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 activity 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 simultaneously recorded, 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 time scale that yielded most accurate motion sensing was 10-50 ms for a range of stimulus speeds and contrasts, and approached a limit of approximately 10 ms for high speeds and contrasts. This time scale was on average comparable to the inter-spike interval, indicating that the elementary motion signal is typically carried by one to a few spikes. Several different algorithms for motion sensing yielded similar results. Thus motion-sensitive neurons in the brain could filter their inputs on this time scale, discarding the precise times of indvidual spikes in afferent signals in order to sense motion most reliably.