

# Interrogating the role of hippocampal sharp-wave ripples in curiosity-driven spontaneous memory formation



<sup>1</sup>Shayok Dutta, <sup>1</sup>Kayla Vokt, <sup>3</sup>Jim Zhang, <sup>2</sup>Amy Ho, <sup>4</sup>Ariel Feldman, <sup>1,5</sup>Caleb Kemere

<sup>1</sup>Department of Electrical and Computer Engineering, <sup>2</sup>Biosciences, Rice University, <sup>3</sup>Center for Cognitive Neuroscience, Duke University,

<sup>4</sup>Program in Neural Computation, Neuroscience Institute, Carnegie Mellon University

<sup>5</sup>Department of Neuroscience, Baylor College of Medicine

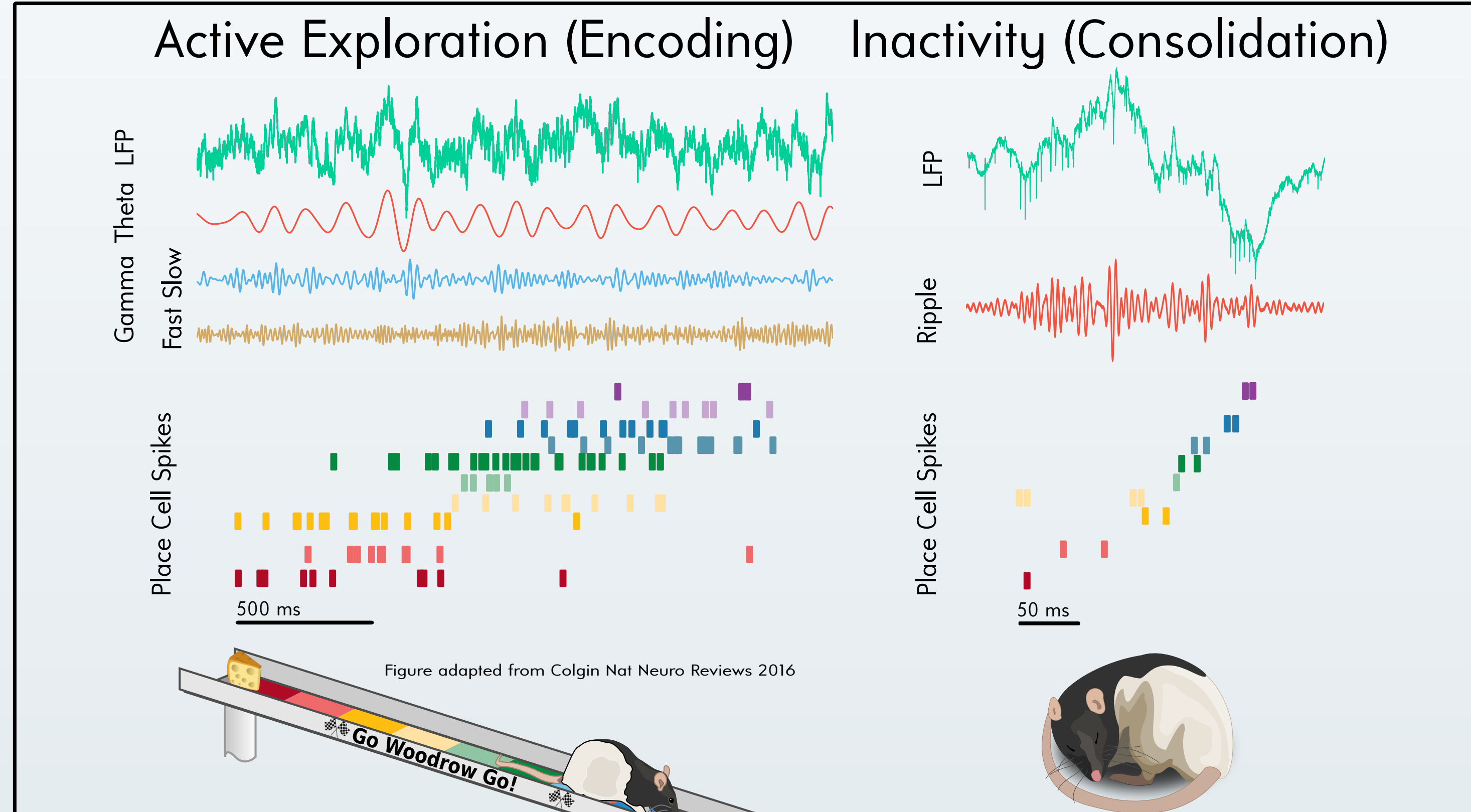


## Introduction

Rodents have an innate curiosity to explore both novel locations and objects. This preference has long been studied behaviorally through various paradigms of a novel object test (NOT). Lesion studies have established that the hippocampus is necessary for this behavior. More recently, studies have been done to find correlative neural substrates to this discrimination. However, we still lack a robust understanding of hippocampal activity that promotes this behavior.

Through closed-loop perturbation we aim to (1) uncover a causal link to this object-place discrimination between hippocampal oscillatory patterns and (2) shed further light upon the intricacies of object-place memory consolidation.

## Background



### Hippocampal background:

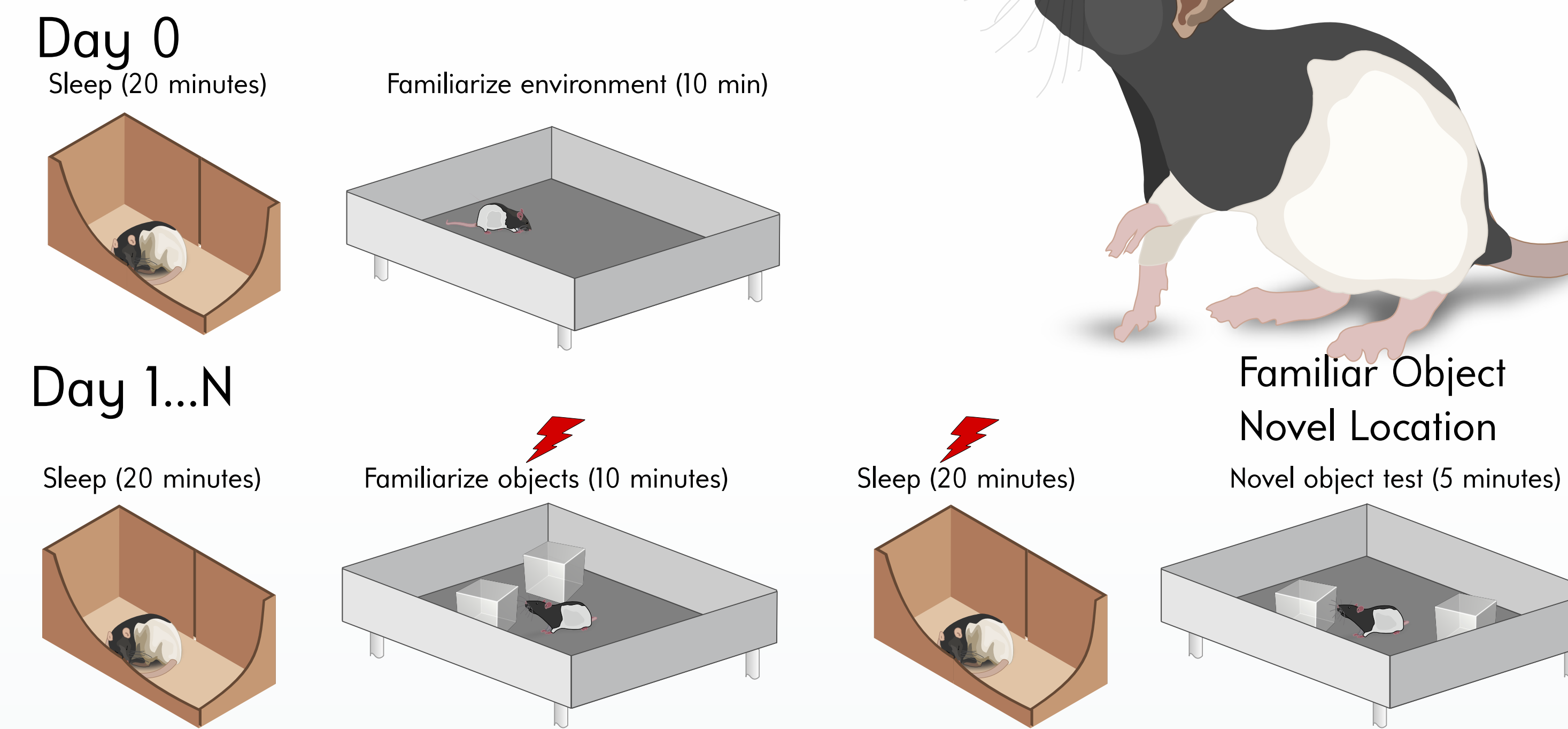
*In vivo* extracellular recordings from the rodent hippocampus exhibits transient oscillations associated with different processes:

- theta & gamma for encoding, retrospection, perspective, decision making
- sharp-wave ripple (SWR) complexes for memory retrieval, consolidation, decision making.

### Novel Object Test Background:

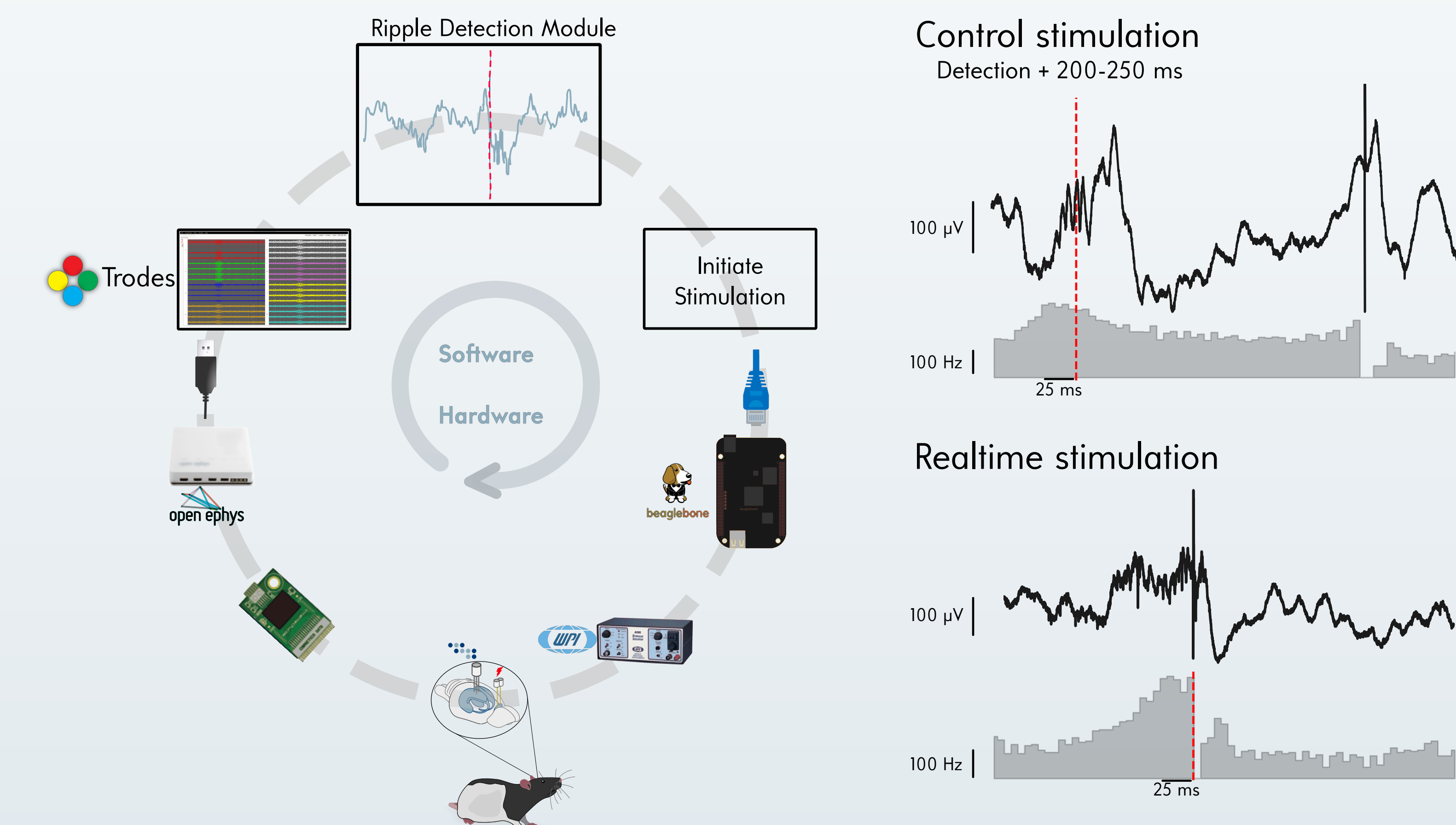
- Hippocampal lesions prevent re-exploration of familiar objects in novel locations<sup>[A]</sup>
- Fast gamma power increases during exploration of novelty<sup>[B]</sup>
- SWRs increase after NOT but ripple content is not reflective of spatial regions of change<sup>[C]</sup>

## Experimental Protocol

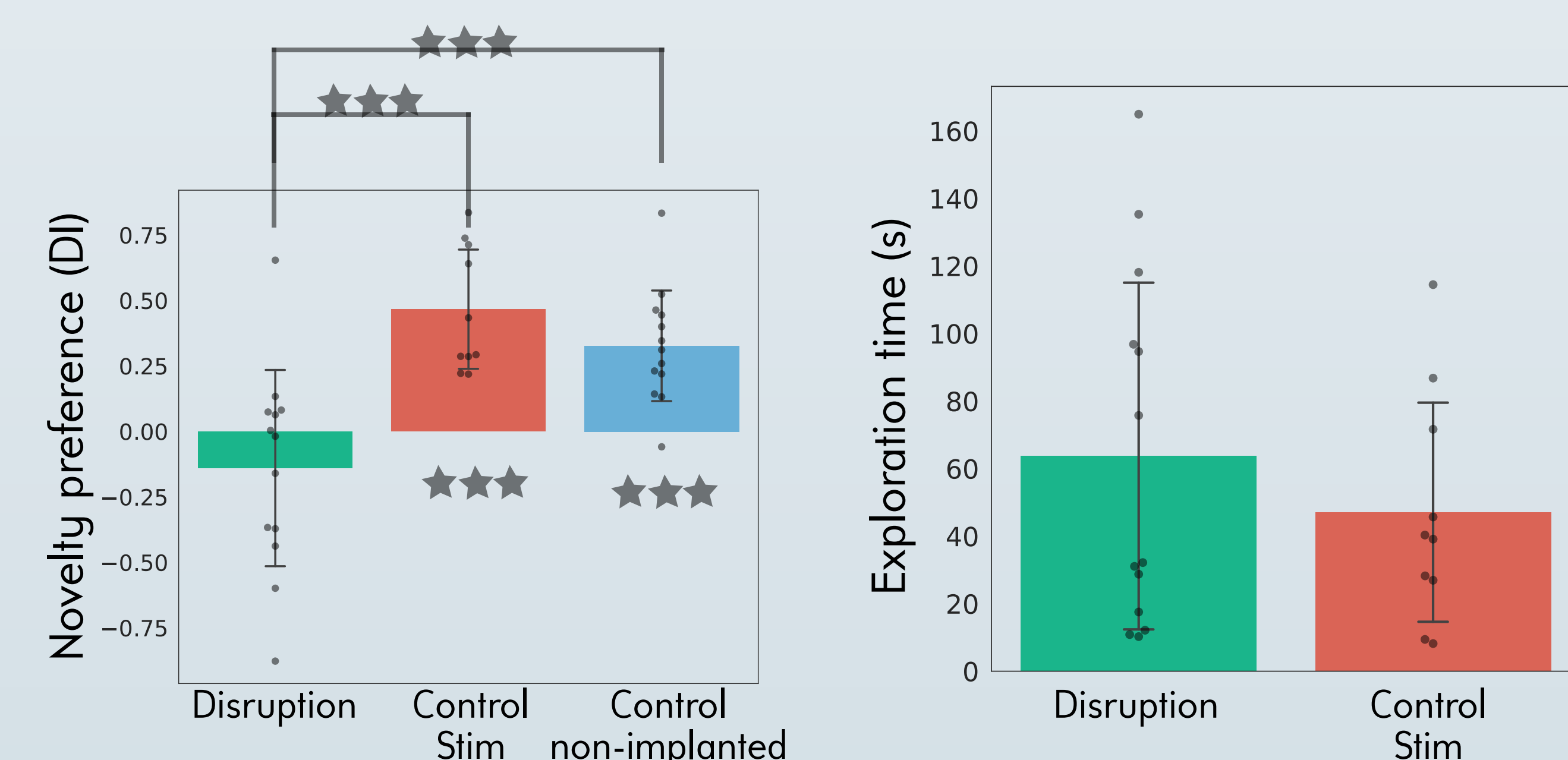


## Closed-loop disruption

- Disruption of sharp-wave ripples during both awake behavior (animal speed < 3cm/s) and sleep using a previously engineered system<sup>[D]</sup>



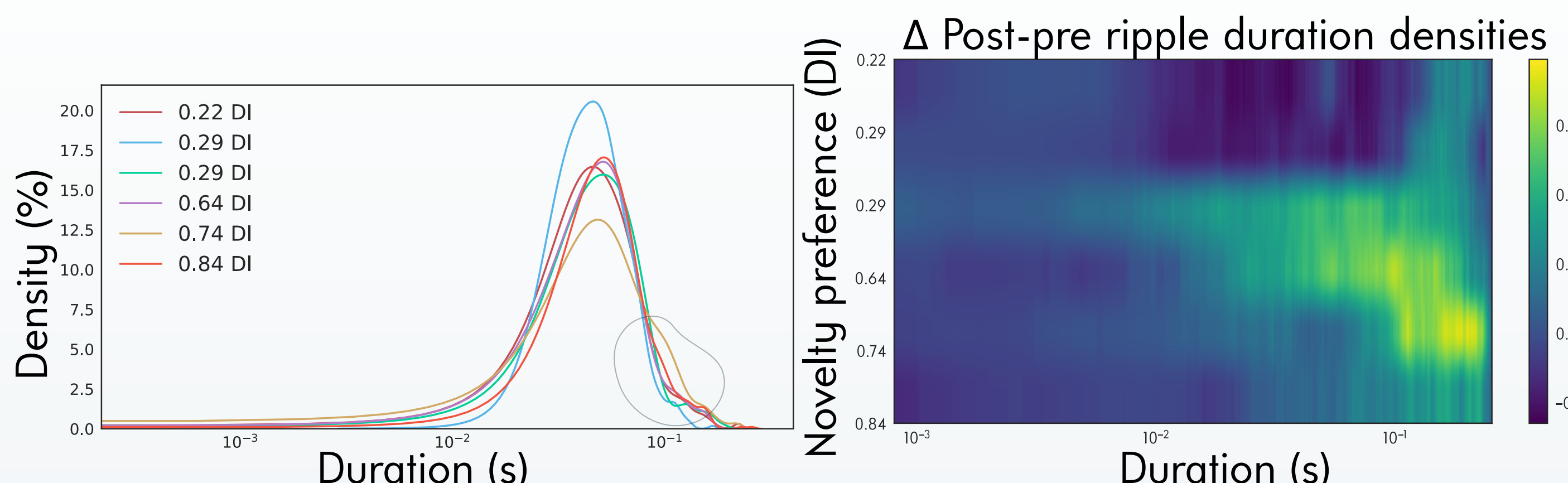
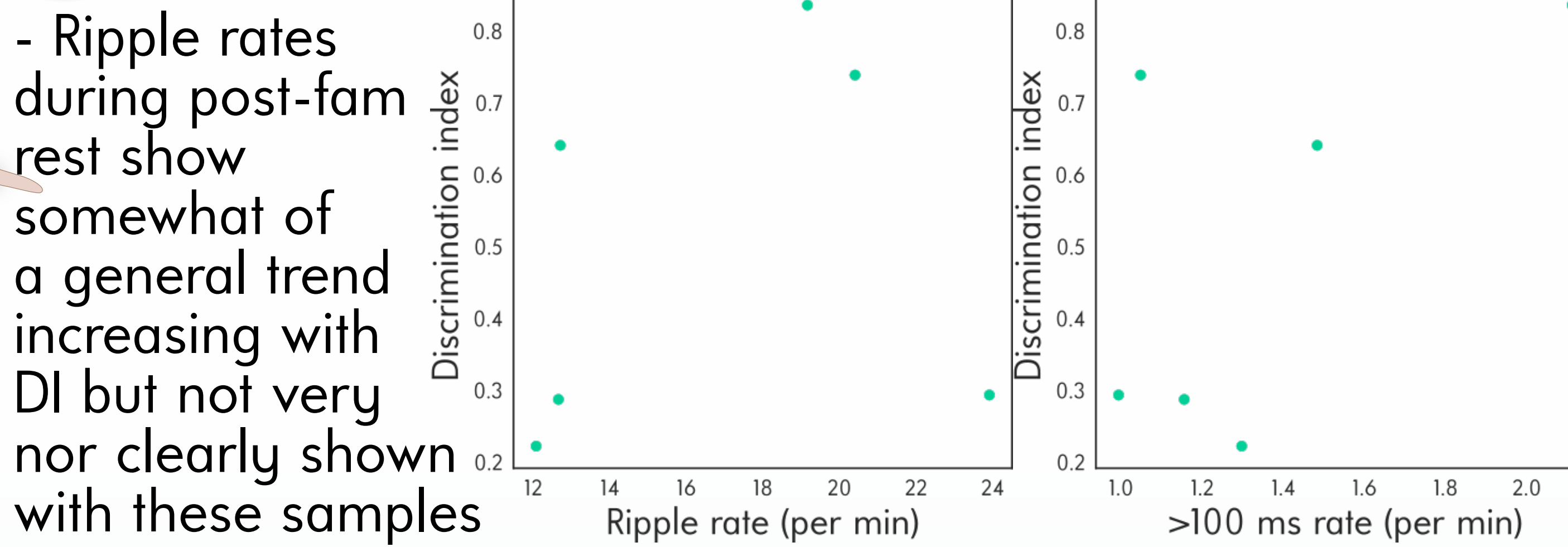
## Behavioral Results



- Disrupting SWRs reduces novel object-location discrimination index scores while the overall exploration times remain similar

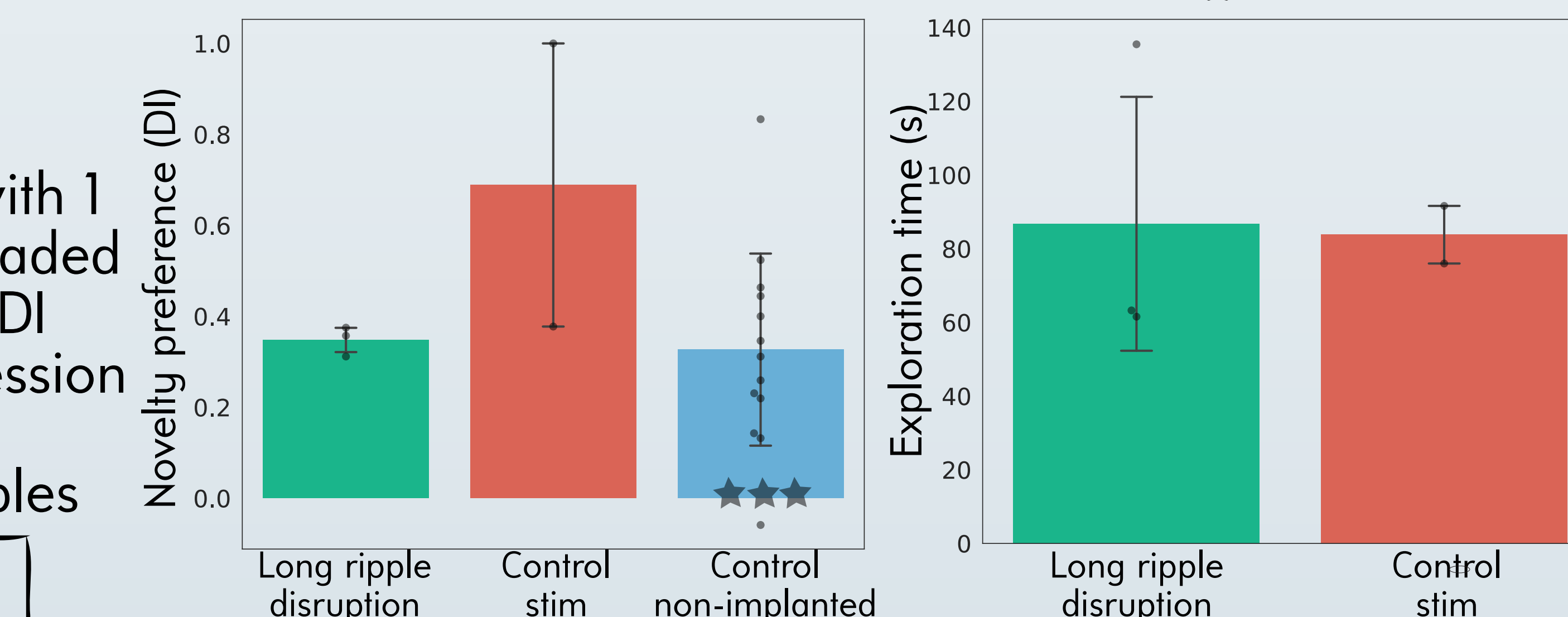
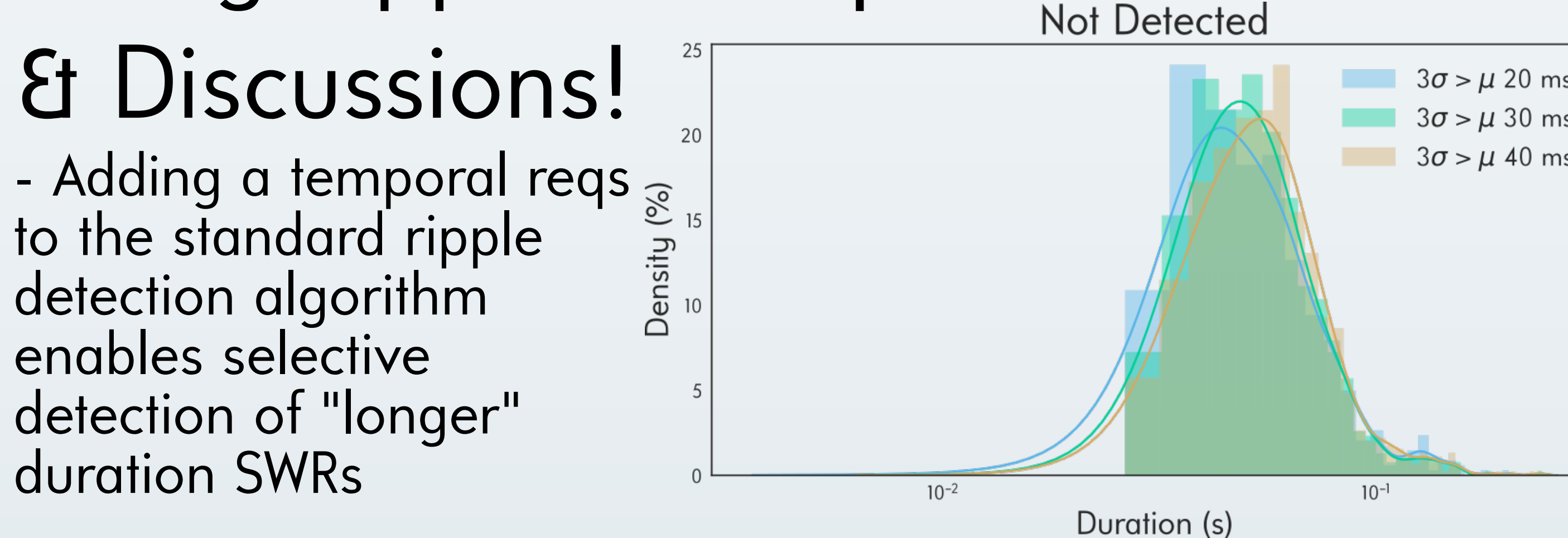
$$DI = (\text{frames exploring novel object location}) / (\text{total frames exploring both objects})$$

## LFP Results



- Density of ripple durations seem to have a general increase towards "longer ripples"
- Even more clearly change between ripple durations in pre & post fam sessions show more "longer ripples" in post fam rest

## "Long Ripple" Disruption Pilot Results



- Adding a temporal reqs to the standard ripple detection algorithm enables selective detection of "longer" duration SWRs
- First closed-loop disruption experiment in natural foraging task (no reward)<sup>[F,G]</sup>
- First ripple interrogation experiment that's repeatable day-after-day!
- Future directions: longer vs shorter ripples, multi-region, place cell stability<sup>[H,J]</sup>

## Funding

This work was supported by an NSF CAREER award (CBET-1251692), an NSF BRNAN EAGER award (IOS-1550994), an HSP Young Investigator's award (BGY10088), and seed funding from the Ken Kennedy Institute for Information Technology.

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