left center (C3), $p < 0.05$, the right central (C4) $p < 0.01$, right parietal (P4) $p < 0.05$, the left occipital (O1) $p < 0.05$, the left anterior temporal lobe (F7) $p < 0.01$, the right anterior temporal lobe (F8) $p < 0.05$, central (Cz) $p < 0.05$, the central parietal (Pz) $p < 0.05$.

Analysis of the amplitude of the P100 component in the perception of emotional and imaginative stimulus in patients with schizophrenia showed significant differences, where the amplitude was less threatening stimulus than neutral in the right parietal region (P4) $p < 0.001$. That indicates the predominance of the braking process the perception of threatening stimulus N170 latency component in the passive perception of emotionally-shaped stimulus in the group of subjects with schizophrenia was significantly longer threatening stimulus than neutral in the following areas: the left anterior frontal (Fp1) $p < 0.01$, the right prefrontal (Fp2) $p < 0.01$, left frontal (F3) $p < 0.05$, the right central (C4) $p < 0.05$, the central frontal (Fz) $p < 0.05$.

Analysis of the amplitude of the N170 component in the perception of emotional stimulus shaped in the group of subjects with schizophrenia showed significant differences, where the amplitude was greater at neutral stimulus in the right occipital (O2) $p < 0.01$, and in the right anterior temporal lobe (F8) $p < 0.05$ areas. Thus, our data may indicate a predominance of inhibitory processes in the perception of threatening stimulus in patients with schizophrenia.

Comparison of latency and amplitude of P100 and N170 components in the perception of neutral and threatening visual stimulus in implicit conditions, between a group of healthy subjects and a group of patients with paranoid schizophrenia in the implicit conditions (Figs. 1, 2).

Analysis of the amplitude of the P100 component in the perception of emotionally-shaped neutral stimulus showed significant differences that were found in the left parietal (P3) $p < 0.01$, in the right parietal (P4) $p < 0.05$, and in the right inferior temporal (T6), $p < 0.05$ areas where amplitude at neutral stimulus was greater in healthy subjects compared with a group of patients with schizophrenia.

Analysis of P100 latency component in the perception of emotionally-shaped neutral stimuli showed significant differences, where latency was shorter in patients with schizophrenia compared with the control group in the following areas: right anterior frontal (Fp2) $p < 0.05$, left center (C3) $p < 0.01$, right center (C4) $p < 0.01$, right parietal (P4) $p < 0.05$, the left anterior temporal lobe (F7) $p < 0.05$, right anterior temporal lobe (F8) $p < 0.05$, left mid-temporal (T3) $p < 0.05$, the left inferior-temporal (T5) $p < 0.05$, the lower right-temporal (T6) $p < 0.05$, the central frontal (Fz) $p < 0.05$, central (Cz) $p < 0.05$.

Analysis of the amplitude of the P100 component in the perception of emotionally-shaped threatening stimuli showed significant differences, where the amplitude of schizophrenia patients was lower than that of the control group in the right parietal region (P4) $p < 0.001$.

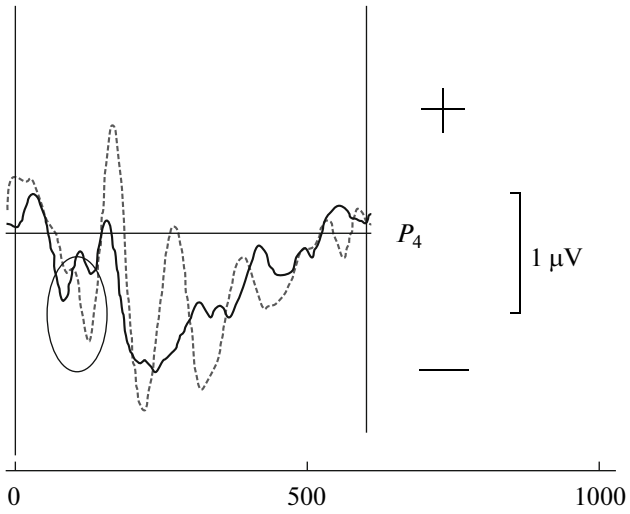

Fig. 1. Example of a component P100 EP threatening visual stimuli among a group of healthy subjects (solid line) and patients with schizophrenia (dashed line). Circle indicates the difference in amplitude and latency between patients and healthy this component.

Analysis of P100 latency component perception of emotionally-shaped threatening stimulus revealed no significant differences between subjects with schizophrenia and control subjects.

Analysis of the amplitude of the N170 component in the perception of emotionally-shaped neutral stimulus showed significant differences in the right mid-temporal (T4) $p < 0.05$, the bottom left-temporal (T5) $p < 0.05$, and in the lower right-temporal (T6) $p < 0.01$ areas wherein the amplitude was smaller in schizophrenic patients compared with healthy subjects.

Analysis of latency component N170 in the perception of emotionally-shaped neutral stimulus revealed no significant differences between subjects with schizophrenia and control subjects.

Analysis of the amplitude of the N170 component in the perception of emotionally-shaped threatening stimulus showed significant differences, where the amplitude of schizophrenia patients was more than a group of healthy subjects in the left anterior temporal region (F7) $p < 0.001$, in the right anterior temporal lobe (F8) $p < 0.001$ in the central (Cz) $p < 0.05$ areas.

Analysis of latency component N170 in the perception of emotionally-shaped threatening stimulus showed significant differences, where latency was shorter in the group of healthy subjects, compared with a group of schizophrenic patients in the following areas: the left anterior frontal (Fp1) $p < 0.001$, right front frontal (Fp2) $p < 0.001$, left frontal (F3) $p < 0.05$, right frontal (F4) $p < 0.05$, the left parietal (P3) $p < 0.05$, left occipital (O1) $p < 0.01$, the left anterior temporal lobe (F7) $p < 0.01$, the right anterior temporal lobe (F8) $p < 0.05$, left mid-temporal (T3) $p < 0.05$, right middle-temporal (T4) $p < 0.01$, lower left-tem-

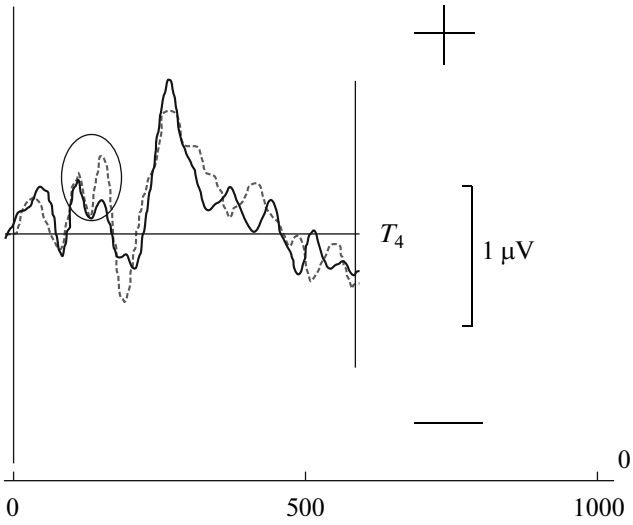

Fig. 2. Example of component N170 VP threatening visual stimuli among a group of healthy subjects (solid line) and patients with schizophrenia (dashed line). Circle indicates the difference in amplitude and latency between patients and healthy this component.

poral (T5) $p < 0.01$, the central frontal (Fz) $p < 0.05$, the central parietal (Pz) $p < 0.01$.

DISCUSSION OF THE RESULTS

When analyzing the amplitude of evoked potentials P100 and N170 components we focused on the area of TPO, as they are located near the projection area. In healthy subjects was observed:

P100 component in TPO positive areas, while in this time interval in the front areas, leads Fp1, Fp2, F3, Fz, F4 in the same component of the negative component is recorded.

N170 component in the areas of TPO in the front area in leads Fp1, Fp2, F3, Fz, F4 in the same component, there are positive indicators of amplitude.

This phenomenon is explained in the literature that are oriented in the interpretation of data on the maximum amplitude of foci induced potentials that reflect the distribution of the electric field on the surface of the head [12]. This does not include the possible orientation and number of sources. When the radial orientation of the source maximum field distribution will coincide with its projection on the underlying convexital surface of the cerebral cortex. On the contrary, when the tangential orientation of the source when it is in the groove of the cerebral hemispheres, positive and negative extremes, depending on the depth of the source, can far removed from its projection on the surface of the scalp, which is the reason for the change of polarity [13].

In our experiment, the majority of patients with schizophrenia polarity P100 and N170 polarity does not change (this phenomenon was observed in only 5 out of a total number of subjects, which is only 12.8%).

Results of the study of visual perception requirements emotionally significant stimuli within a group of healthy shown that threatening stimulus in all sites increased amplitude and shortened latency, thus increasing the level of excitement as early component (P100) and intermediate (N170).

Results of the study of visual perception requirements emotionally significant stimuli within the group of patients with schizophrenia have shown that in all leads decreased the amplitude and increased latency EP threatening stimuli compared with neutral. This may indicate an increase in inhibition in patients in the perception of threatening stimuli in neural networks that generate early component (P100) and an intermediate component (N170). There are studies in which it is noted that in this disease pathological neural responses may depend on the severity of psychotic positive symptoms [14].

Comparison of visual perception requirements emotionally significant stimulus between groups of patients with schizophrenia psychosis and controls showed that the latency component (P100) EP shorter neutral stimulus in patients with schizophrenia compared with the norm, and the amplitude is less than that indicates a distortion of the component (paradoxical effect). A paradoxical effect observed in the perception and emotionally significant incentives between the group of patients with schizophrenia and control subjects, i.e. the component (N170) and the latency and amplitude threatening stimulus schizophrenic patients more than in healthy persons. It could also indicate a problem of perception of emotionally significant stimulus in patients with schizophrenia who are in acute psychosis.

Quite a number of works devoted to the description of the late ERP components (P300). They show that the late ERP components depend on attention, memory and a number of other psychological factors [15]. If you study the late components in schizophrenia studied sufficiently active, the study of early components in the perception of emotionally significant stimulus, as already noted, are not well understood. At the same time, a large number of studies on cognitive function (memory, attention, etc.), which are marked disturbances in schizophrenia [16].

Synchronization of neural networks is one of the most important cortical mechanisms of mental activity. In studies of Tononi and Edelmen (2011) affective perception is viewed through time varying pattern of functional relationship between the prevalence of neural networks, and not as the specific features of any particular group of neurons [17]. Presentation of stimulus actively binds to a common neural network integrated neural process or functional cluster through the thalamo-cortical, cortico-cortical or rienteringovye (return) connection. These authors found that the responses to the stimulus recorded on MEG, become larger, and the cluster is distributed to the front, parietal, temporal and occipital region. This process is accompanied by an increase in neuronal connections between certain areas and intensive interaction between the neural networks. Such differentiation and

integrative implies an active exchange of information between elements within the system.

According to Medkur and other authors in patients with schizophrenia exchange of information between the regions of the brain is disturbed, the severity of these disorders may be due to the severity of psychopathological symptoms productive [18]. These results can be compared with the received data on pathological perception of emotionally significant stimulus.

According to the model "bottom-up"—(ascending activation), neural connections are developed to the central and the anterior part of the cerebral cortex. It is assumed that a violation of neural connections in patients with schizophrenia is particularly aggravated by distributing to the front departments. Further, according to the model "top-down"—(descending activation), in a process apparently involves the premotor cortex, thus enabling the preparation for action, if necessary. In schizophrenia violation downlink and premotor areas impede adequate response inhibition. Based on the assumption Spitzer [19] that in patients with schizophrenia in a psychotic state, the process of disinhibition of neurons and the spread of this activation in neural networks, we believe that excessive activation of neuronal reverberation is a pathological activity of neural networks, resulting in pathological changes occur in the picture VP.

CONCLUSIONS

1. The latency of P100 component of early and intermediate component N170 in healthy subjects shorter threatening emotional stimulus compared to neutral, and the amplitude of the data components, in contrast, more that indicates the predominance of the excitatory process in the perception of affective and meaningful incentives.

2. The latency of P100 component of early and intermediate component N170 in patients with schizophrenia is increased by emotional threatening stimulus compared to neutral, and the amplitude of the data components, by contrast, is reduced, due to the predominance of the process, "the beyond" braking affective important stimulus.

3. Both the latency and amplitude of the P100 component of the early CAP less to neutral stimulus in patients with paranoid schizophrenia compared with healthy, and latency and amplitude of the intermediate component N170 VP greater in patients with schizophrenia than in healthy. Which indicates inadequate perception of emotionally significant stimulus in patients with paranoid schizophrenia in acute psychosis not receiving neuroleptic therapy.

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