UNCOVERING THE NEURAL ARCHITECTURE UNDERLYING DECISIONS ABSTRACTED FROM MOVEMENTS

Project Abstract Decision making is a core component of normal and abnormal cognitive function. Understanding the neural mechanisms of decision-making will lead to advances in the diagnosis, classification and future treatments of disorders affecting thought and control. Mathematical models of the decision process, based on bounded evidence accumulation, have been developed over decades and are being increasingly leveraged to gain deeper insights into the origins of cognitive deficits arising from a range of brain disorders. However, major gaps remain in our understanding of the neural mechanisms responsible for decision-making, thereby limiting the validity and utility of the models. A successful line of research on perceptual decision-making has established that neurons in the parietal and prefrontal cortex of the rhesus monkey (Macaca mulatta) encode the accumulating evidence bearing on the alternatives. These observations are mainly from neurons in areas of the macaque cortex that are associated with preparation of the actions (e.g. hand or eye movements) for reporting the decision alternatives. However, decisions are often formed without knowledge of what actions they might call for, and under such conditions, effector-selective neural activity does not appear to reflect accumulation dynamics. Recent studies, have identified a novel 'abstract' decision signal in non-invasive electrophysiological (EEG) recordings from human decision makers. The signal, termed the central parietal positivity (CPP), represents the accumulation of evidence for decisions irrespective of the sensory or motor requirements of the task, hence the designation, abstract. The neural circuits that give rise to the CPP are likely to explain the capacity to flexibly link decisions to various actions depending on context and goals. However, because the signal has thus far only been observed in EEG recordings from humans, its neural basis is unknown. The proposed aims will (1) establish the neural underpinnings of the CPP by establishing its analogues in single-neuron, multi-neuron, local field potentials and EEG of the macaque and (2) localizing its source in humans through the use of neuroimaging, and electrocorticography (ECoG) from patients undergoing neurosurgery. Both aims draw on an integrated computational effort that combines biophysical modeling, neural networks, and mathematical characterization of the decision process. The knowledge gained through these investigations will increase our understanding of core cognitive capacities whose deficiency contributes to major brain disorders while bridging long-standing methodological gaps in human versus non-human animal investigations.

Public Health Relevance Statement:

Project Narrative A wide range of cognitive functions depend on brain mechanisms that support decision-making. Restoring these mechanisms will likely play an essential role in future treatments of brain disorders affecting cognition. The project will elucidate the neural mechanisms underlying an encephalographic signature of complex decisions made by normal humans by establishing its underpinnings at the level of neural circuits.