REAL NEURON ASSEMBLIES FORMING DURING SCREEN
STRUCTURE ACTIVITIES OF THE BRAIN

A. B. Kogan

The assembly organization of neuron reactions is a specific peculiarity of the screen structures of which the projection fields of the higher parts of the brain are composed. Such an organization is characterized by the local synergism of the responses of neuron groups interacting antagonistically, in contrast to the global neuron synergism of the nuclear segmental structures and the individual neuron antagonism of diffuse unspecific structures. Another characteristic feature of assembly organization is the presumable participation of neurons in the reaction of the assembly which warrants the flexibility and reliability of the realization of central functions. Of interest is the phylogenetic decrease in size and increase in number of working assemblies per unit area of projection field which enhances the resolving power of the analyzer. In different analyzer fields under the action of different stimuli a constant relationship of the reactions is found, i.e., two excited neurons to one inhibited neuron. Apparently, this proportion underlies the organization of balanced assemblies. The inadequacy of the stimuli and the deterioration of the functional state of the brain favor the "spreading" of assemblies; they increase in size, but at the same time the close correlation is lost between the impulse currents of the incoming neurons.

The accumulation of data on the functional organization of the mechanisms of the central nervous system made it possible to draw the conclusion that this organization is based on the formation of specific internally integrated populations of nerve cells called "neuron assemblies" [17, 22]. Several suggestions have been made as to the nature of similar assemblies, the significance of feedback connections, and the mosaic nature of the functional structures forming them. The formation of neuron assemblies is considered an element of the training mechanism [20] or the prototype of the standard processes of higher nervous activity [3]. This theoretical conception is very important in understanding the high efficiency of analytic and synthetic processes in the brain. The notion on the probability-statistical organization of the higher parts of the brain is based on the part played by dynamic assemblies [8].

But up to now, the notion "neuron assembly" remained hypothetical and was not associated with the properties of the concrete central nervous mechanisms in spite of many facts indicative of the presence of definite regularities in the interrelations of the reactions of nerve cells connected by a common structural and functional organization [9, 11, 12, 19, 21, 24, 26]. This paper deals with the results obtained in a study of the forms of interrelation of neuron reactions in various central nervous structures which made it possible to define the conditions for the formation of neuron assemblies and to describe the fundamental characteristics and properties.

EXPERIMENTAL MATERIAL AND METHODS

The interrelations of the impulse activity of two or more neurons recorded simultaneously were studied in structures representing the main types of nervous organization: 1) nodal-segmental (subpharyngeal ganglion in the snail); 2) diffuse unspecific (formatio reticularis of the medulla oblongata in the frog); and 3) "screening" hemispheral (visual cortex of the frog's brain, visual and somatosensory cortex of the cerebrum in mammals). The tests in our laboratory concerned Roman snails [5], frogs paralyzed by curare [14, 15], rats under artificial respiration after introduction of tubocurarine [13], guinea pigs restricted in...
their mobility [6], and rabbits and cats treated with barbiturates [9]. For the mathematical processing of the parameters describing the dynamics of the correlation between the impulse currents of the neurons studied, caused by afferent stimuli, a "Dnepr-1" computer incorporated in a complex electrophysiological apparatus was used.

RESULTS AND DISCUSSION

Comparing the interrelation of impulse currents of neuron elements in structures of various types of organization made it possible to elucidate a number of specific peculiarities of the interaction of neuron reaction in screening-type structures.

1. Synergism of Neurons in the Group and Antagonism of Group Reactions

The peripheral location of giant cells in the subpharyngeal ganglion of the Roman snail made it possible to derive under visual control the intracellular impulse potentials of neighboring neurons (Fig. 1A), neurons in different parts of the nucleus (Fig. 1B), and neurons of different nuclei (Fig. 1C). This showed clearly the global synergism characteristic of segmental nuclear organization of the reactions of all neurons of a given functional nucleus which is known, by way of example, for the motor nuclei of the spinal cord [25]. Such a global reaction has no inner differentiation which could be considered the manifestation of an assembly structure.

In the forma reticularis of the medulla oblongata predominantly antagonistic relations became manifest between neighboring neurons (Fig. 2A), causing conformity as well as antagonism of the reactions of neurons spaced at various distances from each other (Fig. 2B). With such an individual antagonism of neurons, indications of group integration which might be considered manifestations of assembly formation were absent.

Other relations of neuron reactions were found by studying the projection fields of analyzers for which the screen structure is characteristic. Here, as a rule, neighboring neurons reacted synergistically (Fig. 3A), so differing from the neurons of diffuse structures. This, however, was not the above-mentioned global