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SYNCHRONIZED OSCILLATIONS DURING COOPERATIVE FEATURE LINKING IN A MODEL OF VISUAL CORTEX. D. Somers and S. Grossberg, Department of Cognitive and Neural Systems, Boston University, Boston, MA 02215

A model of synchronized oscillations in visual cortex is presented to account for neurophysiological findings (Eckhorn, et al, Biol. Cyber., 60, 1988, Gray, et al, Nature, 338, 1989) that synchronization of neural activity may reflect the binding of local feature detectors into a globally coherent perceptual grouping. Grossberg (Biol. Cyber., 23, 1976;1978) had previously predicted that cortical codes would be expressed by resonant standing waves in which cooperatively linked cells oscillate in phase with one another. It was also noted that the standing waves could be replaced by an approach to an equilibrium point if no "slow" variables exist in the network.

Our model utilizes two neural network architectures previously used in modeling pre-attentive vision (Boundary Contour System[BCS]) and attentive visual object recognition (Adaptive Resonance Theory[ART]). The oscillations in our model are not merely assumed to exist as has been done by others, but rather emerge from a system of nonlinear feedback equations in which inhibition acts more slowly than excitation. Our model and computer simulations account for the rapidly synchronizing response of distant visual cortical cells to both single and double bar moving stimuli. The two network architectures make complementary predictions about the processing of disjoint patterns. The "Bipole Cell" architecture of the BCS predicts that, under appropriate stimulus conditions, activity will be induced and synchronized at sites between disjoint patterns, thus performing a pre-attentive boundary completion. Conversely, the "Adaptive Filter" architecture of ART synchronizes, but does not connect, disjoint patterns during attentive object recognition.

Even nearest neighbor and random coupling schemes can generate synchrony for the single bar input, which demonstrates the robustness of the synchrony effect in cooperative networks. These results suggest how research on this topic can be integrated into formal models of visual perception in cortex.

KEY WORDS: (see instructions pg. 4)

1. visual perception
2. coherent oscillations
3. neural networks
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