IMPULSE ACTIVITY OF NEURONS OF THE PARIETAL ASSOCIATIVE CORTEX IN CONDITIONED INSTRUMENTAL FOOD-PROCURING BEHAVIOR OF CATS

L. A. Daudova

UDC 612.822.3+612.821.6

The attention of many investigators has been directed in recent times to the elucidation of the role of the associative region of the neocortex in the organization of goal-directed behavior [2, 4]. Its participation has been identified in the organization of complex goal-directed movement, in the perception of the "body schema", and in correct orientation in space, as well as in orientational-exploratory [2, 5]. At the same time, until recently substantially less attention has been devoted to the parietal associative cortex by comparison with other associative lobes of the cerebral cortex. The degree of participation of the neurons of the parietal associative region of the cerebral is in the accomplishment of the various stages of integrated behavioral acts.

The aim of the present study consisted in the investigation of the features of the dynamics of the activity of neurons of the parietal associative region of the cerebral cortex at various stages of accomplishment of conditioned instrumental food-procuring behavior.

An instrumental alimentary conditioned reaction was selected as the experimental model. The experiments were carried out in six cats. The animals were brought into the experiment following a one-day deprivation of food. The cats were preliminarily trained to the instrumental act of pedal-pressing, which led, 900 msec from the moment of pressing, to the delivery of 1 ml of milk into the food dispenser. Following the consolidation of this skill, a conditioned instrumental reaction was developed in the animal, using a 1000 Hz acoustic signal as the conditional stimulus. The recording of the neuronal activity of the parietal associative cerebral cortex (g. splenialis) was begun following the consolidation of the skill.

A decrease and stabilization in the coefficient of variance of the duration of the intervals between the sequential performances of the instrumental action was the objective indicator of the consolidation of the skill during learning. The impulse activity was recorded by glass microelectrodes on a multichannel magnetograph simultaneously with the markers of behavior, and were reproduced on an ink-writing recorder with reduction of the speed of movement of the magnetic tape. The experiments were carried out three to four days after the operation fixing the micromanipulator on the cat's skull. The dynamics of one and the same neuron were investigated by means of the plotting of stage-by-stage scans and the construction of summary histograms during a one-time performance by the cat of the consolidated instrumental act in the time segment from the moment of the switching on of the conditional signal to the removal of the muzzle from the food dispenser after lapping.

The impulse activity of 31 cortical neurons was recorded and analyzed. The fact that one and the same neuron did not manifest the identical activity in each case during the animal's repeated accomplishment of the monotypal instrumental behavior was noteworthy. However, the construction of the summary histogram made it possible to establish the features of the change in the impulse activity of specific neurons at the stages of behavior analyzed. The results of the analysis of the specific character of the dynamics of the change in the impulse activity of the parietal associative region of the cerebral cortex at different stages of the accomplishment of the conditioned instrumental food-procuring behavior are presented in Table 1. As can be seen from Table 1, the majority of the neurons investigated increased their impulse activity at the stage of the perception of the conditional signal (Fig. 1).

The majority of neurons investigated at the stages of the animals' behavior associated with the pressing on the pedal with the paw, the lowering of the muzzle into the food dispenser, and its extraction, decreased their impulse activity (Fig. 2). At the moment of the animal's perception of the appearance of the milk in the food dispenser, an almost equal number of cortical neurons increased and decreased their impulse activity (see Table 1).

Comparative analysis of the dynamics of the reorganization of the impulse activity of each neuron investigated at sequential stages of behavior demonstrates individual differences in the activity of the nerve cells at different stages of behavior. In-

P. K Anokhin Institute of Normal Physiology, Academy of Medical Sciences of the USSR, Moscow. Translated from Zhurnal Vysshei Nervnoi Deyatel'nosti imeni I. P. Pavlova, Vol. 41, No. 2, pp. 415–418, March–April, 1991. Original article submitted April 28, 1990; revision submitted October 31, 1990.

 0009-3122/91/2701-0142$12.50

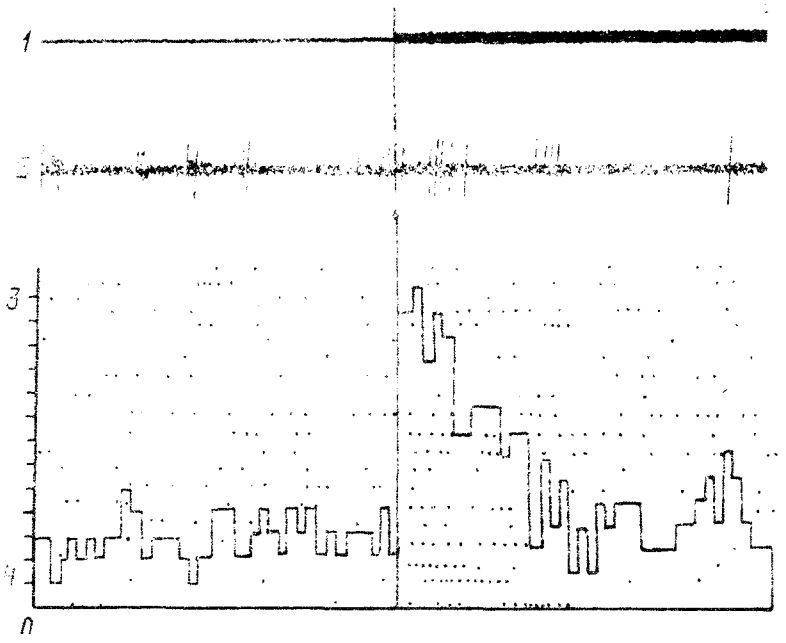

Fig. 1. Impulse activity of a neuron of the parietal associative region of the cortex, increasing upon the turning on of a conditional acoustic signal. 1) Marker of behavior; 2) neurogram; 3) raster of impulse activity of the neuron; 4) summary histogram. Vertical line, the moment of the turning on of the sound. Along the abscissa: time (width of the histogram channel 25 msec); along the ordinate: number of spikes in a channel.

TABLE 1. Character of the Changes in the Impulse Activity of Neurons of the Parietal Region of the Cerebral Cortex at Sequential Stages of a Goal-Directed Behavioral Act

Character of the changes	Stages of the behavior				
	conditional acoustic signal	pedal pressing by animal	appearance of milk in the food dispenser	lowering of muzzle into food dispenser	withdrawal of muzzle from food dispenser
Activation	26 (83.9%)	6 (19.4%)	13 (41.9%)	4 (12.9%)	12 (38.7%)
Inhibition	4 (12.9%)	17 (54.8%)	14 (45.2%)	21 (67.7%)	18 (58.1%)
Areactivity	1 (3.2%)	8 (25.8%)	4 (12.9%)	6 (19.4%)	1 (3.2%)

dividual neurons of the parietal associative cortex altered activity in the process of the animal's performance of the behavioral act only at some stages of behavior and were areactive at others. Thus, each stage of the conditioned instrumental food-procuring behavior of the animal was characterized by a collection of neurons reorganizing their impulse activity to various degrees.

These investigations showed that the neurons of the parietal associative cerebral cortex of the cat had an individual pattern of the changes in impulse activity at sequential stages of behavior of the conditioned instrumental alimentary behavior they performed. At the same time, the activation of the greatest number of neurons at the moment of the switching on of the acoustic signal and the appearance of the milk in the food dispenser (visual perception) makes it possible to imagine an association of these cells with the mechanisms of perception by the animal of external influences which have concrete informational significance at these stages of behavior. The multimodality of the perceived afferent signals by individual neurons is explained by the great convergent capacity of the neurons of the parietal associative cerebral cortex, as well as by its pronounced integrative functions [3].

The decrease in the impulse activity of the majority of the neurons investigated at the stages of behavior associated with movement (pressing on the pedal with the paw, lowering of the muzzle into the food dispenser, and its extraction) apparently reflects the integrative mechanisms of attention and choice of goal [2]. Since the pressing on the pedal with the paw and low-

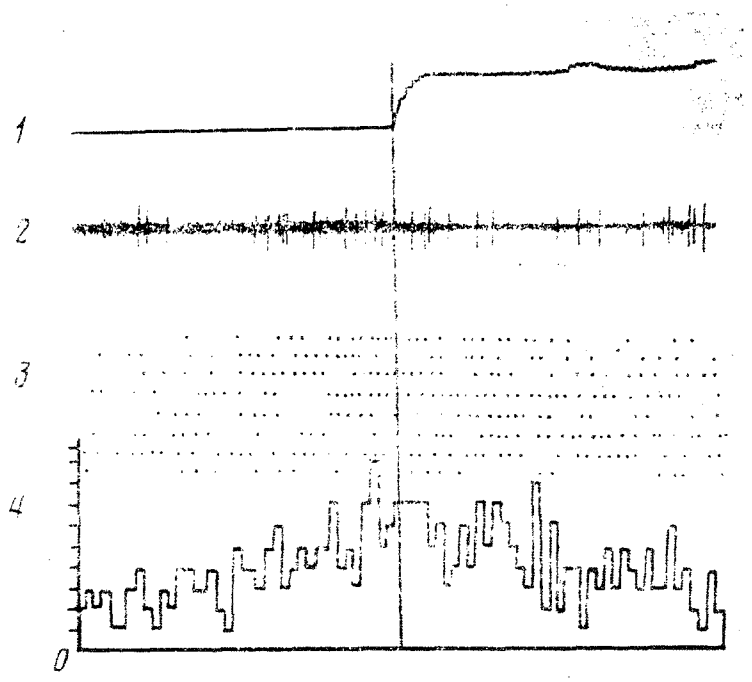

Fig. 2. Impulse activity of a neuron of the parietal associative region of the cortex, associated with the lowering of the animal's muzzle into food dispenser. 1) Marker of behavior - the lowering of the animal's muzzle into the food dispenser. Vertical line, the beginning of the lowering of the muzzle. Other designations as in Fig. 1.

ering of the muzzle into the food dispenser assured the animal the obtaining of useful results (the obtaining of milk and lapping, respectively), it can be conjectured that the features of the dynamics of the change in the impulse activity of the neurons investigated is in many respects determined by "reverse" afferentation which informs the central nervous system of the achievement of stage-related and final useful results of the behavioral act [1]. The possibility of such reorganizations of the impulse activity of neurons of the visual and sensorimotor regions of the cerebral cortex has been convincingly demonstrated in a number of investigations [2, 3].

It can be concluded on the basis of these experiments that the neurons of the parietal associative region of the cerebral cortex can selectively reorganize their impulse activity at one or several stages of conditioned instrumental alimentary behavior, which can be regarded as a sequential change in the integrative activity of individual nerve cells.

LITERATURE CITED

1. P. K Anokhin, "The systemic analysis of the integrative activity of the neuron," *Uspekhi Fiziol. Nauk*, **5**, No. 1, 5–52 (1974).
2. A. S. Batuev, *Associative Systems of the Brain* [in Russian], Nauka, Leningrad (1985).
3. Yu. A. Fadeev, *Neurons of the Cerebral Cortex in the Systemic Organization of Behavior* [in Russian], Meditsina, Moscow (1988).
4. L. V. Cherenkova and Yu. A. Yunatov, "The influence of damage to the associative zones of the neocortex on visual-motor cortex in cats," *Zhurn. Vyssh. Nervn. Deyat.*, **3**, No. 5, 954–963 (1980).
5. I. Hyvarinen, "Posterior parietal lobe of the primate brain," *Physiol. Rev.*, **62**, 1060–1129 (1982).