BIOENGINEERING
Faculty Candidate Seminar

Date: **Monday, February 8, 2021**
Time: **12:00 pm - 1:00pm**
Location: **Virtual**

Join Zoom Meeting:
Meeting ID: 988 0549 4005 Passcode: 454698

Holger Dannenberg, Ph.D.

Biography:

As a first-generation college student and an immigrant to the United States from Germany, I am committed to diversity, equity, and inclusion in academia and have experienced the importance of excellent mentorship. My educational background is in Molecular Biomedicine, an interdisciplinary program at the University of Bonn, Germany, that provided me with the scientific knowledge of physiology and an understanding of disease mechanisms. During that time, I developed a deeper interest in memory processes and therefore decided to do my Ph.D. thesis work in Dr. Heinz Beck's laboratory of Cognition Research at the University of Bonn Medical Center in Bonn, Germany, to investigate circuit mechanisms underlying learning and memory. My Ph.D. thesis work used silicon probe recordings of neural activity in mice, signal processing tools, and optogenetic circuit manipulations to investigate how cholinergic neurons in the medial septal complex shape activity patterns and theta rhythmic oscillations in the hippocampus. Finishing my Ph.D. thesis, I came to the United States to join the laboratory of Dr. Michael E. Hasselmo in the Center for Systems Neuroscience at Boston University. At Boston University, I was a senior postdoc leader on a collaborative research project between the Center for Systems Neuroscience and the Department of Computer Vison.

Title:

Neural dynamics underlying the coding of location and running speed in the medial entorhinal cortex

Abstract:

Neuronal representations of spatial location and movement speed in the medial entorhinal cortex during the 'active' theta state of the brain are important for memory-guided navigation and path integration—the integration of linear and angular speed signals to update self-location on a cognitive map. However, the exact nature of such a speed signal remains elusive.

In this talk, I will present data from neural recordings in the medial entorhinal cortex of freely moving mice as well as from computational analyses that examine neural representations of location and running speed.

First, I demonstrate that a proposed speed signal by neuronal firing rate is too slow to support accurate

real-time coding of running speed in the medial entorhinal cortex as required by current computational models of path integration. I further demonstrate that optogenetic inhibition of the medial septal complex reduces a potential oscillatory speed signal by local field potential theta frequency but not the proposed speed signal by neuronal firing rate.

Next, I will present data on the existence of a direct and an indirect septo-hippocampal cholinergic pathway. We found that the direct cholinergic pathway modulates firing rates in the hippocampus and the indirect cholinergic pathway drives theta rhythmic activity via an intraseptal GABAergic relay.

The medial septal complex is not only important for theta rhythmic organization of neural activity in the hippocampus and medial entorhinal cortex but also critical for the spatially periodic firing of grid cells in the medial entorhinal cortex. The spatially periodic firing of grid cells has been utilized in computational models of path integration. However, any path integration system accumulates error over time. In the last part of my talk, I demonstrate that the spatiotemporal accuracy of grid cell firing is reduced in the absence of visual cues. These data are consistent with a role of vision in updating grid cell firing and correcting errors in a path integration system. Intriguingly, the observed changes in the spatial accuracy of grid cell firing showed a slow component of change on a time scale of tens of seconds and correlated with changes in the proposed oscillatory speed signal represented by local field potential theta frequency. Taken together, these data suggest that the representation of space by grid cells in the medial entorhinal cortex is malleable by past experiences and may be a function of velocity signals integrated over past time.