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Title

Modularity and Hierarchy in the Circuit Basis of Behavioral Control

Abstract

Broadly speaking, the brain is for control. In vertebrates, mechanisms in the spinal cord and hindbrain are responsible for automated control, such as reflex circuits, central pattern generators, and circuits for movement primitives. These control elements can be selected, modulated, and chained together by the descending influence of brain systems positioned more rostrally that possess a rich capacity to learn from experience. My laboratory is primarily interested in understanding these more adaptive systems. However, control by these learning systems appears to be fundamentally both heterarchical, requiring distinct computations performed by specific brain systems, and hierarchical, with each system operating at varying degrees of abstraction relative to the immediate physical world. In this talk, I will describe how experiments in my laboratory have revealed signatures of hierarchical representations that jointly produce robust behavioral policies, and how different brain systems appear to handle distinct aspects of behavioral control.

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Bio

Joe Paton is the Director of Neuroscience and Senior Principal Investigator at the Champalimaud Foundation in Lisbon, Portugal. Focusing on the neurobiology of time, learning, and decision-making, his work bridges the gap between circuits, systems, computation and behavior. He earned his PhD from Columbia University and held research positions at Harvard and Stanford before moving to Portugal. He currently leads the Champalimaud Neuroscience Programme, where he has been instrumental in establishing the Centre for Restorative Neurotechnology - a hub dedicated to merging neuroscience with robotics and digital therapeutics to treat chronic diseases. His "Learning Lab" utilizes a multidisciplinary approach, combining electrophysiology, modern techniques for circuit neuroscience and computational modeling to uncover how the constellation of modular brain systems that comprise the mammalian nervous system gives rise to intelligent behavior. He is a Howard Hughes Medical Institute (HHMI) International Research Scholar, a recipient of a European Research Council (ERC) Consolidator Grant, and a member of the Centre for Responsible AI. His current research focuses on "Synthetic Neuroscience" - applying biological insights to construct integrative models for the neural control of behavior and using such models in concert with experiments to ratchet forward our understanding of whole brain mechanisms of behavior.