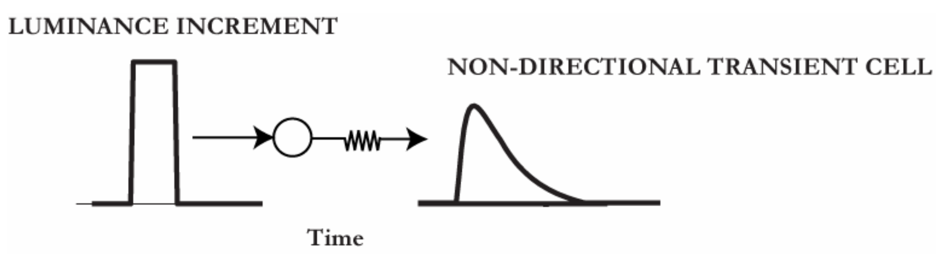

Figure 1. A dot flash at a given spatial location elicits a transient response in the non-directional transient cell layer of the MODE model.

Non-directional transient cells

Non-directional transient cells (Grossberg et al., 2001) simplify how magnocellular cells in Retina and lateral geniculate nucleus transiently respond to temporal luminance changes in the visual input. Two kinds of these magnocellular cells, ON and OFF, give transient responses to bright stimulus onset and offset or dark stimulus offset and onset, respectively (Baloch et al., 1999; Schiller, 1992). Non-directional ON transient cell activities b_{ij} at each spatial location (i, j) that respond to bright stimulus onset are modeled as follows:

$$b_{ij} = [x_{ij} z_{ij} - \theta_b]^+ . \tag{1}$$

In Equation (1), cell activities x_{ij} perform shunted, and thus bounded, leaky integration of input luminance increments I_{ij} :

$$\frac{dx_{ij}}{dt} = A_1\left(-B_1 x_{ij} + \left(1 - x_{ij}\right) I_{ij}\right). \tag{2}$$

The output from cell activity x_{ij} is gated by a habituative transmitter z_{ij}, which is initially fully accumulated at 1. Non-zero activation x_{ij} results in habituation, or depression, of the transmitter gate z_{ij} according to the following equation (Grossberg, 1972, 1980):

$$\frac{dz_{ij}}{dt} = A_2\left(1 - z_{ij} - K_2 x_{ij} z_{ij}\right). \tag{3}$$

When a non-zero input I_{ij} turns on, x_{ij} in Equation (2) approaches 1 with a rate proportional to $\left(1 - x_{ij}\right)I_{ij}$, balanced by passive decay to 0 at a rate proportional to $-B_1 x_{ij}$. As x_{ij} grows, the transmitter z_{ij} begins to habituate or depress. When I_{ij} shuts off, x_{ij} returns to 0, whereas z_{ij} recovers to 1. These inverse changes in x_{ij} and z_{ij} create a transient pulse of activation in their product $x_{ij} z_{ij}$ in Equation (1). The output threshold θ_b in Equation (1) ensures that the duration of a typical non-directional transient cell signal is roughly about 50 ms (Kaplan & Benardete, 2001). Parameters are $A_1 = 1$, $B_1 = 10$, $A_2 = 1$, $K_2 = 50$, and $\theta_b = 0.1$.

These transient responses are sensitive to the contrast of the moving dots; i.e., the magnitude of I_{ij}, but are insensitive to the duration for which stimulus stays on or off beyond a critical duration (see Figure 2 in Grossberg & Pilly, 2008). ON and OFF transient cells code the leading and trailing edges, respectively, of a moving bright object (Schiller, 1992). Here, only ON transient cells sensitive to luminance increments are simulated for simplicity. Modeling OFF cells and their cross talk with ON cells becomes crucial if the model primate were to judge the direction of contrast polarity-reversing or reverse-phi motion stimuli (Anstis, 1970; Anstis & Rogers, 1975; Baloch et al., 1999; Chubb & Sperling, 1989).

Reference

Grossberg, S., Mingolla, E., & Viswanathan, L. (2001). Neural dynamics of motion integration and segmentation within and across apertures. *Vision Research*, *41*, 2521-2553.