International Scientific Journal
Journal of Medical and Biological Sciences
http://bioscience.scientific-journal.com

FUNCTIONAL PECULIARITIES OF HIPPOCAMPAL THETA-RHYTHM

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Abstract. The phenomenon of disappearance of the theta rhythm after lesioning of the septum and fornix has in its time stimulated a series of reports describing attempts to understand the roles of various structures in determining the electrical activity of the hippocampus and the functional significance of the theta rhythm. In chronic experiments with rabbits have shown that electrical destruction of dorsal amygdalofugal pathways leads to complete and persisted blockade of hippocampal theta rhythm in contrast to ventral one. When studies correlation between theta-rhythmand various forms of behavioral electrostimulation and destruction of dorsal and ventral amygdalofugal ways were carried out. The obtained data testify that frequency stripes of theta-rhythm seems reflects a level of activation of the brain structures.

Keywords: hippocampal theta rhythm, dorsal and ventral amygdalofugal pathway, electrostimulation, destruction, behavioral reactions, drinking conditioned reflex.

I. INTRODUCTION

Hippocampal theta rhythm for many years attracts the attention of electrophysiologists. The study of the genesis of hippocampal theta rhythm most often accompanied by a parallel investigation of its correlation with the various forms of behavior. Existing literature data are numerous and contradictory. So theta rhythm is associated with various forms of behavior [1, 2], the orienting-investigative reaction [3], emotional and motivational condition [4], motional acts [5], learning and memory processes, selective attention [6,7] and so on.

In studying the amygdala-hypothalamic interrelations we obtained the differentiated influence of dorsal and ventral amygdalofugal ways in regard to hippocampal theta rhythm. In previous studies, by us is shown a complete and irreversible blockade of rhythmical activity of the hippocampus at destruction the dorsal amygdalofugal way [8]. This led us to conduct a special study to examine the correlation of hippocampal theta rhythm with the various forms of behavior. For this purpose were recorded the time parameters of execution of the conditioned drinking reflex during stimulation and destruction of the dorsal and ventral amigdalofugal ways.

II. METHODS

Experiments were performed using 20 rabbits breeds of “Chinchilla” in weight 2-3kg trained to perform a conditioned operant drinking behavior reflex.

Prior to the experiment, the animals were trained drinking conditioned reflex skills: on the a sound signal commit the jumps and runs compartment of the camera in the targeted in which was located drinking bowl with water and returned back into the starting compartment of experimental chamber. Sound signal is fed at every 45 seconds from 10 to15 times in current of experiment. Throughout the experimental day, animals received an average of 100-120 ml of water. Experiments were carried out in a 100% of training. To investigate the behavior reactions were registered time from the moment the inning of signal before the jump (latent period), the time of jump and running, drinking, and the time taken to return to the starting box of the experimental chamber.

The electrical stimulation of the dorsal (A-1; L3,2; H11,5) and ventral (P5; L6; H15,8) amygdalofugal pathways was performed using an ÉSU-1 stimulator by rectangular pulses 50-200 mA, frequency of 10-20 Hz, 0.5 msec duration. With the help of high-frequency diathermy apparatus UDL-200M was produced electrolytic destruction of the dorsal and ventral amigdalofugal ways. We used a current of up to 1.0 mA, which was fed during the 15-25 seconds.

III. RESULTS AND DISCUSSION

The results of these experiments showed that the baseline hippocampal and septal EEG demonstrated irregular activity dominated by oscillations in the

range 4–6 Hz. Comparison of the electrical activity of the hippocampus and different fragments of conditioned reflex reactions supported the presence of a marked correlation of the theta rhythm with forms of behaviour such as resting (irregular theta rhythm with a frequency of 4-6 Hz), jumps and runs (regular theta rhythm with a frequency of 7.5-12 Hz), and licking (regular theta rhythm with a frequency of 5-6 Hz). The electrical stimulation of the dorsal amygdalafugal way, as well as ventral, from the first minutes was observed emergence of signs of emotional concern. In connection with this was increased the latent period of reaction from 1.23±0.07 to 3.23±0.07 sek. Other parameters of the conditioned reflex remained at background values and accounted: jumps and runs 3,23±0,07 sek; licking 20,13±0,14 sek; inverse returning 4,25±0,07 sek. (Fig.1).

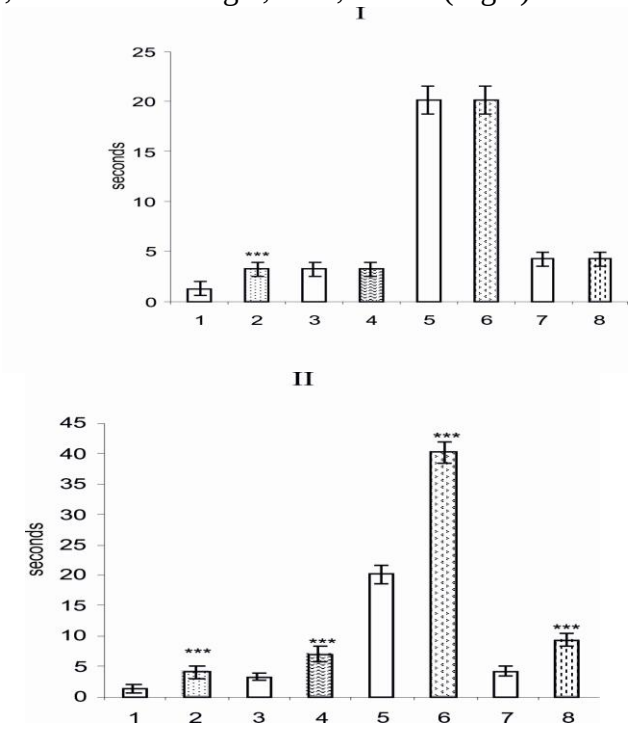

*Fig. 1. Influence of electrostimulation (I) and electrolytic destruction of the dorsal amygdalofugal pathway (II) for execution generated drinking skill. 1,3,5,7 - latent period, a jump and running, to drink the water and return before (I); 2,4,6,8 - after stimulation (I) and destruction (II) of the DAW. Credibility these distinctions respect to the control:*** - P <0.001.*

Electrical destruction of dorsal amygdalofugal pathways leads to complete and persisted blockade of hippocampal theta rhythm in contrast to ventral one. In the event of damage the dorsal amygdalafugal way were observed depressed state. It increases the latent period of from 1.3±0.07 to 4.03±0.1 sec, jumps and runs of from 3.23±0.17 to 7.03 sek, licking of from 20.13±0.1 to 40.17±0.2 sek and inverse returning of from 4.23±0.07 to 9.43±0.1 sek. When a unilateral electrolytic destruction of the ventral amigdalofugal ways observed enhancement orienting-investigative reaction, which is accompanied by a increase of time the jump and runs (from 3.27±0.07 to 7.5±0.1sek) and reverse returning (from 4.27±0.07 to 8,5±0,1 sek). Other parameters of the conditioned reflex remained at background values (Fig.2).

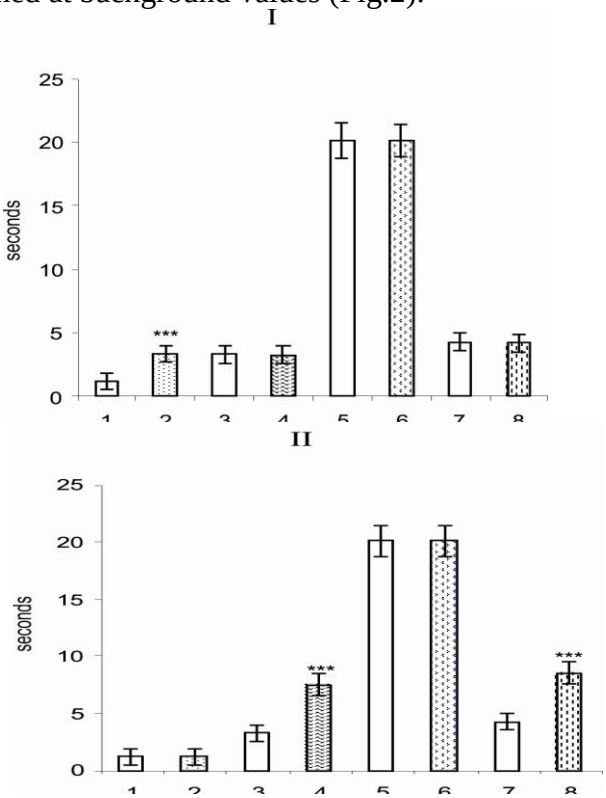

*Fig. 2. Influence of electrostimulation (I) and electrolytic destruction of the ventral amygdalofugal pathway (II) for execution generated drinking skill. 1,3,5,7 - latent period, a jump and running, to drink the water and return before (I); 2,4,6,8 - after stimulation (I) and destruction (II) of the VAP. Credibility these distinctions respect to the control:*** - P <0.001.*

Electrical stimulation of dorsal amygdalofugal ways unlike of ventral resulted in an increase of consumption of water, that is leading to the emergence of thirst. Over the entire period of the experiment the amount of water was increased by 2 times and amounted to 200-250 ml (Fig. 3). The unilateral damage to of dorsal amygdalofugal ways as well as the ventral had no effect on the amount of water consumed (Fig. 4).

On the basis of our investigations we can assume that a unilateral damage to of dorsal amigdalofugal ways leads to irreversible blockade of hippocampal theta rhythm [9] and does not cause violation of the execution conditioned reflex drinking skill. While the destruction of the anterior hypothalamus supraoptic

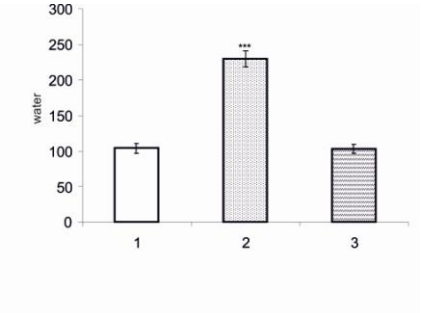

*Fig. 3. Change the number of water consumption as a result of electrical electrical stimulation and destruction of dorsal amygdalofugal pathway 1 - background 2.3 - after the electrical stimulation and destruction of DAP, respectively. Credibility these distinctions respect to the control:*** - P <0.001.*

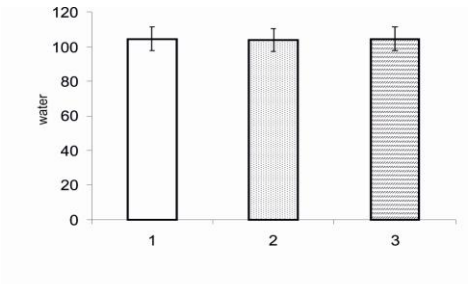

*Fig. 4. Change the number of water consumption as a result of electrical electrical stimulation and destruction of ventral amygdalofugal pathway 1 - background 2.3 - after the electrical stimulation and destruction of VAP, respectively. Credibility these distinctions respect to the control:*** - P <0.001.*

nucleus leading to disruption of the motivational drinking behavior because of the arisen hypodipsia without causing disappearance of hippocampal theta activity [10]. The main feature of our data is the fact that in conditions of coagulation of the dorsal amygdalofugal ways we did not observe changes in the amplitude-frequency amplitude-frequency characteristics of the EEG, but profound and long-lasting depression of the overall electrical activity of various hippocampal fields, including the septum, while there were no great changes in the performance of previously acquired conditioned reflex activity.

All of the above allows concluding that, apparently, the presence of hippocampal theta rhythm is not a prerequisite for the implementation movement. Similar results were obtained in studies of some researchers [11,12,13], who believe that the theta rhythm reflects the state of a tonus of the central nervous system. In these works [11] is shown that a major correlate memorization is the level of activation of brain structures, and the theta rhythm is probably is one of the correlates of this activation. Existing literature data testify that the availability of theta activity is not the main condition for the appearance of orienting-research reflex , with which it is bound [14].

The obtained data testify that the frequency range incidence of theta-rhythm seems not to be necessary for the realization of thos and other varieties of movement. First of all they reflect the certain level sof activity in brain structures which are necessary for realization of studied behavior forms.

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