1791 — B584

SHORT AND LONG-TERM PLASTIC EFFECTS INDUCED BY THE MULTIPLE TIME SCALES OF EVENTS AT THE CELLULAR AND SYNAPTIC LEVEL IN A MODEL OF SPIKING NEURONS IN PRIMARY VISUAL CORTEX **((V. Dragoi[1] and D. C. Somers[2])) Dept. of Psychology: Experimental, Duke University, Durham, NC[1]; Dept. of Brain and Cognitive Sciences, MIT, Cambridge, MA[2].**

Purpose. Cells in primary visual cortex (V1) have the capacity to undergo short-term plastic changes within a time course of minutes (DeAngelis et al., 1995; Das & Gilbert, 1995), and long-term changes within hours and days (Gilbert & Wiesel, 1992; Darian-Smith & Gilbert, 1993). We propose a model of spiking neurons in V1 which relies on the different time courses of cellular and synaptic events to explain both short and long-term plastic changes in the receptive field properties of cortical cells. Methods. We model 80 cortical excitatory cells, 20 fast-spiking cortical inhibitory cells, and 80 LGN cells. Plastic changes at the cellular level are modeled as activity-dependent regulation of maximal conductances of ionic currents, a slow process which depends on the intracellular concentration of calcium ions. Plastic changes at the synaptic level are modeled as synaptic depression and potentiation. Results. After long conditioning, the long-range pyramidal cells provide the local inhibitory interneurons with sufficient excitation to induce Ca-dependent changes in their maximal conductances of ionic currents, and therefore local inhibitory cells become less responsive to excitation. Since local excitatory cells receive less inhibition the gain in the local circuitry increases. As a result excitatory inputs from portions of the receptive field which were subthreshold become suprathreshold, determining the RF to increase in size. During presentation of a classical or test stimulus, local excitatory synapses depress to reduce gain level of the local circuitry. This faster mechanism can quickly restore normal RF sizes. If conditioning is extended the changes in maximal conductances overcome the effect of depression, and the increased responsiveness becomes persistent. The same mechanism can explain the shift in RFs following retinal lesions. Conclusions. Activity-dependent slow changes in maximal conductances combined with faster synaptic plastic events constitute a powerful mechanism by which the gain of the local circuit changes as a function of activity. In the case of large network populations these changes in the local gain can induce plastic changes that go beyond the classical RF.

Dragoi, V. and Somers, D.C. (1997) Short and long-term plastic effects induced by the multiple time scales of events at the cellular and synaptic level in a model of spiking neurons in primary visual cortex. Invest. Opthalmol. Vis. Sci. Suppl., 38 (4), 1791