

Temporal resolution of ensemble visual motion signals in primate retina

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Recent studies have examined the temporal precision of spiking in visual system neurons, but less is known about the time scale that is relevant for behaviorally important visual computations. We examined how spatio-temporal patterns of spikes in ensembles of primate retinal ganglion cells convey visual motion information to the brain. The direction of motion of a bar was estimated by comparing the timing of responses in ensembles of parasol (magnocellular-projecting) retinal ganglion cells recorded simultaneously, using a cross-correlation approach similar to standard models of motion sensing. To identify the temporal resolution of motion signals, spike trains were low-pass filtered before estimating the direction of motion. The filter time constant that resulted in most accurate motion sensing was in the range 10-50 ms for a range of stimulus speeds and contrasts, and approached a lower limit of approximately 10 ms at high speeds and contrasts. This time constant was on average comparable to the length of inter-spike intervals. These findings suggest that cortical neurons could filter their inputs on a time scale of tens of milliseconds, rather than relying on the precise times of individual input spikes, to sense motion most reliably.

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