HIPPOCAMPAL UNIT ACTIVITY IN ACUTE EXPERIMENTS WITH GALLAMINE AND CHRONIC EXPERIMENTS WITHOUT MUSCLE RELAXANTS

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Hippocampal unit activity of hens during acute experiments with gallamine differs from the same activity in chronic experiments. In chronic experiments an increase in excitability of the hippocampal neurons and changes in their functional mobility and the character of their responses to acoustic stimuli were observed, compared with these parameters in chronic experiments.

Few investigations have been made of the activity of single neurons in hens [2, 3, 6, 8]. Because of the great complexity of microelectrode experiments under chronic conditions, most investigations have been undertaken in acute experiments with the use of muscle relaxants. The writers studied hippocampal unit activity in hens originally [3] under acute experimental conditions. By means of a special technique it then became possible to continue investigations of unit activity under chronic experimental conditions.

The object of this investigation was to compare activity of hippocampal cells under acute (using gallamine) and chronic (without muscle relaxants) experimental conditions.

EXPERIMENTAL METHOD

Acute experiments were carried out on Leghorn hens immobilized with gallamine (0.9-1.2 mg/kg) and maintained on artificial respiration. A tube was first passed through the mouth into the trachea. The skin incision in the head was made under local anesthesia (2% procaine solution). A hole 2-3 mm in diameter was drilled in the parietal region of the skull. The hen was then placed in a frame, and the head was fixed in a special halter. In the acute and chronic experiments glass microelectrodes with a resistance of 5-15 MΩ were inserted into the hippocampus in the region of coordinates A 8-9 from the atlas of Tienhoven and Juhasz [9]. Chronic experiments were performed on 10 hens. Using a technique similar to that developed previously for experiments on cats [10], a plate was fixed to the hen's head 7-10 days before the experiment. A hole for the microelectrode was drilled before the experiment began above the hippocampal region to correspond to the coordinates mentioned above. The hen's head was then fixed in a special frame by means of the plate secured to the head.

To record potentials a physiological apparatus of the UÉF-PT type was used. Spikes generated by the neurons were counted by means of a type Ch3-4A electronic frequency meter. The stimuli used were a pure tone (2000 Hz, 80 dB above the human threshold of audibility) and a danger cry of the same loudness, emitted by the hen and recorded on magnetic tape. The duration of the stimuli was 6 sec and the interval between them 10-30 sec.

In the acute experiments 122 neurons were tested and 175 in the chronic. The results were subjected to statistical analysis using the Wilcoxon, Mann–Whitney, and Student criteria.

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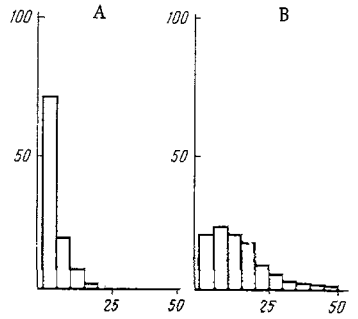

Fig. 1. Histograms of frequency of spontaneous hippocampal unit activity of hens in chronic (A) and acute (B) experiments. Abscissa, frequency of spontaneous activity (spikes/sec); ordinate, number of cases (in %).

EXPERIMENTAL RESULTS AND DISCUSSION

In the chronic experiments the most typical spontaneous activity of the hippocampal neurons had a frequency of 1-5/sec, compared with 6-10/sec in the acute experiments (Fig. 1). The mean frequency of spontaneous activity in the acute experiments was considerably higher (13.7/sec) than in the chronic experiments (4.4/sec). These results suggest that under acute experimental conditions excitability of the hippocampal cells is increased. This is shown not only by an increase in the frequency of spontaneous unit activity in the hens, but also by an increase in the magnitude of the hippocampal unit responses to acoustic stimuli: in the acute experiments the magnitude of the unit responses to the danger cry was 85% of the initial background compared with 55% in the chronic experiments ($P = 0.05$).

The number of cells responding to acoustic stimuli was the same in the acute and chronic experiments: 68% of cells tested responded by a change in the spontaneous firing rate to the pure tone and 93% to the danger cry. At the same time it must be noted that when the acoustic stimulus (cry or tone) was applied after a short time interval (6 sec) in the acute experiments fewer of the hippocampal neurons (34%) responded to the cry than under chronic experimental conditions (71%; $P = 0.05$). Similar differences also were observed during the action of the tone. These facts suggest that under acute experimental conditions there is not only an increase in excitability but also, evidently, a decrease in the functional mobility of the hippocampal neurons. This hypothesis is supported by the increase in number of responding cells in the acute experiments with a change in the interval between stimuli from 6 to 20 sec.

In the acute experiments, of the total number of cells responding to the tone 53% of neurons did so by an increase in the spontaneous firing rate, 32% by a decrease, and 15% by both a decrease and an increase. In the chronic experiments 30% of neurons responded to the tone by an increase in the spontaneous firing rate, 50% by a decrease, and 20% by an increase followed by a decrease. In the acute experiments most of the hippocampal cells thus responded to acoustic stimuli by an increase in the spontaneous firing rate, while in the chronic experiments most responded by a decrease. Considering the results obtained by Anichkov and Belen'kii [1], showing that muscle relaxants limit their actions to nicotine-like cholinergic systems of skeletal muscles only in small doses, and that with an increase in the dose other nicotine-like cholinergic systems are affected, and also considering the evidence [7] of permeability of the blood–brain barrier in hens, the writers are inclined to believe that the change in the functional state of the hippocampal cells under acute experimental conditions must be attributed not only to traumatic factors, but also to the effect of gallamine. This conclusion is supported by investigations [4, 5] into the effect of gallamine and tubocurarine on hippocampal electrical activity (when the drugs were injected into the hippocampal cells or into the cerebral ventricles). This work showed that these drugs cause excitation of the hippocampus. This effect was explained by blocking of inhibitory synapses. The present writers consider that the change in character of the hippocampal unit responses in the acute experiments (an increase in the spontaneous firing rate in response to the action of acoustic stimuli instead of a decrease) must also evidently be explained by the blocking action of gallamine on inhibitory synapses. The possibility cannot be ruled out that the same mechanism lies at the basis of the decrease in the functional mobility of the hippocampal cells.

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