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Functional MRI in alert behaving monkeys during goal - directed saccades

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We developed experimental techniques to study the neural substrates of goal-directed oculomotor behavior in trained rhesus macaques using a high-field 4.7 T vertical MRI scanner. We recorded BOLD activity, eye movements, reward and timing information while monkeys performed direct and memory saccades to visual cues during GE-EPI scans. Using a saccade vs. fixation block design, we obtained reliable activation maps of cortical and subcortical structures implicated in eye movement control. Next we compared BOLD responses during direct and memory saccades, in order to extract spatial-specific memory and/or planning signals. However, differential activation between memory and direct saccades in the block design was obscured, in part because block activity comprises signals from several task-related components.

We therefore utilized an event-related design to delineate contributions from different epochs within the task sequence - presentation of visual cues, motor planning, spatial memory, saccade execution, as well as reward expectation and acquisition. Many discrete visual, parietal, and frontal areas displayed multiple dependencies on these variables. These findings emphasize the need for cautious interpretation of potentially confounded and overlapping signals in the BOLD time-course. The analysis of "cognitive" (as contrasted to sensory and motor) components is an important prerequisite for future investigation of decision-making. Combined with FMRI-guided neurophysiological recordings in the same monkeys and with human imaging, using identical paradigms, these studies promise to form a comprehensive approach to investigation of various aspects of primate behavior.

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