Neural Substrates of Deterministic Decision Making

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Research Abstract
? DESCRIPTION (provided by applicant): Our environment is composed of pervasive deterministic and quasi-deterministic (very high- probability) relationships. A basal ganglia (BG) reinforcement learning system plays a key role in optimizing probabilistic decisions based upon an accrued history of experience, but it is unknown if this system contributes to deterministic decision-making. A medial temporal lobe (MTL) associative memory system could play a dominant role, since experiencing a deterministic choice outcome even once can provide

sufficient information to optimize future decisions. We will use functional neuroimaging (fMRI) and neuropsychological methods to investigate how the BG and MTL systems work together to support deterministic decision- making. There is a crucial need to understand this question. Normal aging slows down memory- retrieval processes, leading to slower, inefficient, or impaired decision-making skills for even simple judgments. In patient populations with memory disorders, severely affected individuals can become unable to utilize information from deterministic outcomes, leading to a reduced ability to learn from basic everyday experiences. To address our research questions, we will use an innovative approach that will (a) incorporate factors drawn from both the decision and memory literatures, (b) allow us to investigate alternative computational models of deterministic decision-making, and (c) unmask effects of medication state on the cognitive performance of patients with Parkinson's disease. Experiment 1 will test how two factors differentially linked to reinforcement learning and associative memory are encoded and subsequently used to guide deterministic decision-making. The main objectives are to determine what information is gained from an initial decision event, and how this information influences a subsequent choice (Aim 1a) and value learning (Aim 1b). We expect activity in the BG and the MTL during an initial choice will predict subsequent choice-making ability across changes in value and associative context, respectively. This would indicate that these two systems make separable contributions to deterministic decision-making, a finding with significant theoretical impact. We will use computational agents to evaluate whether value learning from repeated choice experiences is best described as ""model-based"" or ""model-free,"" a question that has critical implications for how individuals learn from sampling their environment. Experiment 2 will involve a neuropsychological investigation of deterministic decision-making behavior in Parkinson's Disease (PD) and Mild Cognitive Impairment (MCI) patients. Deficits arising from problems with BG-mediated reinforcement learning in PD and MTL-mediated associative memory in MCI should reflect an inability to update value or encode associative information, respectively. This leads us to predict that subjects with PD will show reduced effects of value updating, but intact effects of experience (e.g., context) on choice accuracy. The converse is expected for MCI subjects. Such findings would point toward preserved learning and memory mechanisms that could be exploited to reduce the functional impact of these disorders.

Further information available at:

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