

Just decide: Computational studies of intertemporal choice in humans and monkeys

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Over the last 5 years the basic architecture for general purpose decision-making in the primate brain has begun to emerge. Growing evidence suggests that circuits of the basal ganglia and the frontal cortex place subjective valuations on the actions available at any instant in time. A second operation, likely in the parietal cortex, selects one of these actions for execution. These empirically observed operations parallel the operations of standard economic theory in which the expected utilities of options are compared during a discrete choice. Confirming that neural circuits represent a quantity like expected utility has been complicated, however, by the fact that under many conditions expected utility and choice are tightly correlated. Our recent studies of inter-temporal choice in both humans and monkeys seem to have overcome this limitation. By studying the subjective values of delayed rewards we have been able to disassociate subjective value from choice under a range of conditions. Our studies of humans using fMRI suggest that the basal ganglia and frontal cortex do explicitly represent a quantity like expected utility. Our single unit studies in monkey parietal cortex suggest that when monkeys make choices early activity (that following the presentation of the available options) represents the subjective value (not choice probability) of those options. Late activity (the activity that immediately precedes action), in contrast, appears to encode choice. These data support the notion that an abstract subjective value, of the type required by axiomatic models of efficient choice, are represented in the primate nervous system. They also suggest that the posterior parietal cortex lies within the choice circuit itself and that single unit studies of this area visualize the operation of a decision-making circuit in action.