A Bayesian Model of Motor Reward Learning

Gregory Dam[1], Konrad Koerding[1,2]
[1]Northwestern University Interdisciplinary Neuroscience Program,
[2]Departments of Physiology and Physical Medicine & Rehabilitation, Northwestern University, Chicago, IL

Abstract

We often need to learn a motor skill by using feedback we obtain after the completion of individual movements. For example, when we learn how to throw darts we adjust how we throw by assessing where the darts stick. Computationally, learning to throw darts is a search through a multi-dimensional space of possible movements with a desired outcome, an accurate throw. We tested this kind of search behavior using a motor learning paradigm. Here we present an experiment where participants are asked to learn movement trajectories that vary in direction and curvature. At the completion of each trajectory a single numeric score is provided. Each score represents the error made in both direction and curvature of the attempted trajectory and is used to learn the target trajectory. Participants are faced with a credit assignment problem. They need to learn how much each property of their trajectory contributed to the error. A good strategy should systematically explore the two trajectory dimensions, while simultaneously maintaining and updating a memory of search results. We developed a search model that implements optimal Bayesian learning under a set of simple constraints (i.e. limited memory and motor noise). We found that our model replicates salient aspects of human search behavior. Our results suggest that participants may employ a near optimal method for updating their memory of searches, which is then used to inform the subsequent search strategy.