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Temporal Facilitation of ON Retinal Ganglion Cell Responses to Drifting Gratings

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Visual perception in mammals is modulated by past visual experience. The retina extracts salient features from the visual world and sends them to the brain via the spike trains of 40-50 different retinal ganglion cell (RGC) types. As few studies have explored how stimulus features interact temporally, we sought to investigate how the response of RGCs to brief stimuli evolves over time, and how RGCs respond to a sequence of stimuli presented in quick succession. Conceptually, our experiments seek to determine whether the retina compares present stimulus features to preceding ones and how such temporal stimulus interactions are encoded in RGC spike trains. Using multi-electrode array (MEA) technology, we recorded simultaneously from large ensembles of RGCs to explore visual history effects using between flashed and drifting gratings. We varied parameters of our stimulus such as the difference in orientation between a flashed and drifted grating, and the delay between them, in order to determine how these specific features contributed to our observed results. In addition, we measured spatiotemporal receptive fields and contrast sensitivities of these RGCs.

We discovered a single functional type of ON RGCs, ON_{Fac} RGCs, that exhibits a secondary delayed response to brief flashes of light as well as an enhanced response to a drifting grating if it is preceded by a flashed grating. Our findings suggest this functional RGC type displays previously unreported response patterns as well as time-dependent facilitation and depression, contributing to the developing model of how past experience is encoded in the retina. Although the mechanisms by which these processes arise in the circuitry are unclear, our initial results provide a foundation for further studying temporal interactions of stimuli and prediction in the retina.