Responses of macaque V1 neurons to fixational and voluntary eye movements correlate with receptive field properties

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Natural viewing in primates consists of abrupt saccades followed by slower movements. We recorded the activity of single V1 neurons in response to a stationary bar while monkeys performed a fixation task or made voluntary saccades of different sizes. The classical receptive fields (CRFs) were mapped with drifting and flashing bars while compensating for fixational eye movements. Voluntary saccades were elicited so that the CRF would cross the stimulus bar, land on it, or leave it. Three characteristic patterns were found in response to both fixational and voluntary eye movements: 1) "Saccade" cells discharged transiently whenever the CRF was swept across, onto, or off the stimulus, but were not activated during intersaccadic periods even when the CRF was constantly on the stimulus. They had transient responses to flashes and were tuned for relatively high velocity. 2) "Position/drift" cells did not respond to rapid crossings of the stimulus but fired continuously while the stimulus was within the CRF. They had sustained flash responses, preferred low velocity, and tended to be selective for sign of contrast. 3) "Mixed" cells fired bursts of activity following saccades but also continued to fire at a lower rate during intersaccadic intervals, if the CRF remained on the stimulus. Their properties were intermediate between "saccade" and "position/drift" cells. In many "mixed" and "saccade" cells, the response decreased or disappeared with increasing size of crossing saccades. It remains an open question what causes this effect: a high velocity cut-off, an active suppression, or both. Our results suggest that different V1 neurons selectively extract information about motion, change, position and visual detail.

Both fixational and voluntary saccades modulated neuronal firing in the absence of a visual stimulus, but the modulation was slower and much weaker than the visual response. Thus an extraretinal input to V1 is effective, even for the smallest saccades.

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