Got Milk? Assessing Goal Directed Behavior Driven By Sensory Cues and Memory in Rats

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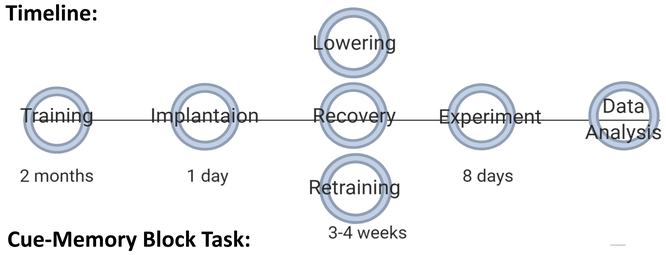
Introduction

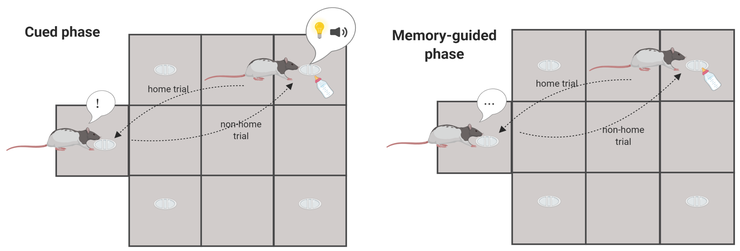
- Memories of places help us navigate without persistent external cues.
- Hippocampus (HPC) is active while representing space (Eichenbaum et al. 1999) and the prefrontal cortex (PFC) is active during goal-directed behavior (Miller and Cohen, 2001), respectively.
- How does HPC promote goal-directed behavior in conjunction with PFC during spatial navigation tasks when rats are driven by sensory cues and memory?

Behavior

Timeline:

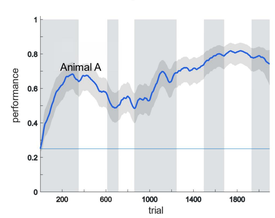


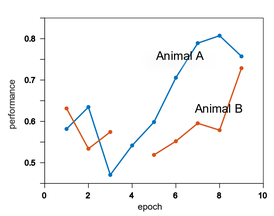
Cue-Memory Block Task:



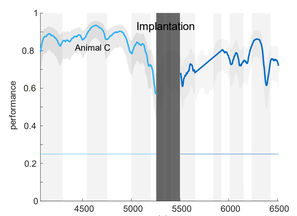
- Training is progressive and tailored to learning of the task

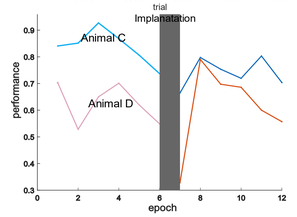
Behavioral performance:





Training performance. Upper: performance by trial for one animal; Lower: performance by epoch for two animals.

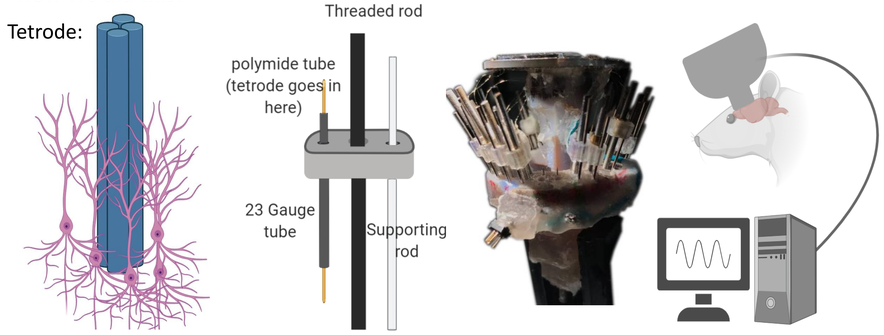




Performance before and after implant surgery. Upper: performance by trial for one animal; Lower: performance by epoch for two animals.

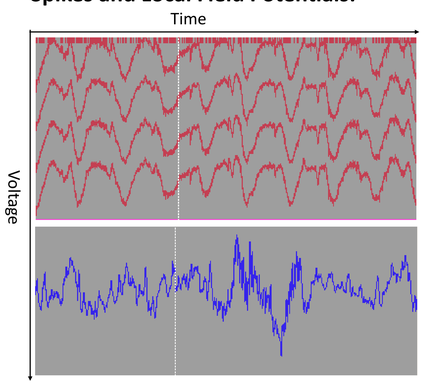
Electrophysiology

How we did this:

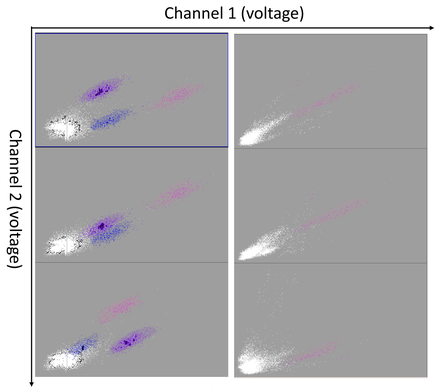


- 128 channels (32 tetrodes) drive currently implanted;
- Tetrodes were lowered to PFC and CA1 region of HPC;
- 256 channels (64 tetrodes) drive under construction.

Spikes and Local Field Potentials:

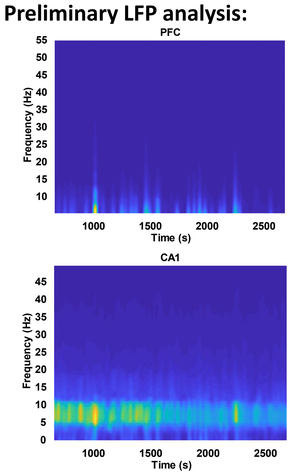


Upper: raw signals collected by one tetrode's four channels. Lower: averaged local field potential (LFP) from one HPC tetrode.

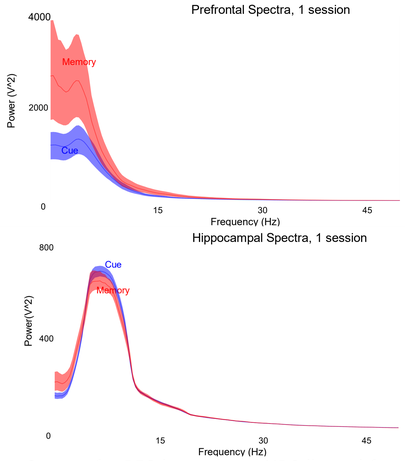


Left: example spike shape from one tetrode in PFC with zoom range 450 μV; Right: example spike shape from one tetrode in CA1 with zoom range 750 μV. Threshold is 40 μV.

Preliminary LFP analysis:



Spectrogram of LFP in PFC (upper) and HPC (lower) for one epoch of one animal



Spectra for PFC (upper) and HPC (lower) for one epoch of one animal

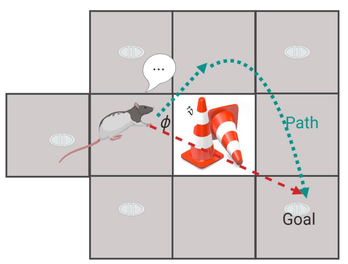
Conclusions & Future Directions

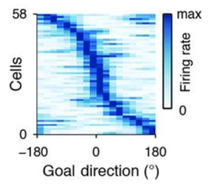
Preliminarily, we have shown:

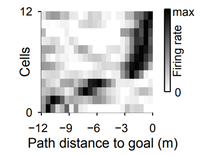
- Animals can successfully be trained to perform this task with high accuracy. Such performance persists after micro-drive array implantation.
- Potential differences in the spectra properties of PFC and HPC between cue and memory-guided phases of the task

Going forward, we would like to:

- Gather electrophysiological data from more animals using higher capacity micro-drive array.
- For the present and incoming data, we would:
  - Examine co-firing of CA1 and PFC cells during goal-directed behavior;
  - Examine cell firing properties in CA1 to see if they display tuning to the angle and path distance of an animal's target, as observed by Sarel et al. (2017);







Ensemble tuning insets from Sarel *et al.* 2017

References

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2. E. K. Miller and J. D. Cohen. *Annu. Rev. Neurosci.*, vol. 24, no. 1, pp. 167–202, 2001.
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