Systems/Circuits

Retinal and Nonretinal Contributions to Extraclassical Surround Suppression in the Lateral Geniculate Nucleus

Tucker G. Fisher, Henry J. Alitto,* and W. Martin Usrey*
Center for Neuroscience, University of California, Davis, California 95618

Extraclassical surround suppression is a prominent receptive field property of neurons in the lateral geniculate nucleus (LGN) of the dorsal thalamus, influencing stimulus size tuning, response gain control, and temporal features of visual responses. Despite evidence for the involvement of both retinal and nonretinal circuits in the generation of extraclassical suppression, we lack an understanding of the relative roles played by these pathways and how they interact during visual stimulation. To determine the contribution of retinal and nonretinal mechanisms to extraclassical suppression in the feline, we made simultaneous single-unit recordings from synaptically connected retinal ganglion cells and LGN neurons and measured the influence of stimulus size on the spiking activity of presynaptic and postsynaptic neurons. Results show that extraclassical suppression is significantly stronger for LGN neurons than for their retinal inputs, indicating a role for extraretinal mechanisms. Further analysis revealed that the enhanced suppression can be accounted for by mechanisms that suppress the effectiveness of retinal inputs in evoking LGN spikes. Finally, an examination of the time course for the onset of extraclassical suppression in the LGN and the size-dependent modulation of retinal spike efficacy suggests the early phase of augmented suppression involves local thalamic circuits. Together, these results demonstrate that the LGN is much more than a simple relay for retinal signals to cortex; it also filters retinal spikes dynamically on the basis of stimulus statistics to adjust the gain of visual signals delivered to cortex.

Key words: corticogeniculate; receptive field; spatial; temporal; thalamus; V1