Dynamic Delays and Subspaces Sculpt Motor Information Flow: Insights from Multimodal Neurotechnologies

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Wednesday, February 18th @ 2:00 pm in BRK 1001

Coffee and snacks served before seminar

also on MS Teams

Abstract: Coordinated motor integration in the mammalian cortex emerges from precisely timed interactions among distributed neural populations, yet the circuit-level mechanisms remain incompletely characterized. Here, I present new data leveraging 2D nanotextured ECoG arrays in conjunction with high-density, multi-site electrophysiology, optogenetics, and focal cooling perturbations to dissect inter-areal communication within motor networks. We demonstrate that traveling waves constitute a canonical organizing motif across primary (M1) and secondary (M2) motor cortices during cue-driven voluntary behavior, structuring sequential neural activity via dynamically relayed time delays along cortico-cortical and thalamocortical pathways, with M2 acting as a gating hub – a result backed by modeling. This mechanism enables near-zero-lag synchrony between M1 and M2 despite mesoscale separation, supporting rapid and flexible sensorimotor integration. Our analyses reveal that the temporal structure of these delays critically modulates the velocity, stability, and latency of M1 neural sequences, directly impacting behavioral output. Furthermore, we identify a low-dimensional “communication subspace” linking M2 and M1, in which neural trajectories are tightly coupled with the spatiotemporal properties of traveling waves, enabling dynamic reconfiguration within a stable subspace architecture. This framework integrates the temporal precision and flexibility necessary for complex motor execution. M1 wave dynamics exhibit task-dependent modulation and robustly predict trial-by-trial behavioral performance, underscoring the functional relevance of spatially structured time delays in motor control. Time permitting, I will highlight some novel neurotechnologies my group is developing to address critical questions across the spectrum of circuits and systems neuroscience.

Bio: Dr. Krishna Jayant is the Leslie A. Geddes Assistant Professor at Purdue University's Weldon School of Biomedical Engineering. His research focuses on understanding behaviorally relevant computations using biophysically based approaches and innovative electrical and optical neurotechnologies. Topics of interest in his lab include synaptic, dendritic, and network-level circuit computations, particularly those that underlie sensorimotor integration and learning, as well as the circuit dynamics disrupted in synucleinopathies. Dr. Jayant completed his graduate studies in electrical and computer engineering at Cornell University, where he worked with Dr. Edwin Kan on CMOS bioelectronics. He then pursued postdoctoral training in Neuroscience at Columbia University, working with Dr. Rafael Yuste, Dr. Ken Shepard, and Dr. Ozgur Sahin, focusing on advanced neurotechnologies to investigate synaptic and dendritic biophysics. In addition to receiving the NIH Director’s New Innovator Award, Dr. Jayant has been honored with several accolades, including the NIH NIBIB Trailblazer Award, a Human Frontiers Science Young Investigator Grant, the Ralph E. Powe Junior Faculty Enhancement Award, and an Air Force Office of Scientific Research DURIP. In 2025, Dr. Jayant was selected to lead a DoD AFOSR MURI across 6 universities.

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