

Perceptual consequences of the temporal input modulations resulting from normal eye movements

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While viewing a natural scene, eye movements constantly shift the image on the retina, producing temporal modulations of the input signals to the visual system. Saccades occur 2-3 times per second, and microscopic eye movements are present during the intersaccadic periods of visual fixation. Characterizing the spatiotemporal input resulting from this incessant alternation between large and small eye movements is critical, as this constitutes the input signal to the visual system. In a previous study, we have focused on fixational eye movements¹ and shown that, during viewing of natural scenes, microscopic eye movements carry out a crucial information-processing step: they remove predictable correlations in natural scenes. This is done by equalizing the spatial power of the retinal image within the frequency range of ganglion cells' peak sensitivity, a transformation, previously attributed to center-surround receptive field organization. Here, we focus on the temporal modulations resulting from saccades, which strongly affect neural responses at fixation onset. We show that the space-time transformation due to saccades consists of two distinct regimes. Below a critical cut-off frequency, saccades amplify spatial power: that is, similar to ocular drift, the amount of temporal power resulting from saccades increases with the spatial frequency of the stimulus. In contrast, for spatial frequencies higher than the cut-off frequency, temporal modulations carry equal power at all spatial frequencies. The cut-off frequency depends on the saccadic amplitude; it is smaller for larger saccades. Furthermore, our analysis shows that, for any saccade, there is a critical high spatial frequency (related to saccadic amplitude) above which the temporal modulations resulting from ocular drift contain more power than those given by the saccade. These results suggest that saccades and ocular drift contribute to encoding different frequency ranges, with saccades enhancing low spatial frequencies and drift filling in high spatial frequencies. We present the results of psychophysical experiments which support this hypothesis.

References

1. Kuang, X., Poletti, M., Victor, J. D., and Rucci, M. (2012). Temporal encoding of spatial information during active visual fixation, *Current Biology*, 22(6): 510–514.

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