Research Project Title

Visuospatial attention, motor intention, action affordance and brain plasticity: neurophysiology and network analysis

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Abstract

The project addresses sensorimotor integration for motor intention and execution within a unitary perspective, based on the assumption that the underlying processes can only be understood if considered as different aspects of a unitary mental construct, enabling non-human primates and humans to deploy attention and encode command functions to move and act effortlessly in the extra-personal space.

The core objectives of the project concern: a) cortical encoding of kinetics and kinematics of grasping and reaching, their coupling during coordinated action, and action recognition when performed by another agent; b) the analysis of the memory reservoirs which help planning future action based on previous experience; c) how complex motor cortical circuits generate ethologically relevant forms of behavior; d) brain encoding of action affordances; e) the mechanisms necessary to allocate attention to a salient target, while resisting distractors, as a necessary prerequisite for successful action planning and performance. The statistical analysis of the distributed cortical system responsible for these functions will unravel the anatomical substrates of the above mentioned functions.

Our approach will combine behavioral neurophysiology and neuroanatomy in monkeys, and will also include neurophysiological studies in humans. Neural activity (single unit, multi-unit, local field potentials) in different frontal, parietal and extrastriate cortical areas, including some of their subcortical targets such as the putamen, will be studied while monkeys perform ad hoc tasks assumed to recruit these areas, and inspired by their anatomical input and by the consequences of their lesion on behavior. These studies will not only be of correlative nature, but will also include the complex analysis of the causal relations between neural activity and behavior, through reversible inactivation of specific cortical sites in behaving animals. Cutting-edge experimental techniques will also be adopted in humans as well, where motor cortex will be electrically stimulated during neurosurgery in awake patients at behaviorally-relevant time scales, to study how ethologically relevant actions are generated, how their repeated performance affects cortical circuits, and how the wiring diagram of the cortical motor output can be reshaped by (hand) use.

The relevance of these studies of sensorimotor control for the rehabilitation of skilled hand action as consequence of brain lesion is direct. Beyond the obvious statement that understanding brain function is essential to understand brain dysfunction, our project aims at conveying the message that this can only be feasible at multi-scale level, i.e. the micro-scale of cell function, the meso-scale level of cortical circuits, and the macro-scale level of behavioral analysis.