AUTO- AND CROSS-CORRELATION ANALYSIS OF UNIT RESPONSES IN THE VASOMOTOR CENTER TO ADEQUATE VESTIBULAR STIMULATION

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The relationship between the activity of 81 neurons in the vasomotor center and the pulse wave of arterial pressure was investigated by auto- and cross-correlation analysis. Two types of unit responses to movement of the test bench in a vertical plane were discovered: type I) reproduction of the rhythm of swinging, and type II) no connection with swinging.

In previous investigations [4] the effect of adequate vestibular stimulation (swinging the animal on a test bench in the vertical plane with an acceleration of 0.8–1.2 g) on unit activity in the vasomotor center was investigated. Five types of unit response characterized by modification of the rhythm curing swinging were discovered.

To continue the study of the character of the unit responses in greater detail, in the investigation described below an auto- and cross-correlation analysis was made by the digital filtration method [1-3]. The purpose of the analysis was to determine the correlation between a discrete value (intervals between the spikes) and continuous values (amplitude of the pulse wave of the arterial pressure under normal conditions and the magnitude of the overload acting during swinging).

EXPERIMENTAL METHOD

Experiments were carried out on cats lightly anesthetized with chloralose and nembutal. Unit activity of the vasomotor neurons was recorded extracellularly. A metal microelectrode was introduced into the region of the reticular formation in the floor of the 4th ventricle, using Alexander's scheme [5].

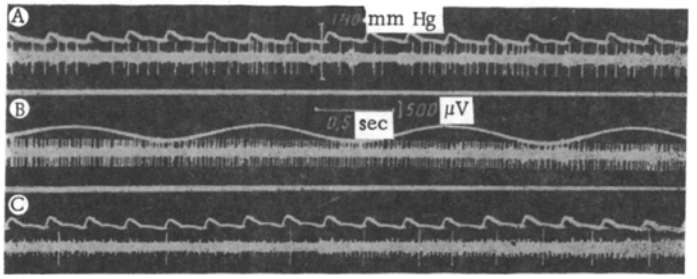

Fig. 1. Unit activity of a vacomotor neuron. A) Background activity; B) unit response to swinging; C) after-activity of neuron. Records are not continuous. Top beam: in A, C – arterial pressure; in B – amplitude of overload.

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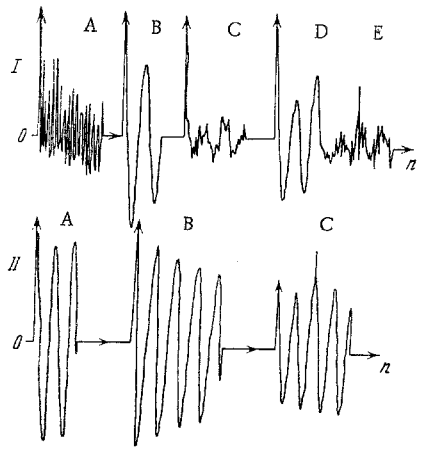

Fig. 2. Graphs of auto-correlation functions of the vasomotor neuron whose spike activity is shown in Fig. 1. I: A) graph of original function of initial background arterial pressure record; B) application of digital filtration method (smooth curve drawn through the points); C) graph of original auto-correlation function of unit activity; D) smoothed-out curve of auto-correlation function of unit activity; E) graph of cross-correlation function between smoothed auto-correlation function of unit activity and recording of arterial pressure. II: A) smoothed-out graph of auto-correlation function and unit activity during swinging; B) graph of amplitude of swinging; C) graph of cross-correlation function between unit activity and amplitude of swinging. Abscissa, serial number of interspike interval; ordinate, values of standardized correlation function.

Unit activity and the pulse wave of the arterial pressure were recorded simultaneously by motion picture camera from the screen of a dual-beam ÉMOF2-01 cathode-ray oscilloscope on photographic film. During swinging, instead of the pulse wave of arterial pressure, the amplitude of the overload was recorded.

To detect the unit response to swinging, the number of spikes generated during a time interval of 0.083 sec and the magnitude of the overload corresponding to the middle of this interval were determined. The time interval for a recording speed of 6 cm/sec corresponded to the distance between two perforations on standard 36-mm motion-picture film From the series of numbers obtained, auto-correlation functions were plotted using the digital filtration method. If a periodic component was present in the spike activity corresponding to the frequency of swinging, graphs of the cross-correlation functions between unit activity and the overload were plotted, and the phase shift between these values was determined.

To detect the correlation between unit activity and the pulse waves of the arterial pressure, successive inter-spike intervals and the amplitude of the pulse wave of the arterial pressure were determined. After calculation of the auto-correlation functions (using the digital filtration method), the duration of the period obtained in the unit activity on an actual time scale were determined and compared with the periods obtained by analysis of the arterial pressure curve.

EXPERIMENTAL RESULTS

Responses of 81 neurons in the vasomotor center were analyzed. A consecutive recording of unit activity of a vasomotor neuron is shown in Fig. 1. During swinging (Fig. 1B) the number of spikes per unit time was appreciably increased, but no direct connection with swinging could be detected visually. Other neurons responded by a decrease in activity to vestibular stimulation. As a result of the analysis 58 neurons reproducing the rhythm of swinging were detected. The phase shift between the beginning of movement of the bench (up–down) and the unit response varied from 0 (20 neurons) to 0.664 sec.

On the graph of the auto-correlation function of the vasomotor neuron (Fig. 2, II, A), a new rhythm equal to the rhythm of swinging was discovered. Consequently, the rhythm of swinging was bound on the unit activity of the vasomotor neuron. The peak on the graph of the cross-correlation function (Fig. 2, II, C) shows a phase shift of the onset of the response which depends on movement of the test bench, and in this case, its value was 0 (unit activity reproduced the rhythm of swinging after the first few seconds of movement of the bench).

In 23 neurons no direct connection was found between unit activity and swinging. It was decided to analyze the background activity of the neuron and its connection with the pulse waves of arterial pressure. However, because of the complexity of the method of analysis, only 6 neurons could be studied from this point of view, and in 2 cases a definite correlation was found between unit activity and the pulse waves of pressure. On the graph of the auto-correlation function of background activity (Fig. 2, I, D), a rhythm corresponding to the rhythm of the pulse wave of arterial pressure was discovered.

The use of the method of auto- and cross-correlation analysis thus reveals two types of vasomotor neurons: type I) neurons reproducing the rhythm of swinging (the neuron acquired a new rhythm, bound with the up–down movement of the bench), type II) neurons not demonstrating such a connection.

LITERATURE CITED

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