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Title: Neural computations associated with exploratory decision-making in the human brain.

Abstract: A fundamental dilemma faced by humans and other animals when foraging for rewards concerns whether or not to exploit an option that is known to yield a certain amount of reward, or to explore other unknown alternatives that might prove even more fruitful. Computational theories suggest that a number of different variables can be used by an agent to make sensible decisions about whether to explore or exploit. These theories include taking into account the novelty of a decision option (whether or not the stimulus has been seen before), or the uncertainty one has in the distribution of reward available on an option. Here, we aimed to examine the distinct contributions of novelty, uncertainty and the expected value of a stimulus in driving exploratory decisions at both behavioral and neural levels in humans. To achieve this, we developed a new decision-making task in which novelty and uncertainty can be separately manipulated to assess how human participants rely on these variables to drive decision making over time. In this talk, I will first describe results we obtained from behavioral and computational modeling-based analyses which suggest that both novelty and uncertainty drive behavior, but that each evolve differently in their contribution to behavior as a function of the horizon of opportunity. I will then describe evidence from both fMRI (in healthy participants) and single-unit recordings (in patients undergoing neurosurgical treatment for epilepsy) to suggest that these exploration-related variables are flexibly encoded in the pre-supplementary motor cortex (preSMA) and the ventromedial prefrontal cortex (vmPFC) respectively. Moreover, by leveraging the increased spatial and temporal resolution offered by single unit recordings, we were able to pinpoint markedly distinct roles for these two areas. While PreSMA neurons encode decision variables that serve as in input to the decision process as well as the decision itself, the vmPFC by contrast, appears to be predominantly involved in encoding information about a decision once it has already been made. Collectively, these findings shed light on the neural computations associated with the explore/exploit dilemma in the human brain as well as helping to distinguish the brain regions involved in making action-based decisions from those involved in reporting the consequences of those decisions.