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- Thursday, March 22, 2007

Form vision with a function: Attention modulates visual tuning of V4 neurons

Neurophysiological studies have produced numerous models to account for neuronal responses to visual and auditory stimulation. One general modeling framework, the spectro-temporal receptive field (STRF), has been applied frequently to describe the stimulus-response transformation under passive behavioral conditions, but little is known about how such models perform during more natural active behavior. We ask the question: In the visual cortex, how do changes in attention state modulate neuronal STRFs? Most previous physiological evidence supports the idea that attention does not change the tuning of individual neurons but rather enhances the firing rates of neurons already tuned to the attended locations or features; this idea predicts that attention modulates only the global gain of STRFs. However, we show that feature-based attention causes local shifts in the STRFs of nearly one third of neurons in visual area V4, indicating that attention can in fact change the tuning of individual visual neurons. When tuning shifts occur, they enhance responses to the attended features, consistent with a matched filter model of visual attention. These results suggest that decision-making processes required for visual behavior are integrated into the basic processes of visual representation. Preliminary investigation suggests that a matched filter also describes the effects of attention on the tuning of neurons in auditory area A1.

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