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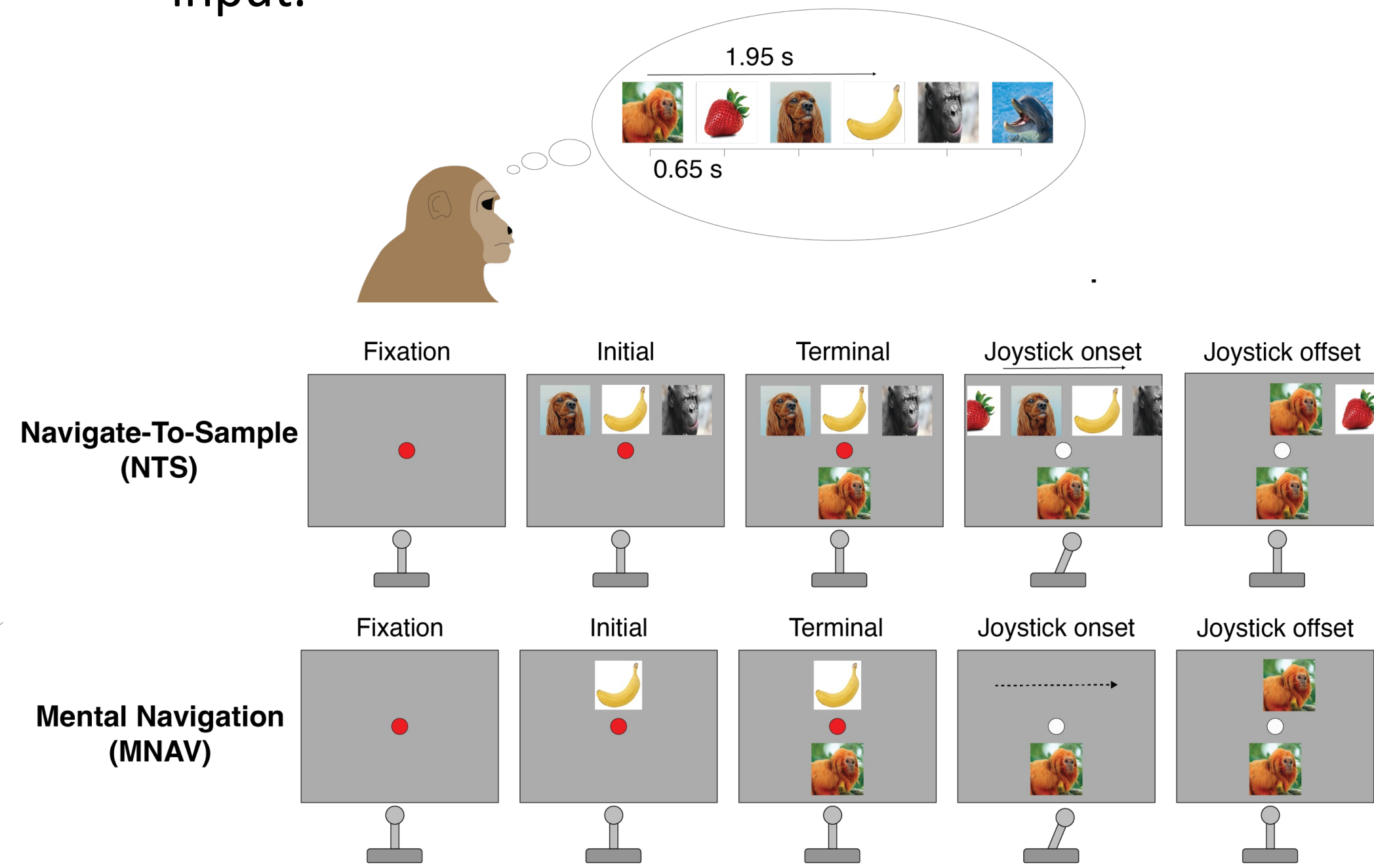
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## Mental Navigation

### Motivation and Behavioral Paradigm

- A cognitive map is thought to organize experiences into knowledge that can be retrieved flexibly to perform mental computation.
- Neural representations of such latent knowledge should enable mental computations in the absence of sensory input.

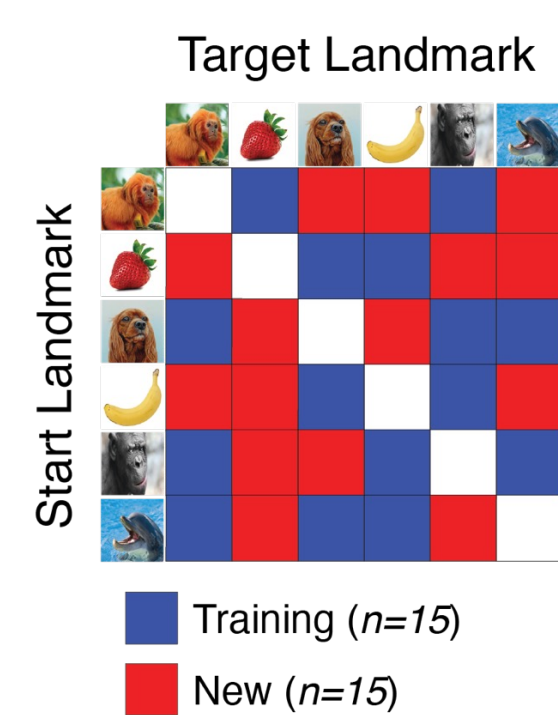


### Generalization

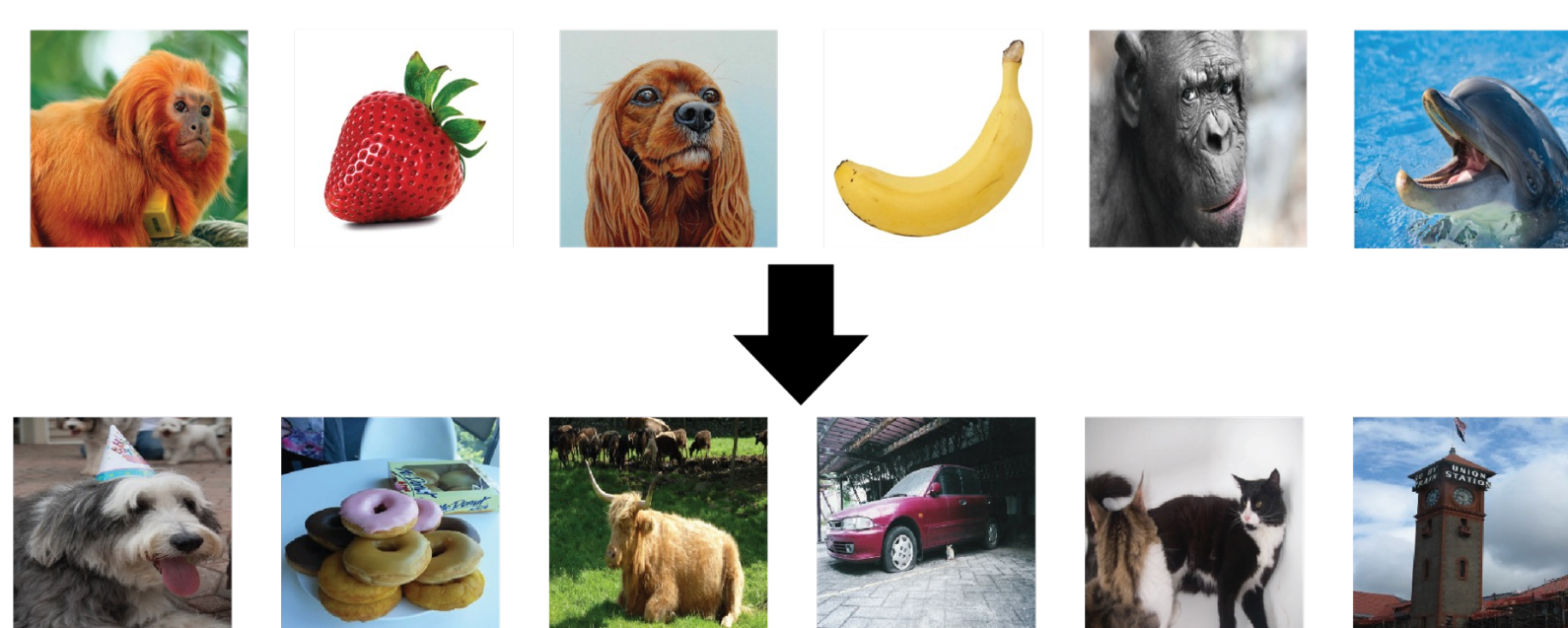
#### NTS -> MNAV



#### Rapid Generalization to Unseen Routes

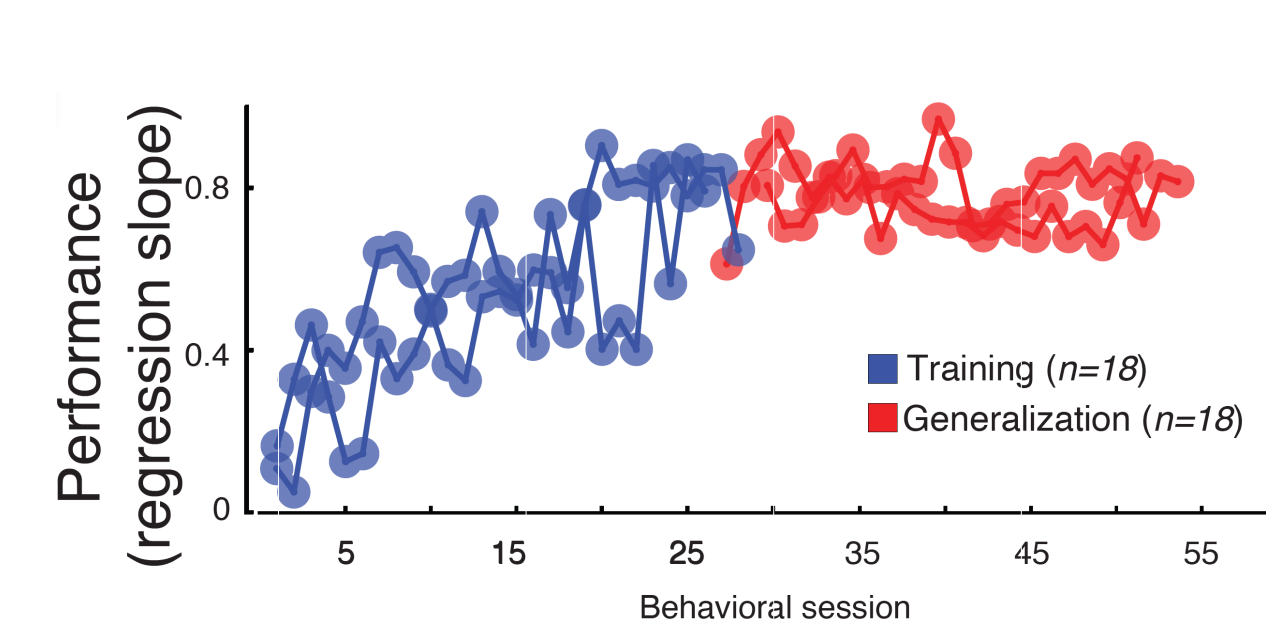


#### Learn the Structure of Landmark Sequence

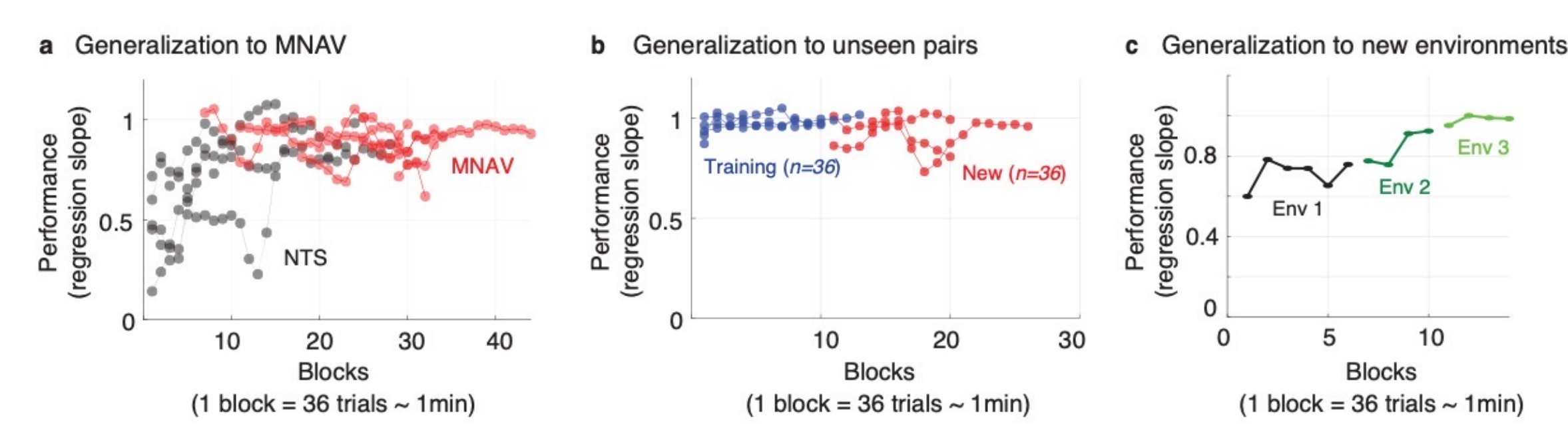


## Behavioral Study

### Monkey

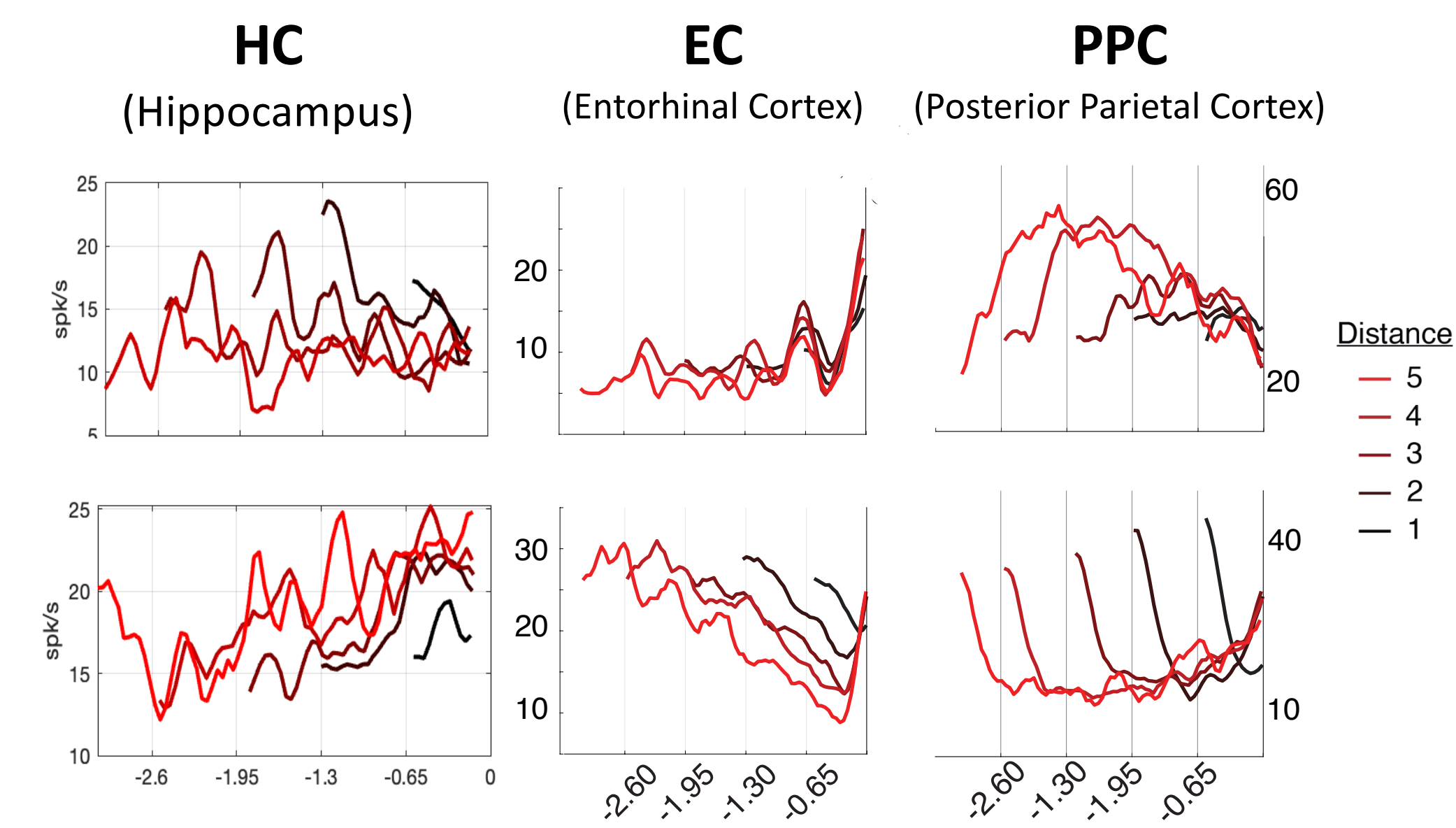


### Human

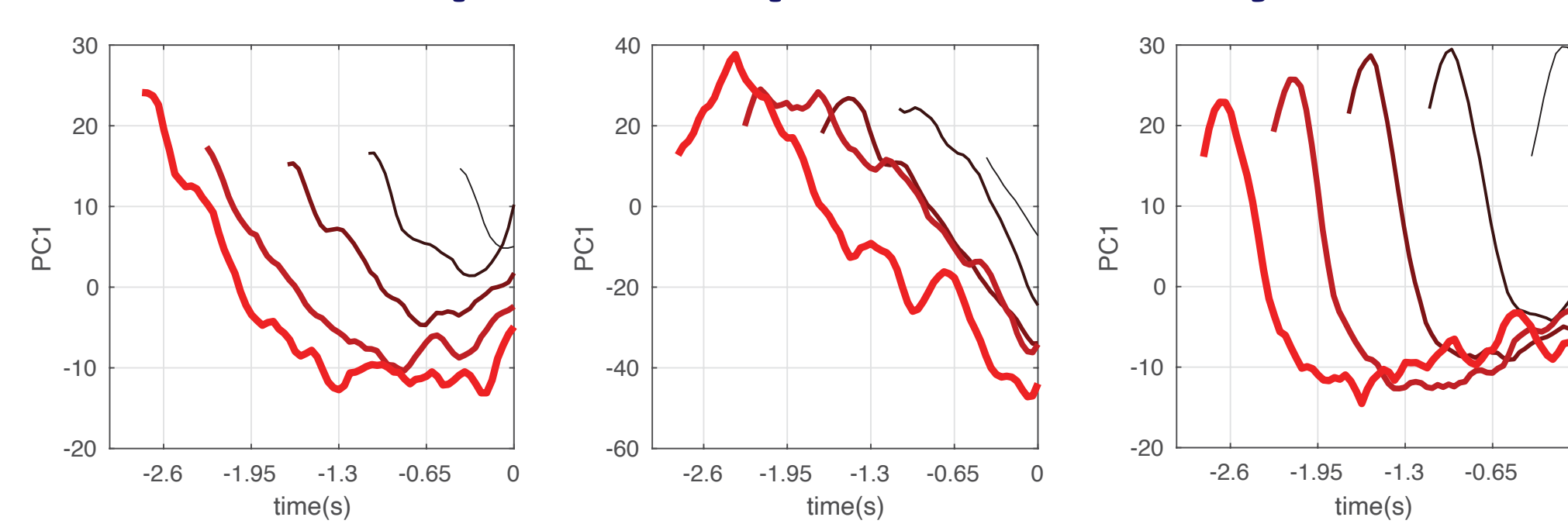


## Monkey Physiology

### Single Neuron Activity

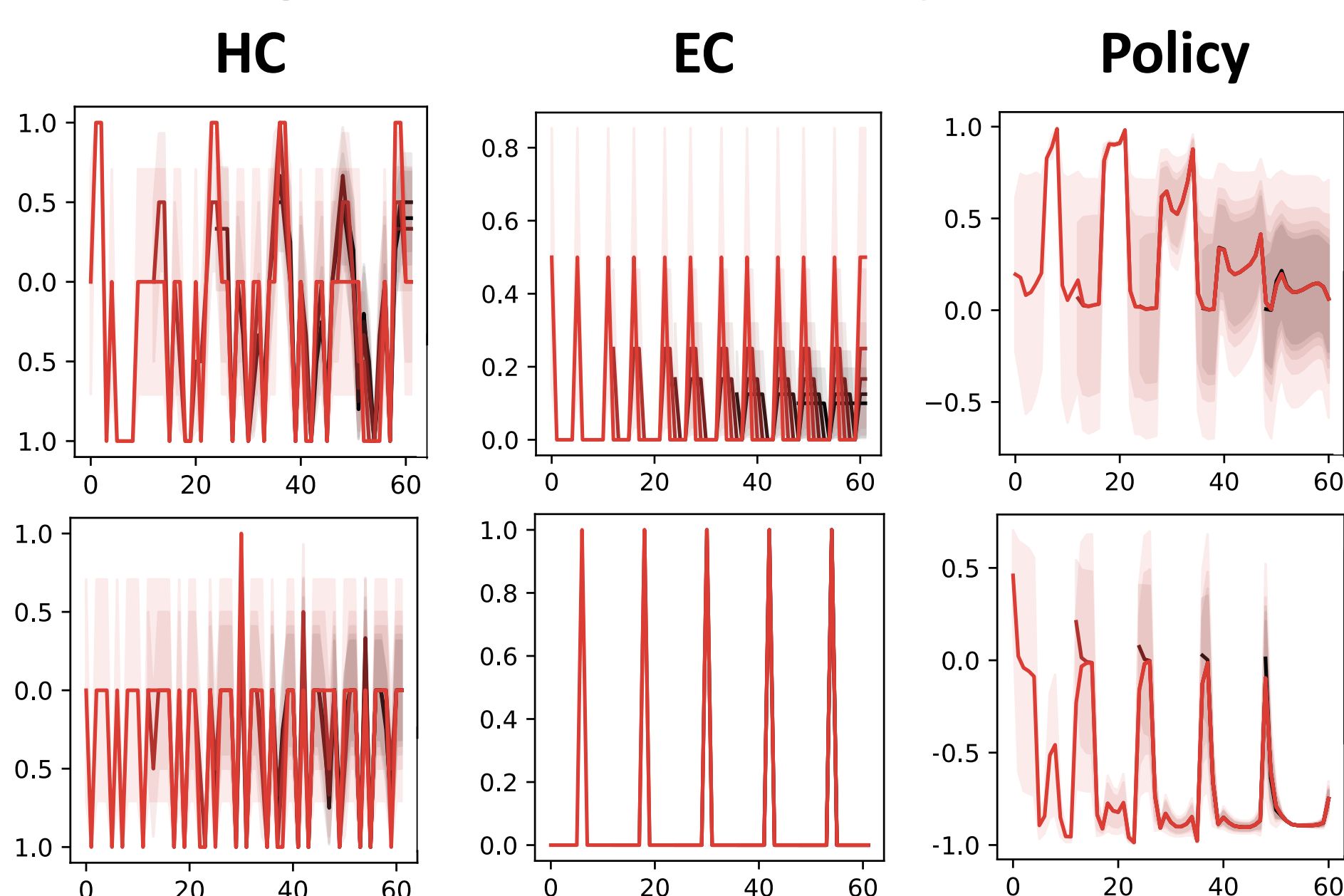


### Principal Component Analysis

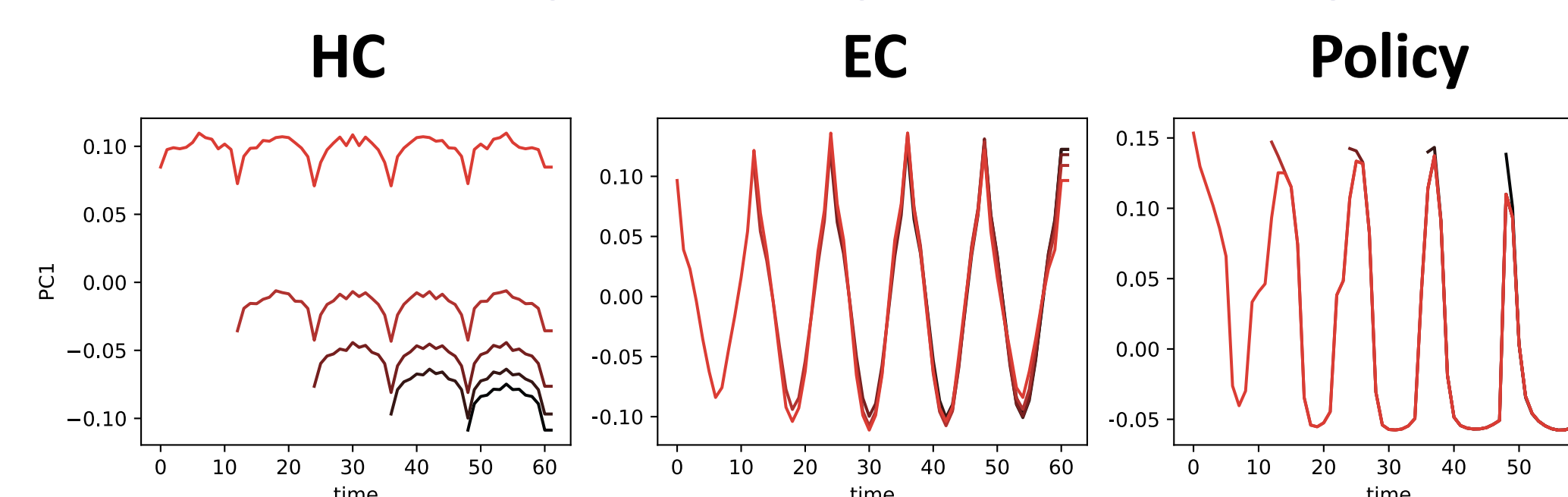


## Model Dynamics

### Single Neuron Activity



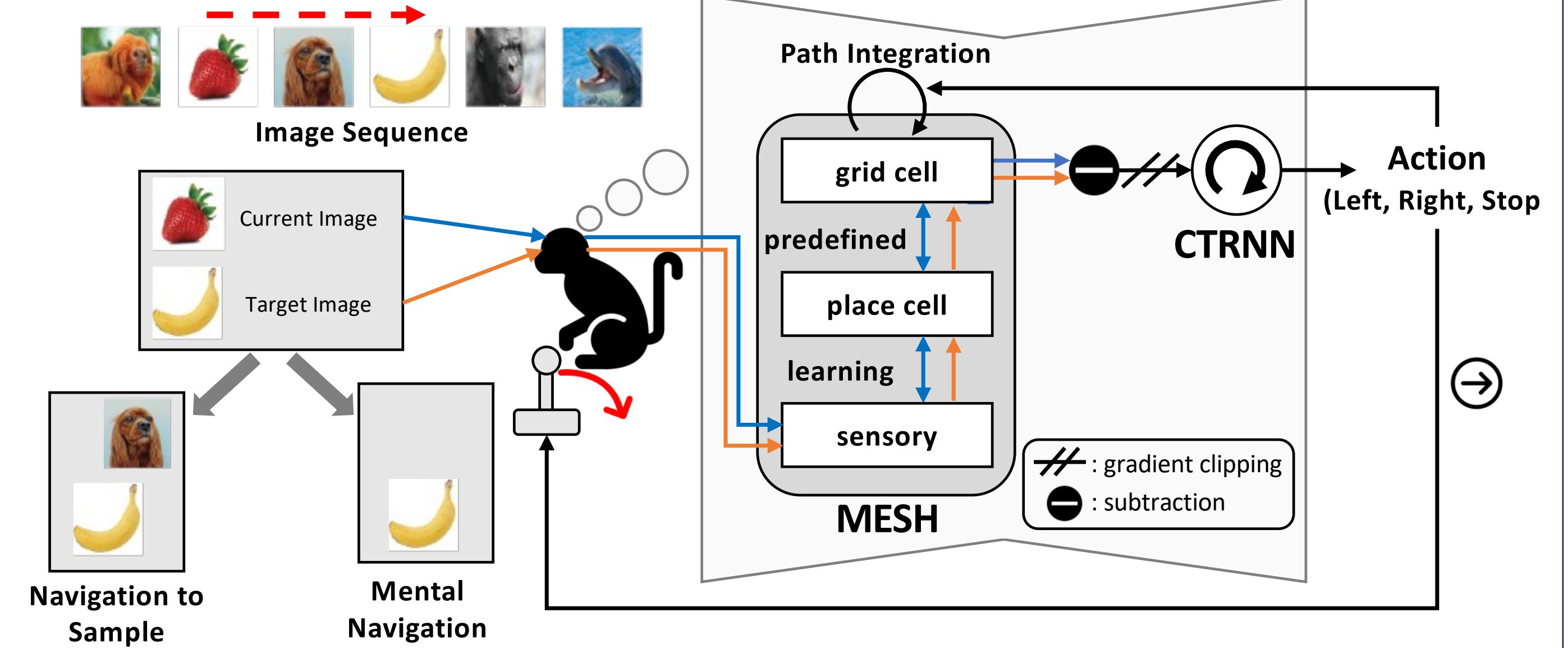
### Principal Component Analysis



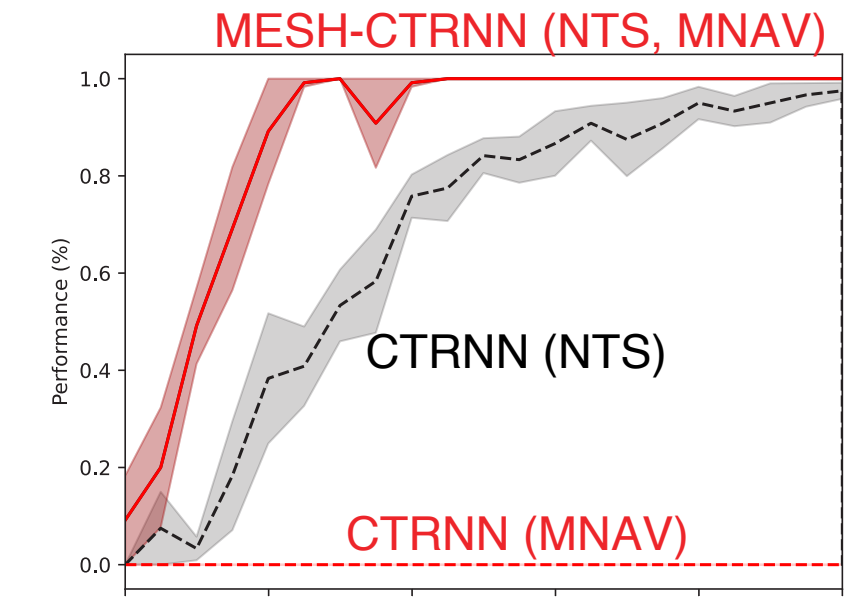
### Reference

- Neupane, Sujaya, Ila R. Fiete, and Mehrdad Jazayeri. "Vector production via mental navigation in the entorhinal cortex." *bioRxiv* (2022)
- Sharma, Sugandha, Sarthak Chandra, and Ila Fiete. "Content addressable memory without catastrophic forgetting by heteroassociation with a fixed scaffold", *ICML*, 2022
- Chandra, Sarthak, et al. "High-capacity flexible hippocampal associative and episodic memory enabled by prestructured "spatial" representations." *bioRxiv* (2023)

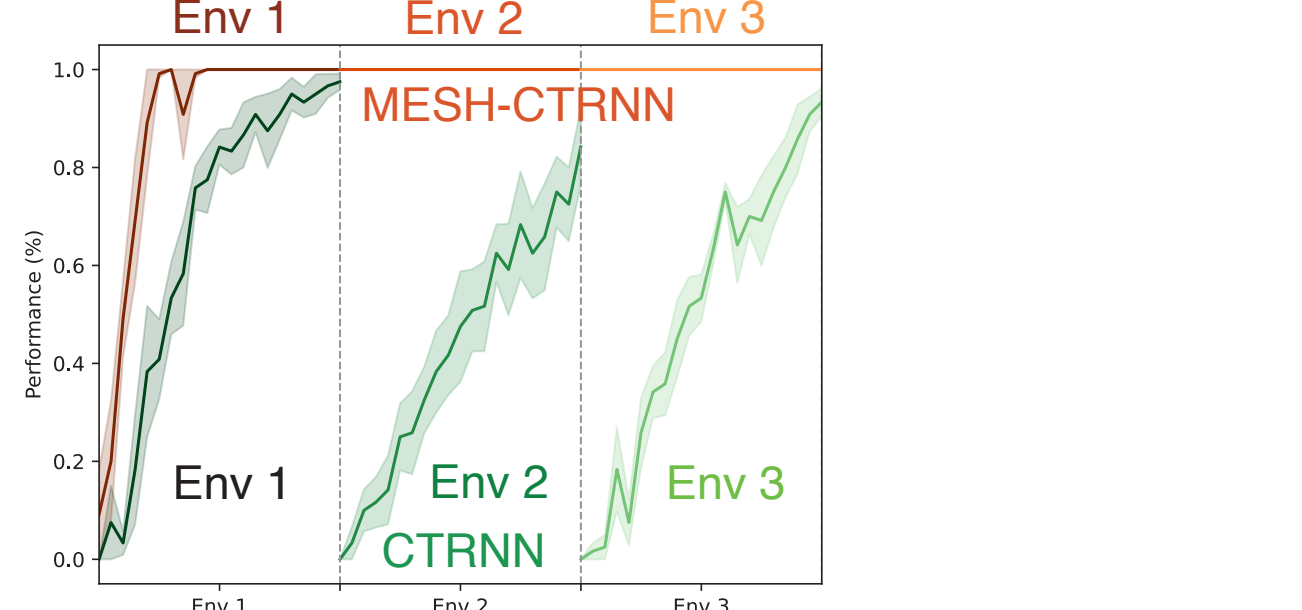
## Modeling



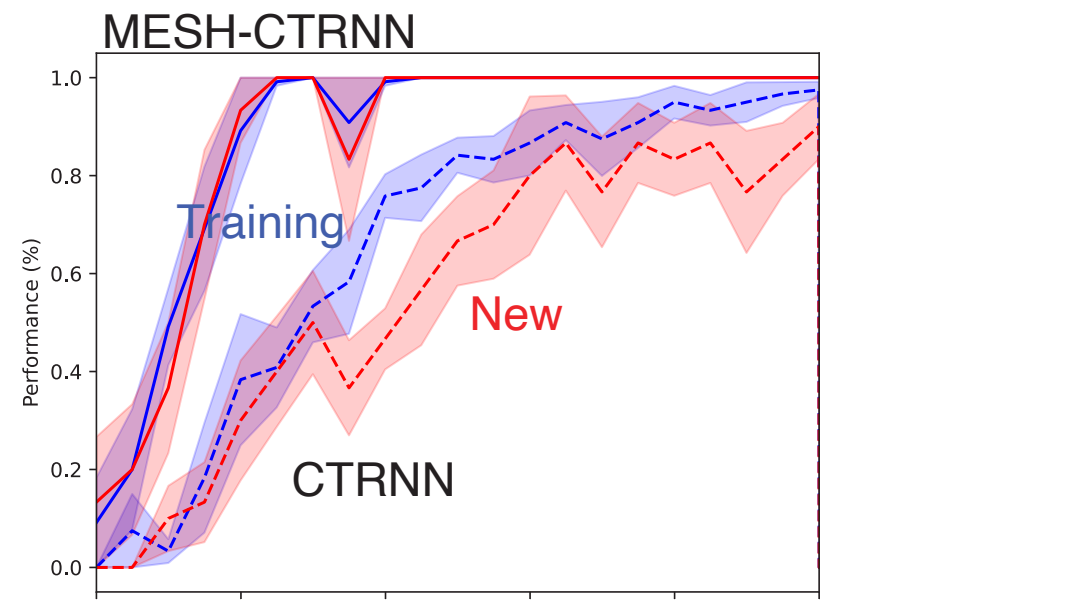
### Generalization to MNAV



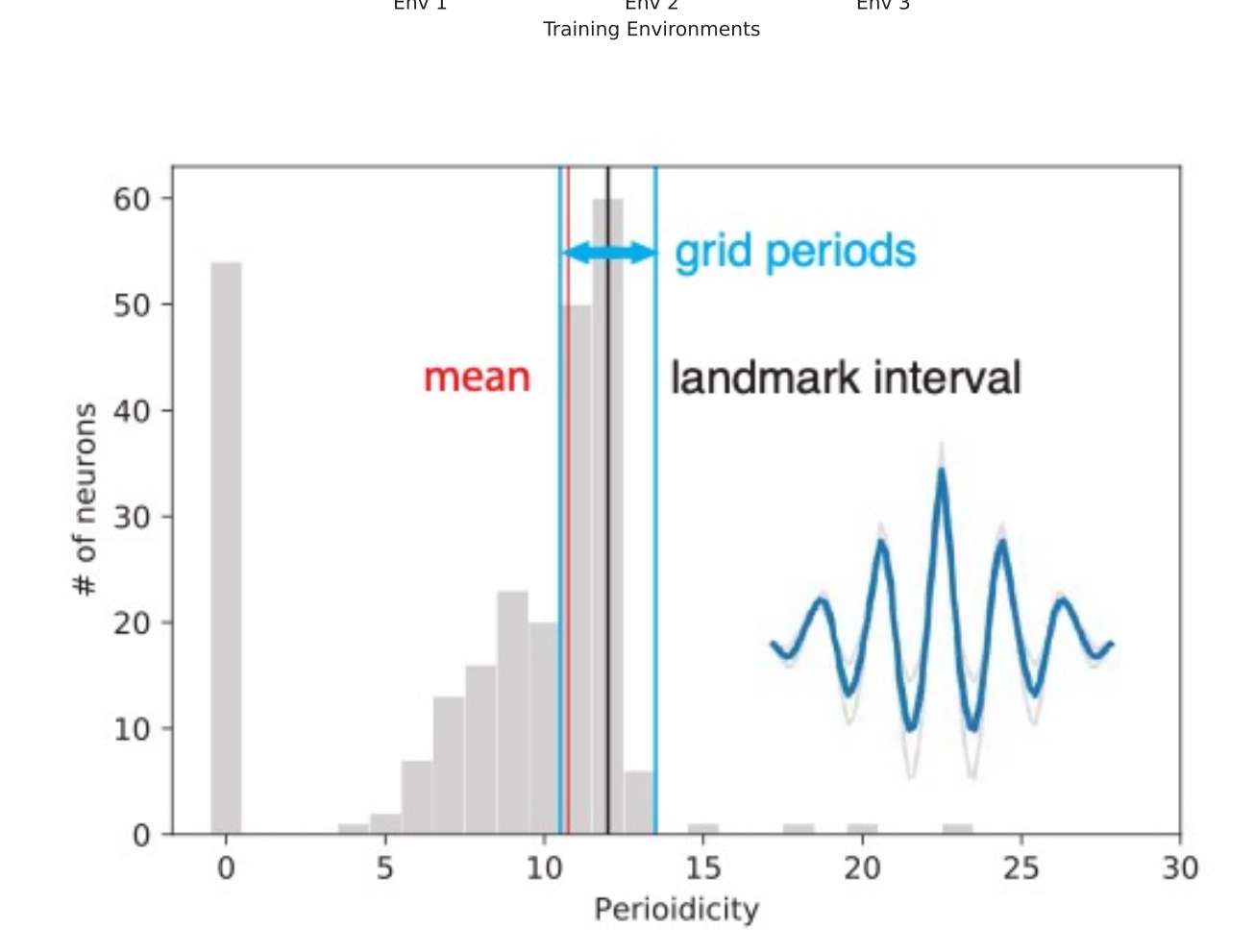
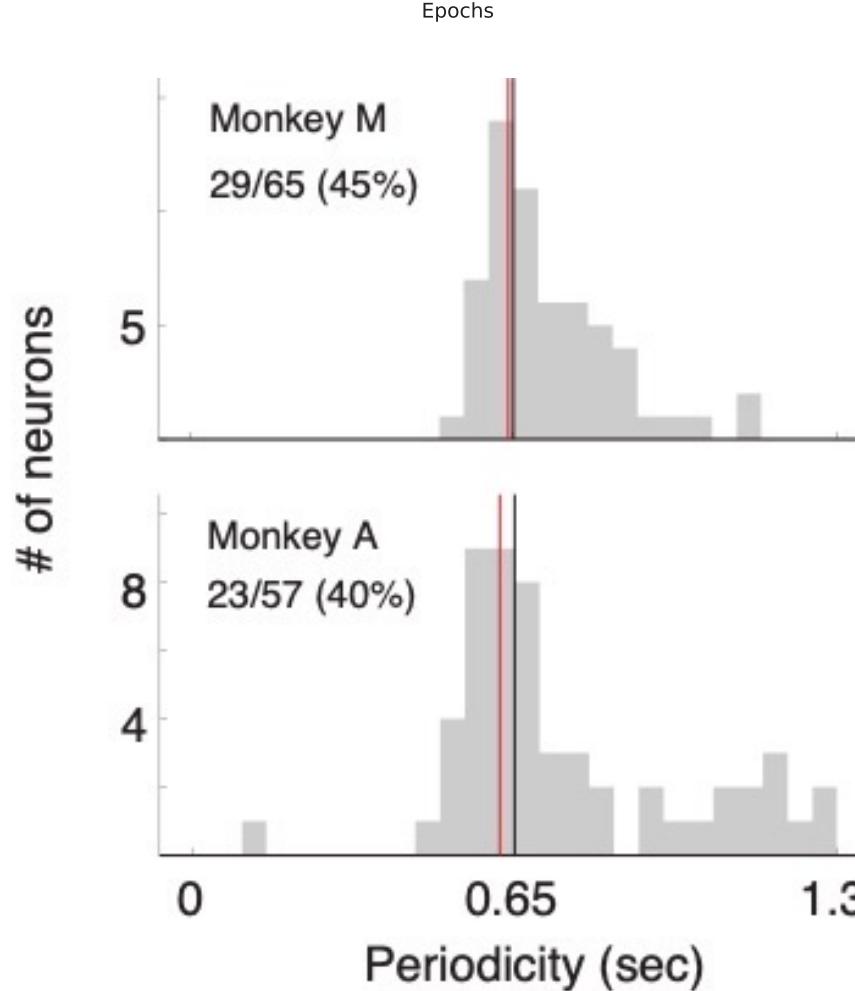
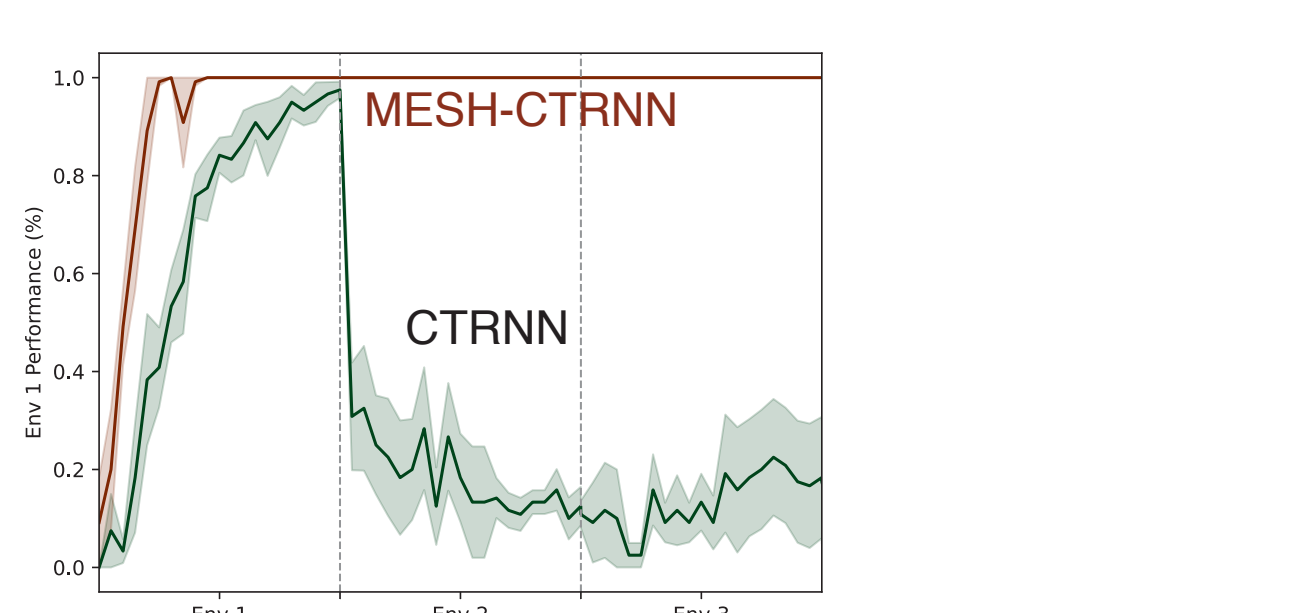
### Generalization to new environments



### Generalization to unseen pairs



### Overcoming Catastrophic Forgetting



## Discussion

- Human and Monkeys exhibit rapid generalization to mental navigation and for unseen routes.
- Humans show faster learning in new environments and resilience to catastrophic forgetting.
- Artificial agents endowed with associative learning mechanism to form cognitive maps shows similar generalization behavior as humans and monkeys.
- Neurons in monkeys and models show signatures of mental navigation.