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PHYSIOLOGY

Early Afferent Reactions in Caudate Nucleus and Neocortex during Consolidation and Extinction of Conditioned

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Experiments in cats revealed a clear-cut dependence of the early complex (up to 100 msec) of evoked potentials recorded in the caudate nucleus and temporal cortex on biological relevance of the stimulus (presence or absence of alimentary signal), with constant physical parameters. The early complex of evoked potentials can reflect activity of the mechanisms preventing non-specific motor response to exteroceptive stimulus, although it does not exclude processing the stimulus-carried information during generation of evoked potentials.

Key Words: *evoked potentials; caudate nucleus; temporal cortex; exteroceptive stimulus; operant conditioning*

Participation of caudate nucleus (CN) in the formation of behavior is widely discussed [6,9,10,12,13]. It is evidenced not only by the data on behavioral aberrations resulting from damage to CN [2,4,6], but also by the results attesting to the development of functional changes in CN during learning or acquisition of adaptive behavioral reactions [5,7,11]. The accumulated data allow to place this anatomical structure into the class of integrating cerebral subdivisions such as the cerebral cortex. Therefore, it is instructive to consider the relationship between functional changes in CN during leaning and analogous processes in the cortex.

MATERIALS AND METHODS

Functional state of temporal cortex and the head of CN was assessed by the early (up to 100 msec) complex of evoked potential (EP) induced by an acoustic stimulus (click 85 dB, 20 V, 0.5 msec), *i.e.* early afferent response to an exteroceptive stimulus.

Experiments were carried out on 18 cats with chronically implanted electrodes. The surgery was performed under hexenal narcosis (80 mg/kg) in a stereotaxic apparatus according to F. Reinozo-Suares coordinates [14]. The caudate electrodes were implanted bilaterally (A=13; H=0-15; L=15). The cortical electrodes were implanted into the field 22 (A=4; L=15).

Auditory EP were recorded using a referent electrode measuring the integral potential of the parietal and occipital cranial bones. Single EP were analyzed using KAD-03 software.

The following parameters were determined: latency, mean peak time of each component, their incidence (the percentage of evoked components to the number of presentations), and amplitude. The results were analyzed statistically using Student's t test at $p<0.05$.

The changes in the early complexes of auditory EP induced by acquisition and loss of biological relevance by the stimulus were studied simultaneously in CN and temporal cortex (18 cats), recording from 36 points in both CN and from 36 points in temporal cortex of both hemispheres. The incidences of primary-

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positive responses were 91% and 86% in CN and temporal cortex, respectively.

The study was carried out in a screened chamber and consisted of 3 stages: I) the stimulus was biologically indifferent; II) the stimulus was reinforced by food and became the signal in the operant response leading to opening of the shut and taking food; and III) alimentary reinforcement was eliminated (the stimulus loses its biological relevance). Each stage consisted of 12-18 experiments, in which the stimulus was presented 34-38 times with irregular intervals of 1-3 min. The data were grouped in each stage. At stage I, the group consisted of 4 experiments. At stage II, the group 1, 2, and 3 comprised the experiments with 20%, less than 100%, and 100% implementation of the operant response, correspondingly. At stage III, the group 1 and 2 comprised the experiments with more and less than 40% implementation of the operant response, correspondingly, while group 3 was characterized with complete extinction of the operant response.

RESULTS

During stage I, when the stimulus had no biological relevance, the latency, incidence, amplitude, and peak time of both initial components remained unchanged in all points of the examined structures (Fig. 1). During the following stages, the latency and peak time of the early components did not vary, and the change of biological relevance occurring at stages II and III affected only the incidence and amplitude of these components. At stage II, the incidence of the early components in both structures continued to decrease; the amplitude of cortical EP decreased in parallel with its incidence. In most cats, the amplitude of EP in CN decreased at the beginning of stage II, but than it increased in parallel with consolidation of the conditioned reflex and surpassed the initial value, when 100% performance was achieved (Fig. 1). The initial decrease in the amplitude was absent in some cats, and this parameter increased in parallel with consolidation of

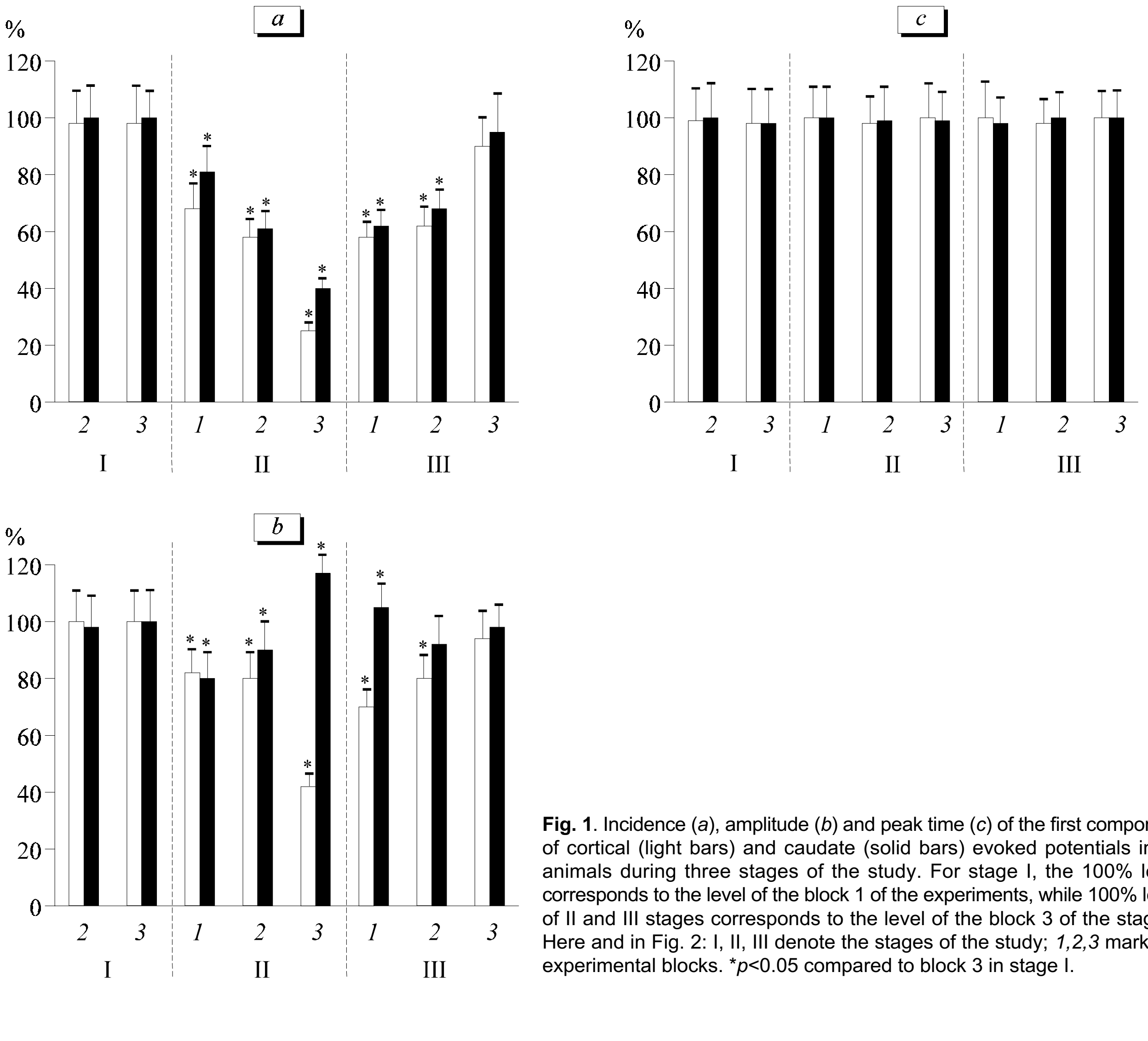

Fig. 1. Incidence (*a*), amplitude (*b*) and peak time (*c*) of the first component of cortical (light bars) and caudate (solid bars) evoked potentials in all animals during three stages of the study. For stage I, the 100% level corresponds to the level of the block 1 of the experiments, while 100% level of II and III stages corresponds to the level of the block 3 of the stage I. Here and in Fig. 2: I, II, III denote the stages of the study; *1,2,3* mark the experimental blocks. *p<0.05 compared to block 3 in stage I.

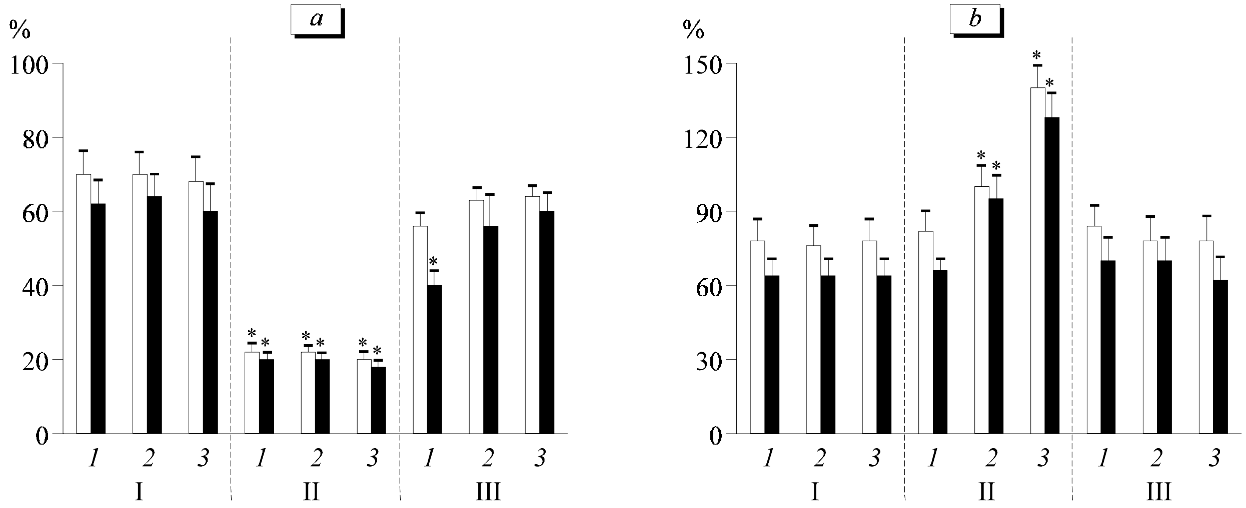

Fig. 2. Incidence (*a*) and amplitude (*b*) of the first component of EP recorded in the head of caudate nuclei in the right (light bars) and left (solid bars) hemispheres in cat 18 during three stages of the study.

the reflex. Therefore, at stage II, the opposite changes in the incidence and amplitude of the early components were observed, while the dynamics of these parameters in the cortex was similar (codirected).

At stage III, the parameters of early EP components in both structures returned to the level of the end of stage I, when the stimulus was biologically indifferent. As expected, the incidence of EP in both structures and the amplitude of cortical responses increased, while the amplitude of caudate responses decreased. Similar results were published elsewhere [1,8].

The opposite changes in the incidence and amplitude of caudate EP were clearly demonstrated in cat 18 (Fig. 2).

Thus, the parameters of early (up to 100 msec) complex of EP in the examined structures demonstrate a clear-cut dependence on biological relevance of the stimulus, whose physical parameters were unchanged. These experimental data contradict the conception that the early components of EP reflect processing of information relating the physical parameters of a stimulus [3].

It can be suggested that changes in EP amplitude result from changes in the number of neurons synchronously responding to the afferent impulse train. The mechanisms determining the responsible for incidence of EP are poorly understood, which impedes interpretation of its changes. The early complex of EP can reflect activity of the mechanisms inhibiting or blocking non-specific motor response to an exteroceptive stimulus. This interpretation of functional importance of EP does not exclude its participation in processing of information contained in the stimulus.

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