606.7. Event-related fMRI in alert behaving monkeys and humans during visually-guided and memory saccades

Presentation Time: Oct 17, 02:30 PM : Oct 17, 02:45 PM

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Presentation Number:606.7

Keyword:functional, imaging, eye movements, macaque, parietal cortex

Delayed (memory) response paradigms have been used extensively in monkey electrophysiology and more recently in human functional imaging studies in order to dissociate visual and motor responses, and to investigate mechanisms of working memory and movement planning. However, the exact relationship between these studies in the two species is not clear due to differences in methods and time-scales. Here we provide a direct comparison between monkeys and humans with the same tasks and techniques, using a high-field 4.7T vertical MRI scanner for monkeys and a 3T scanner for humans. Eye movements, reward, timing and other behavioral information (e.g. body or head motion in monkeys) were recorded while subjects made visually- and memory-guided saccades to visible or remembered cues. The performance of the task and the behavioral feedback was controlled in real-time.
Advancing previous monkey fMRI studies that used block design, we applied event-related analysis of BOLD signal time-courses to delineate responses from different epochs within the task sequence - fixation, cue, delay period, saccade execution, reward expectation and acquisition. In the first experiment we compared responses during visually- and memory-guided saccades to extract “cognitive” signals related to spatial working memory and motor preparation. In monkeys, prefrontal and parietal areas, in particular discrete bilateral regions in arcuate sulcus, principal sulcus, intraparietal sulcus, and superior temporal sulcus, exhibited spatially-specific, contralateral cue and memory/preparation activity. The event-related time-courses from these areas revealed cognitive-related differential activation seen as a separate peak or elevated activity in the middle and late memory period, distinguishable from the early cue response. Consistent activation patterns were found in putative functional human homologs, although exact shape and contribution of these signals varied between subjects in both species. In control experiments we varied the duration of the memory period and the relevance of the cue for subsequent action to further separate sensory cue response from the memory/preparatory processing. Our results demonstrate that dynamics of “higher-order” cognitive signals can be detected in monkeys using event-related FMRI, making it a powerful link between human imaging and monkey electrophysiology.

I. Kagan, None; **A. Iyer**, None; **A. Lindner**, None; **S. Wagner**, None; **R.A. Andersen**, None. Support: Moore Foundation
National Eye Institute Boswell Foundation

[Authors]. [Abstract Title]. Program No. XXX.XX. 2006 Neuroscience Meeting Planner. Atlanta, GA: Society for Neuroscience, 2006. CD-ROM.

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