Johns Hopkins Whiting School of Engineering

Johns Hopkins University
Department of Mechanical Engineering
2021 Spring Virtual Seminar Series: Class 530.803

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"Neural pathways for initiating a six-legged walk"

Presented by Professor Salil Bidaye

Research Group Leader, Max Planck Florida Institute for Neuroscience

A stationary animal can instantaneously initiate goal appropriate walking. For example, a gazelle will instantaneously sprint into an escape at the sight of a cheetah, or in the absence of predators, it might spontaneously trot towards a grassy patch. It is unclear how brain circuits recruit the downstream spinal motor circuits in an instantaneous and task specific manner to manifest an appropriate walking output.

Insects manage to do all these walking maneuvers with relatively few neurons and hence offer an attractive model to figure out the underlying neural circuit principles. In this work, we leveraged genetic tools in the fruit-fly to uncover brain pathways for walking initiation. Using a novel optogenetic assay, we identified two neuronal types, P9 and BPN, in the fly brain that initiate two distinct walking patterns. Neuronal activity imaging and silencing during naturalistic behaviors showed that these two neurons are central nodes in two distinct walking initiation pathways. P9 is specifically involved in object directed walking in the context of courtship, whereas BPN is recruited during sprinting. In the case of P9, we unraveled a neural circuit motif that underlies the context specific recruitment of this pathway. Thus, this work provides the first characterization of genetically defined neural pathways that encode task-specific walking in fruit flies.

Dr. Bidaye will start his Research Group Leader position at the Max Planck Florida Institute for Neuroscience in April 2021, leading the Neural Control of Locomotion group. His research will focus on understanding how fast and precise locomotor decisions are executed at the level of genetically defined neural circuits.

Prior to this Dr. Bidaye was a Postdoctoral Fellow at the University of California-Berkeley in the lab of Professor Kristin Scott. Before that he earned his Ph.D. at the Research Institute of Molecular Pathology (IMP), Vienna in Dr. Barry Dickson's laboratory. Over the course of his doctoral and postdoctoral work, Dr. Bidaye has established an independent research program centered around understanding motor control using Drosophila walking as a model system. While a Ph.D. student, Bidaye discovered the neurons that constitute the central pathway for backward directed walking in fruit-flies, dubbed the "moonwalker neurons". This work has spurred several studies aimed at understanding how animals instantaneously switch their walking directions in response to sensory stimuli. During his postdoctoral work, Bidaye used Drosophila genetics tools to address another fundamental question pertaining to locomotor control: how do animals initiate walking? This led to identification of two distinct brain pathways that initiate distinct forward walking programs. Functional characterization of these neurons uncovered how contextual information impinges on sensory-motor circuits to achieve task specific walking control. This work not only characterizes the central nodes in the walking circuit of the fly, but also provides genetic tools to begin unravelling the downstream circuits essential for executing an optimal walking pattern.