

Attention and Arousal in the Parietal Cortex

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The primate brain does not have enough resources to process the entire visual world at once. Visual attention is the mechanism by which the brain selects some objects for further analysis, and ignores others. Attention has two basic mechanisms – exogenous attention, in which salient objects in the environment that may be behaviorally irrelevant grab attention automatically – a bright flash of light, sudden motion. Endogenous attention is the selection of an object not because of its physical characteristics, but because the object is somehow behaviorally important. The selected object can be further analyzed perceptually, and it can also become the target for movement.

The lateral intraparietal area of the brain analyzes far visual space, the part of the world we explore with our eyes using rapid eye movements called saccades. Neurons in this area receive bottom-up visual, and top-down motor and cognitive information and sum these signals to provide a priority map of the visual world. Visual attention, as measured by an improvement in perceptual threshold, is pinned to the peak of the priority map. Stable, behaviorally unimportant objects in the visual world evoke weak responses in LIP neurons, even when a saccade brings one into the receptive field of a neuron. Saccades are made to the peak of the priority map when they are appropriate. The priority map is sharpened by surround suppression and by surround stimulation decreasing the variability of neuronal responses

The efficiency of visual selection is gated by a second, less specific arousal process, measurable in the baseline activity of neurons, which predicts the intensity of subsequent neuronal responses and the efficiency of performance. The baseline signal is nonspatial, and is not dependent upon specific spatial attention. It is inversely proportional to the monkey's recent history of reward. Iontophoresis of acetyl choline increases the baseline activity and the intensity of the visual transient response evoked by the array, and improves the monkey's performance. Iontophoresis of scopolamine, a muscarinic antagonist, decreases both the visual transient and the baseline, but has a greater effect on the visual transient. Iontophoresis of mecamylamine, a nicotinic antagonist, also decreases both the transient and the baseline, but preferentially affects the baseline. These data demonstrate that the parietal cortex has two sorts of signals: a sensorimotor signal that has visual and movement activity, and builds a priority map of the visual environment; and a cholinergic signal that has no sensorimotor activity, but determines the monkey's current state of arousal – how well he will perform the task.