Dynamics and Neural Mechanisms of Decision Making
(1R01MH073246-01-FY04)

Daeyeol Lee
University of Rochester

Xiao-Jing Wang
Brandeis University

Impaired abilities to make flexible decisions characterize many mental disorders, including depression, obsessive-compulsive disorders, autism, and schizophrenia. Nevertheless, the neural mechanisms responsible for rational decision-making are poorly understood. By combining methods of computational modeling and single-neuron recording from behaving monkeys, this collaborative proposal seeks to obtain novel insights as to how the brain evaluates the expected outcomes of alternative actions and make optimal choices in the face of a highly dynamic and interactive environment. The brain mechanisms responsible for decision making might adopt optimal computational strategies that can be dynamically adjusted based on expected rewards. Recently, signals related to some elements in reinforcement learning algorithms have been identified in various brain areas, such as brainstem dopamine neurons signaling reward prediction errors. The proposed research program will bring together formal models (game theory and reinforcement learning), electrophysiology in behaving primates, and biophysically-based computational modeling of large- scale cortical networks. The proposed studies will (1) further develop the primate paradigm of decision- making tasks based on competitive games, (2) examine the activity of single neurons in several key areas in the frontal lobe to identify neural basis of computational steps in dynamic decision-making, (3) develop a biophysically-based cortical network model for dynamic decision-making by implementing reward-based synaptic learning rules, (4) examine possible mechanisms responsible for the randomness of choice behavior, such as irregular spike activity and stochasticity in the synaptic learning rules, and (5) investigate the possibility that a distinct neural network is endowed with the ability of cross-trial temporal integration to estimate expected reward through experience.

Project and PI Website

http://www.bcs.rochester.edu/~dlee/

http://wanglab.ccs.brandeis.edu/