

Prefrontal-visual cortex interactions in attention

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The voluntary control of visual attention to behaviorally relevant stimuli is thought to involve “top-down” feedback to visual processing areas. For spatially-directed attention, one key source of top-down attention is the frontal eye fields (FEF). We have found that feedback to visual cortex from FEF causes enhanced responses to stimuli at attended locations, and leads to synchronized neural activity in the gamma frequency range between FEF and visual processing areas. Recent evidence suggests that the pulvinar may also serve as an important relay of attentional feedback to visual cortex, and it may also serve to desynchronize cortical activity in the alpha frequency range. The neural basis of feature, or object attention has been much more difficult to understand. One possibility is that attention to objects with particular features causes spatially directed attention to be directed to those objects, utilizing known pathways for spatial attention. Another possibility is that attention to objects or features such as faces, colors, or shapes, depends on feedback to visual cells that are selective for those features, biasing activity in favor of those stimuli. Such a mechanism would be similar to what is thought to mediate visual recall memory. We have recently found evidence for both types of mechanisms in prefrontal cortex. Neurophysiological studies show that when monkeys direct attention to an object with a particular color or shape in the visual field, responses of cells in the FEF with receptive fields containing that location become selectively potentiated. Feedback from FEF to visual cortex then serves to highlight these salient locations. To help identify sources of direct object-related feedback to visual cortex, we have tested humans in a task that requires attention to one of two spatially overlapping objects (faces and houses), precluding the use of spatial attention. Neural activity was recorded using magnetoencephalography (MEG) and fMRI. In this task, we found that attention to faces or houses causes enhanced activity and synchrony with the fusiform face area or the parahippocampal place area, respectively, and these areas synchronize their activity with the inferior frontal gyrus, an area in prefrontal cortex with known object selectivity. Thus, attention to locations and objects involves different feedback mechanisms in the prefrontal cortex.