

The neurobiological explanation for color appearance and hue perception

Brian P. Schmidt, Maureen Neitz, Jay Neitz

Neurobiology and Behavior and Department of Ophthalmology, University of Washington

The spectral position of unique hues across a population of observers has received significant attention in color science. The standard model in which small bistratified cells that receive $S-(M+L)$ cone input are the retinal origin of a blue-yellow channel underlying hue perception does not provide a parsimonious explanation for the spectral location and distribution of monochromatic lights identified as unique green. However, recordings from large samples of cells in the lateral geniculate nucleus have identified, another group of cells, about equal in number to $S-(M+L)$ cells, that have input from M-cones with the same sign as S-cones, i.e., they are $(S+M)-L$ cells. Because the only cells in the retina known to carry opponent signals from M vs. L cones are midget ganglion cells, this second class of blue sensitive cells appears to reflect the existence of a small subclass of midget ganglion cells that could be the substrate for blue-yellow (B-Y) color vision. These putative B-Y midget ganglion cells presumably receive S-cone input via H2 horizontal cells. The B-Y midget ganglion cell theory predicts that variation in L:M cone ratio will produce variation in unique green. Using the spectral sensitivities of the cones and a previously measured distribution of L:M ratios, the theory predicted a range of 495 to 555 nm that almost perfectly matches the unique green distribution of Volbrecht et al. (Vision Res., 1997 **37**:407-416). The only assumption is that at the stage where midget inputs are combined, for full field stimuli, responses of chromatically opponent cells produce a null to equal energy white. The parallel idea that red-green hue perception is based on a second subset of midget ganglion cells with $(S+L)$ vs. M-cone inputs accurately predicts narrow distributions for unique blue and yellow centered around 473 and 580 nm respectively as observed experimentally.