MAC-Brain: Developing a Multi-scale account of Attentional Control as the constraining interface between vision and action: A cross-species investigation of relevant neural circuits in the human and macaque Brain.

Main area: HBP04_Cross-species multi-scale data constraints for visuo-motor integration
Keywords: attention; priority settings; attentional control; visuomotor integration; fMRI; EEG; TMS; single-unit electrophysiological recordings; multi-unit electrophysiological recordings; human brain; macaque monkey brain.
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Abstract

Mechanisms of attentional control in primates have been extensively investigated, especially in humans, showing that several factors determine how the brain selectively processes incoming sensory information and targets motor output to deemed-relevant objects in the environment. Attentional control can be thought of as an overarching mechanism that integrates signals from multiple cognitive domains (including instructions, salience, task-relevance, expectations and motivation) in order to assign processing priorities to specific sensory inputs and gate motor response selection in the service of goal-oriented behavior. Available data in humans and animals already identified neurophysiological correlates of different factors contributing to attentional control, but the highly specialized nature of previous experiments has hindered a systematic study of the interactions between these factors. Moreover, studies in humans and behaving macaques have been typically optimized according to different constraints, holding back the integration of system-level human data and cellular-level monkey data within a single framework. The objectives of the current proposal are: 1) to generate a set of standardized protocols for investigating the distinct and combined influence of specific priority signals and 2) to gather a multi-dimensional dataset associated with their neural implementation. All paradigms will employ simple and highly stereotyped stimuli/tasks, enabling us to characterize attentional control within an identical experimental framework across species (humans/monkeys). The first output of the project will be a set of protocols to map and dissect specific sub-components of attention, tracking the contribution of multiple sensory (salience), cognitive (relevance and expectations) and value-related (reward) functions within the unified framework of attentional control. The second output will be a cross-species (humans/monkeys), multi-scale dataset, including data from behavior, system-level functional neuroimaging and scalp-electrophysiology tracking activity over multiple networks and across time, and spatially- and temporally-resolved multi-site electrophysiology of single neuron activity. With the aim of identifying any dynamic reconfiguration of brain networks underlying different forms of priority assignment, additional information will be inferred by assessing attentional influences in different phases of the trial (e.g., preparatory vs. target-related effects) with fMRI, EEG and TMS, and by using analyses of inter-regional functional and effective connectivity. In sum, the research will provide new constraints for validating and extending existing neural simulation models of visuo-motor integration. The collected dataset will also provide insights for the development of theoretical models linking observations at the neuronal level with data on network dynamics, being of immediate value for computation-oriented units of the HBP consortium.

Consortium

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