Neural Organization of Reinforcement Learning: A Computational Approach

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Because reinforcement learning is so frequently successful in predicting what choices are made, it has become **a**, if not **the**, standard framework in which to evaluate goal-seeking behavior. We work to identify the neural substrates giving rise to goal-seeking behavior and relate them to reinforcement models. We have investigated the roles of frontal and temporal lobe brain regions in learning the values of predicted outcomes. Our results show that the medial temporal lobe region rhinal cortex, and orbitofrontal and lateral prefrontal cortices, play different roles in establishing the values used in predicting future outcomes of current behavior. We find that monkeys with bilateral damage to the rhinal cortex are poor in adjusting their behavior according to the differences in rewards; they seem to have difficulty in learning or remembering the differences among the rewards, a conclusion consistent with the hypothesis that rhinal cortex plays a role in the contextual part of episodic memory. Monkeys with orbitofrontal damage are less sensitive than normals to differences in reward size, and monkeys with lateral prefrontal damage have difficulty combining reward sizes and delays to reward (so-called temporal discounting of reward value) into a single value scale, even though they seem completely normal in adjusting to either reward sizes or delays (discounts). The latter is consistent with the idea that lateral prefrontal cortex is important for rule based behavior. Thus, we combine ideas of value and discounting from reinforcement learning and neuroeconomics with knowledge from cognitive psychology to tease apart neural substrates of goal-seeking behavior.