H-patterns in activity of single neurons

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Although transitions between states of synchronous and asynchronous activity in neural pools have been known for decades [1], their computational power for neuronal systems has been discovered only recently by Hopfield and Broudy [2, 3]. Individual neurons participating in synchronized neuronal pools have the following salient property: in the synchronous state, they fire at constant frequencies of the basic oscillatory process of the pool with possible firing omissions during certain periods of the basic process [3]. We report here observation of these Hopfield's patterns (H-patterns) of activity in archived data of diverse types of neurons, recorded in non-anesthetized animals (rabbit and cat) in various experimental conditions [4-6]. In all experiments only single electrodes were used to record neuronal activity. Interspike intervals of 35 neurons (19 from the rabbit motor cortex, 9 from the cat motor cortex and 7 from cat medulla; not less than 4000 (range 4000 - 34000) intervals for each neuron) were screened for the presence of H-patterns (a series of intervals, T_i, i = 1, ..., k_{max}, such that (T_i /min{ T_i }) = 1, 2 or 3 with a precision not less than 0.025). In 12 of 35 neurons the presence of H-patterns was revealed ($P<0.001$, 12 = 9(of 19) + 1(of 9)+2(of 6)). Activity of neurons with the identified H-patterns was further examined visually over 100 interspike intervals, with the H-patterns in the middle of the samples. In one case (rabbit) a sequence of 8 intervals of 50 ms duration (with two "misplaced" intervals in the middle) was detected. Other types of repeated activity patterns were found in the immediate vicinity of H-patterns in the analyzed sequences of impulses. Thus, we have demonstrated that specific patterns of neuronal activity described in the neural network model of perception [3] can be routinely detected in activity of diverse neuronal populations. Their presence may be an indicator of involvement of the neurons in neuronal ensembles whose operation depends on neuronal synchrony. The latter factor should be considered in computational models of the corresponding functional systems.

References

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