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# Modeling the transformation from LGN to V1 color-opponent receptive fields

Sarah M Maynard[1], Bevil R Conway[1] and Mark S Goldman*[2]

Address: [1]Neuroscience Program, Wellesley College, Wellesley, MA 02481, USA and [2]Center for Neuroscience; Department of Neuroscience, Physiology, & Behavior; Department of Ophthalmology & Visual Sciences, University of California Davis, Davis, CA 95618, USA

Email: Mark S Goldman* - msgoldman@ucdavis.edu

* Corresponding author

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Color arises from a network that begins with the cones and progresses through stages of processing involving cells in the lateral geniculate nucleus (LGN), primary visual cortex (V1), and prestriate areas. Color is a three-dimensional percept defined by an achromatic luminance axis along with two chromatic axes, red vs. green and blue vs. yellow. Representation of color along the red-green axis is derived from an opponent process whereby responses from medium-wavelength-selective (M) cones are subtracted from those of long-wavelength-selective (L) cones [1], leading to Type I L/M cells in the LGN [2]: L-ON cells are excited by L-cone activity in the receptive field center and suppressed by M-cone activity in the surround. Type I neurons are by themselves incapable of encoding spatial color contrast, a hallmark of color vision. Color contrast is instead thought to arise through double-opponent receptive fields defined by spatial opponency and color opponency in both center and surround [3,4]. Recent physiological studies have identified double-opponent receptive fields in V1 and characterized them with high-resolution spatial maps [5], which prompts this study modeling how double-opponent receptive fields are established from Type I inputs.

Our model considers known variations of red-green Type I cells as building blocks of physiologically characterized double-opponent cells. A two-dimensional array of Type I cells was defined by a difference of Gaussians, with sizes of center and surround based on experimentally observed values [6]. Spatiotemporal responses of V1 neurons were taken from receptive field mapping experiments using sparse noise stimuli [5]. To model the transformation between LGN and V1 cells, we constructed a feed forward network in which the receptive field of each V1 neuron was fit to a weighted sum of LGN neuron responses, with optimal weights calculated using a linear regression procedure.

We find that the spatial organization of V1 neuron receptive fields can be well accounted for by a threshold linear summation of responses from LGN cells. Present work is taking into account the temporal properties of LGN cells to understand the extent to which temporal receptive fields of V1 cells are inherited from their LGN inputs. By testing the ability of a feed forward model to explain the spatiotemporal response properties of V1 neurons, our model complements previous work in non-color pathways suggesting that many aspects of V1 responses can be accounted for by a feed forward transformation of LGN inputs, while providing a starting point for construction of cortical models of color processing.

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