POPULATION CODING OF STIMULUS LOCATION IN RAT BARREL CORTEX

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It is generally believed that sensory events are encoded in cortex by numerous spikes distributed across large neuronal populations. This makes the code used by neural populations to convey sensory information potentially highly complex. Hence it has been difficult to determine rigorously which aspects of spike trains are really essential for carrying information. In our view, two fundamental questions can help guide the inquiry. First, do neuronal populations convey messages by spike timing with millisecond-precision or by spike counts accumulated over periods that are long compared to the typical inter-spike interval? Second, are the basic information units of the neural code independent spikes, or are correlations between the spikes a key component of the neural code? To answer these questions, we have applied a recently developed information theoretic formalism [1] to single neurons and pairs recorded simultaneously from rat somatosensory cortex. We quantified the roles of individual spikes and neuronal correlations in encoding whisker stimulus location [2,3]. We found that 83% of the total information was contained in the timing of individual spikes: first spike time was particularly crucial and it carried almost all the information present in individual spikes. Correlations between spikes emitted by the same neuron accounted for the remaining 17%. Interestingly, cross-neuronal correlation carried no information at all. Neuron pairs located in the same barrel-column coded redundantly, whereas pairs in neighboring barrel-columns coded independently. The barrel cortical population code for stimulus location appears to be the time of first post-stimulus spike of each neuron – a fast, robust coding mechanism that does not rely on "synergy" in cross-neuronal correlations.

References

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