CNS*2025 Florence

TYPE - KEYNOTE • JULY 5 • SATURDAY

K Keynote

JULY 5 • SATURDAY

PINNED
16:00 – 17:20

K **Welcome and Keynote #1: Konrad Kording, "Causality & Beyond: Neuroscience in the Data-Deluge Era"**
Auditorium - Plenary Room

Speakers: Konrad Kording
Chair: Julie Haas

Neuroscience is thriving in an era of unprecedented data. Advances in recording, imaging, and machine learning have opened new frontiers—but understanding how brain activity causes behavior remains elusive. Traditional inference struggles in vast hypothesis spaces, and many neural correlations resist causal interpretation. This talk explores how exponential scaling is reshaping neuroscience, showcasing successes like speech decoding and outlining the limits of current causal approaches. I argue for a shift toward tractable systems, structure–function integration, and targeted interventions. As we move from intuitive models to machine-driven discovery, we must reimagine what it means to explain the brain—not just predict it.

K Keynote

JULY 6 • SUNDAY

PINNED
09:00 – 10:10

K **Announcements and Keynote #2: Sara Solla, "Low dimensional neural manifolds for the control of movement"**
Auditorium - Plenary Room

Speakers: Sara Solla

A fundamental question of systems neuroscience is how neural population dynamics implement computations and information processing. The problem is formidable, as neural activity in any specific area not only reflects its intrinsic dynamics but must also represent inputs to and outputs from that area, and the computations being performed. The analysis of neural dynamics in several brain cortices has consistently revealed the existence of low dimensional neural manifolds, spanned by latent variables that capture a significant fraction of neural variability. In the motor cortex, the analysis of population activity provides solid evidence in support of low-dimensional neural manifolds and reveals surprising geometric similarities between manifolds associated with various motor tasks. The ability of manifold dynamics to predict muscle activation leads to the hypothesis that these latent variables or "neural modes" are the generators of motor behavior. This manifold-based view of motor cortex dynamics thus may lead to a better understanding of how the brain controls movement.

Chair: Alla Borisyuk

K Keynote

JULY 7 • MONDAY

PINNED
09:00 – 10:10

K **Announcements and Keynote #3: Ken Miller, "Perturbations and Decisions"**
Speakers: Ken Miller Auditorium - Plenary Room
Chair: Matthieu Gilson

I'll present two stories. One is about our work on how perturbation responses derive from circuitry and how circuitry can be derived from perturbation responses. This will focus on responses in E/I networks to optogenetic stimulation of small numbers of cells. I'll introduce a new analytically solvable approach to linear neural field models and a novel nonlinear analysis. Surprisingly, we find that a spatially very narrow component of excitation, surrounded by suppression, does not require a correspondingly spatially narrow component of connectivity, but instead depends primarily on the strength of feedback inhibition, and make a number of other inferences and predictions about circuit structure. The second story analyzes population recordings in macaque area LIP during a reaction-time, perceptual decision-making task (deciding direction of dot motion; saccading to indicate direction as soon as the monkey decides, i.e. a reaction-time rather than fixed-delay task). We show that the trajectories in the neural state space (the space in which each dimension is the firing rate of one neuron) are organized by reaction time in a curved but locally 2D manifold. Analysis of the trajectories shows they divide into two qualitatively different portions: a "deliberation" phase in which neural responses are noisy both in cognitively relevant and irrelevant direction, are driven by fluctuations in sensory evidence, and do not strongly separate by choice; and a "commitment" phase in which noise is suppressed, influence of sensory evidence seems minimal as though the dynamics is more intrinsically-circuit-driven, and trajectories separate strongly by choice and proceed directly to the saccade endpoint. The deliberation phase is not seen for the fastest reaction times, and becomes more and more prominent with increasing reaction time. Surprisingly, the commitment phase can begin a long time (~500ms or more) before the saccade preparation, in contrast to previously prevailing ideas that saccade preparation immediately follows an internal decision reached by sensory evidence integration. A circuit model accounts for all the data, in which activity corresponding to the two possible saccade targets are competing during the deliberation phase, and one "wins" and grows rapidly under its own self-excitation during the commitment phase. The model predicts increasing movement of the neurally encoded saccade target position with increasing deliberation time and thus increasing reaction time, leading to two novel predictions that are confirmed in the data.

K Keynote

JULY 8 • TUESDAY

PINNED
14:00 – 15:20

K **Keynote #4: Maurizio Mattia, "Learning to infer transitively on a mental line in premotor cortex"**

Speakers: Maurizio Mattia
Auditorium - Plenary Room

Understanding how the brain encodes and manipulates sequential knowledge remains a central challenge in neuroscience. In this talk, I will propose and empirically support a geometric framework in which high-dimensional neural representations organize knowledge along a “mental line” learned through experience. This model explains how serial ordering and transitive inference emerge from mixed selectivity in neural populations, enabling robust performance even under noisy sensory and neural conditions. Integrating behavioral, computational, and neural data, I will show that premotor cortex (PMC) in monkeys encodes this mental line as animals acquire novel item relationships. Neural

population activity in PMC dynamically aligns with theoretical predictions, revealing a learning-dependent rotation of the “geometric mental line” that links abstract serial reasoning with motor

planning. These findings highlight a mechanistic bridge between symbolic knowledge, neural geometry, and behavior, suggesting a pivotal role for motor-related associative cortices in the flexible encoding of sequential and inferential knowledge.

Chair: Julie Haas