Master Project

Memory Formation in Cortical and Hippocampal Circuits

This project studies how long-term memories are stored and represented across distributed brain regions. We will combine a multisensory virtual reality environment with electrophysiological recordings and two-photon calcium imaging to address this question.

Background

Our memories link past experiences to present behavior, enabling us to recognize patterns, form associations, and adapt to our environment. Long-term memories are thought to form through a process where the hippocampus initially encodes new experiences, and these representations are gradually transferred to distributed cortical networks for stable storage. While this framework has been influential, the underlying neural mechanisms remain poorly understood. Specifically, we lack knowledge of how neural populations in the hippocampus and cortex coordinate during consolidation, which circuits are engaged at different stages, and how neural dynamics evolve as memories stabilize.

This project will address these questions by combining mouse behavior, two-photon calcium imaging, and electrophysiology to track memory formation across brain regions in real time. Mice will learn to navigate multisensory virtual reality environments while we simultaneously record from thousands of neurons across hippocampal, sensory, and associative cortical areas. This multimodal approach will allow us to characterize how neural activity patterns emerge, interact, and evolve during memory encoding and consolidation.

Goals

In this project, you will:

1. Train mice to perform tasks in a virtual reality environment that we have developed.
2. Perform surgery on mice to implant cranial glass window (for imaging) and probes (for electrophysiological recording).
3. Perform simultaneous two-photon imaging and electrophysiological recordings from hippocampal and cortical regions.
4. Analyze pilot data to understand how neural activity patterns relate to memory formation.

Your profile

We are looking for students who:

- Have strong interest in systems neuroscience and neural circuit mechanisms
- Are motivated to work with laboratory mice, including performing surgery, handling, behavioral training, and conducting recordings (training will be provided)
- Are interested in learning technical skills
- Are detail-oriented and comfortable with technically demanding experiments
- Have some programming experience is helpful (Python or Matlab)

The preferred project duration is 6-12 months. Shorter semester projects can also be considered.

Supervision

This project will be jointly supervised by Dr. Shuting Han, a SNSF Ambizione junior group leader, hosted within the lab of Prof. Fritjof Helmchen at the Brain Research Institute.

Contact

Interested students should sent an e-mail to han@hifo.uzh.ch. Please attach a brief statement explaining your background and interests, a copy of your transcript, and your CV.