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# Head direction and goal direction signals

## Sujet proposé par

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Saints-Pères Institute of the Neurosciences (SPPIN)  
Orientation and Coordination

## M2 Research project title

Head direction and goal direction signals

## Keywords

electrophysiology, population analysis, attractor network, presubiculum, mouse

## Description of the project

We propose a M2 internship project at the SPPIN (CNRS, Université Paris Cité, 45 rue des Saints- Pères, Paris, France) under the co-supervision of Desdemona Fricker and Michael Graupner. The candidate will be involved in an innovative project dedicated to studying the neural basis of navigation by recording from head-direction (HD) circuits in head-fixed mice. The project will investigate goal-direction signals and directional signal in the HD system. Navigation is a fundamental cognitive process based on the brain's compass system. HD signals are generated from vestibular inputs, are stabilized through visual cues and are internally organized as a ring attractor to maintain directional activity. How HD signals influence or are influenced by actively orienting oneself towards a goal is poorly understood from a neurophysiological point of view. This project aims to understand the volitional control of the spatial orientation network. The project is suitable to be pursued as a PhD project to be present at the doctoral school ED3C. We will develop chronic Neuropixels 2.0 implantations to record across several days, including during the learning.

## Methods and techniques

Our setup lets us compare the neuronal population coding during passive rotation of the stage, vs. a condition where head-fixed mice actively choose a direction by turning a steering wheel. We focus on key structures involved in head directional signaling, the presubiculum and the visual cortex. Neuronal activity will be recorded using high-density silicon probes (Neuropixels) that can be positioned across both structures simultaneously. The hypothesis is that actively 'driving' the stage enhances the population code of HD signals and predicts the goal direction. If so, this could be exploited for brain-machine interface approaches. We will use decoding techniques to characterize the information about head direction and heading direction in population activity. The candidate will participate in designing a training protocol, teaching the mouse to move towards a water reward, and recording. He or she will be involved in state-of-the-art high density extracellular electrical recording techniques with Neuropixels probes, and learn data analysis and visualisation, and decoding strategies. A background in engineering, math and/or programming skills will be a plus.

## References (at least 3)

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