Fast coding of orientation in primary visual cortex

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Understanding how populations of neurons encode sensory information is a major goal of systems neuroscience. Attempts to answer this question have mainly focused on responses measured over several hundred milliseconds, a duration much longer than that frequently used by animals to make decisions about the environment. How reliably sensory information is encoded on briefer time scales, and how best to extract this information, is unknown. Here we analyze a latency based decoding algorithm using the framework of a statistical model for the responses of a hypercolumn population in the primary visual cortex responding to the orientation of a visual stimulus. The accuracy of this decoder is analyzed and the effects of the different parameters that characterize the neural response are elucidated. Next we apply this decoding algorithm to responses of neural populations recorded in primary visual cortex of macaque monkeys. We find that almost as much information can be extracted from the first few spikes as from firing rates measured over much longer durations. Our results provide a novel mechanism for extracting information from neural populations over the very brief time scales in which behavioral judgments must sometimes be made.