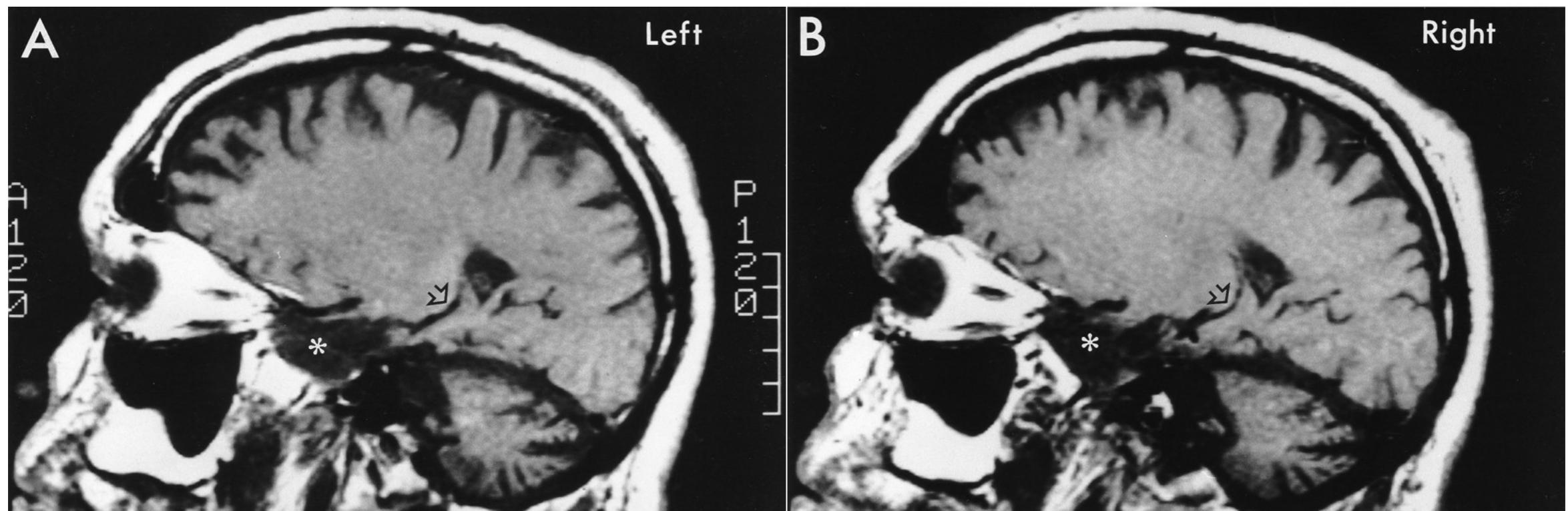


How does the brain encode spatial memories?

Melina Tsitsiklis
Neurobiology PhD candidate
Jacobs and Shohamy labs

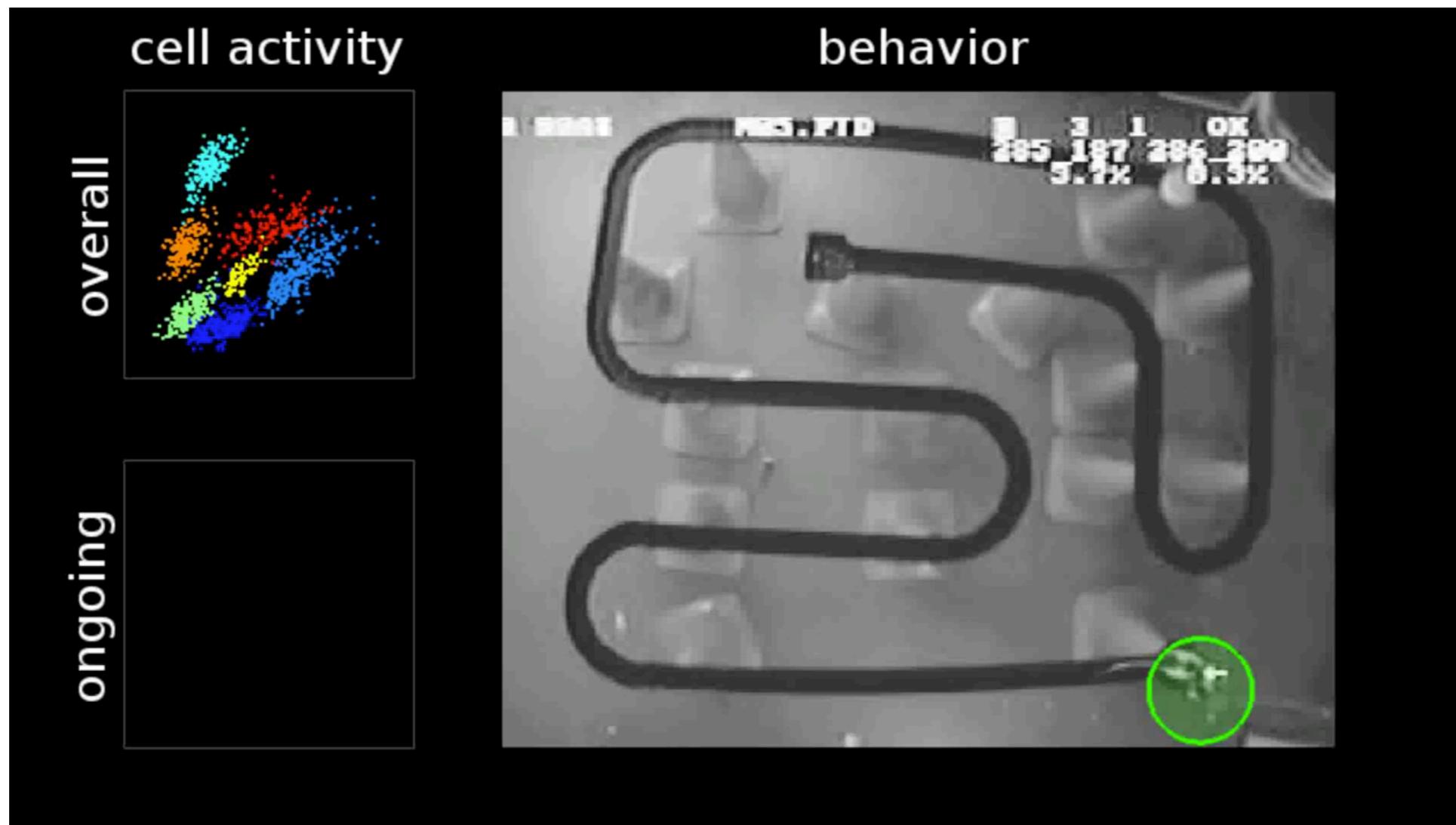
The medial temporal lobe is essential for episodic memory

- Patient H.M.



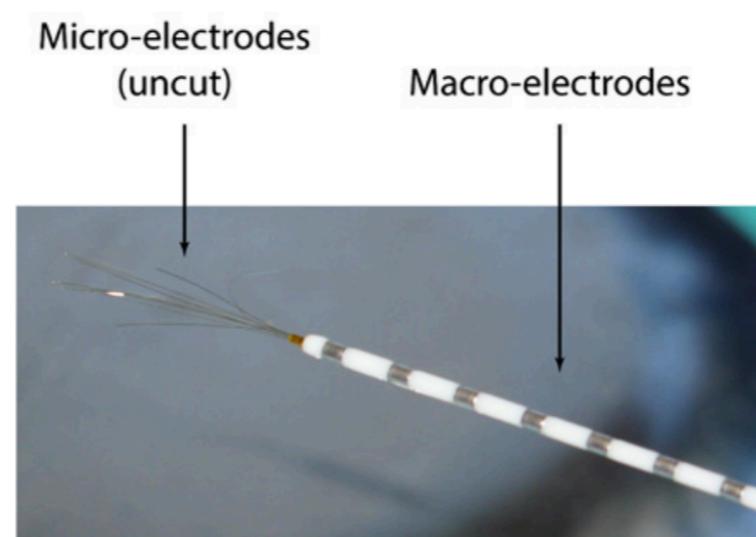
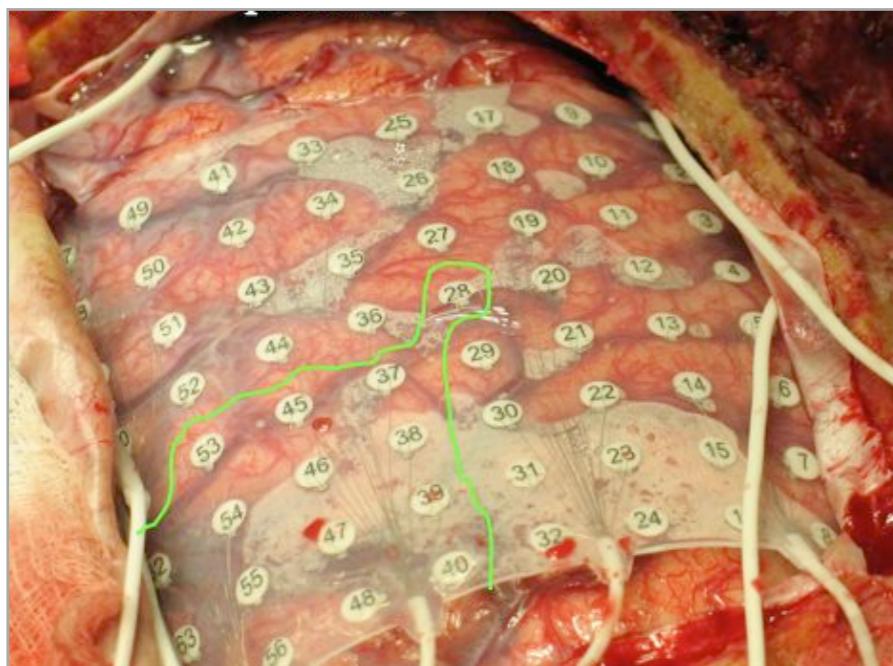
Corkin et al. 1997

The hippocampus contains place cells

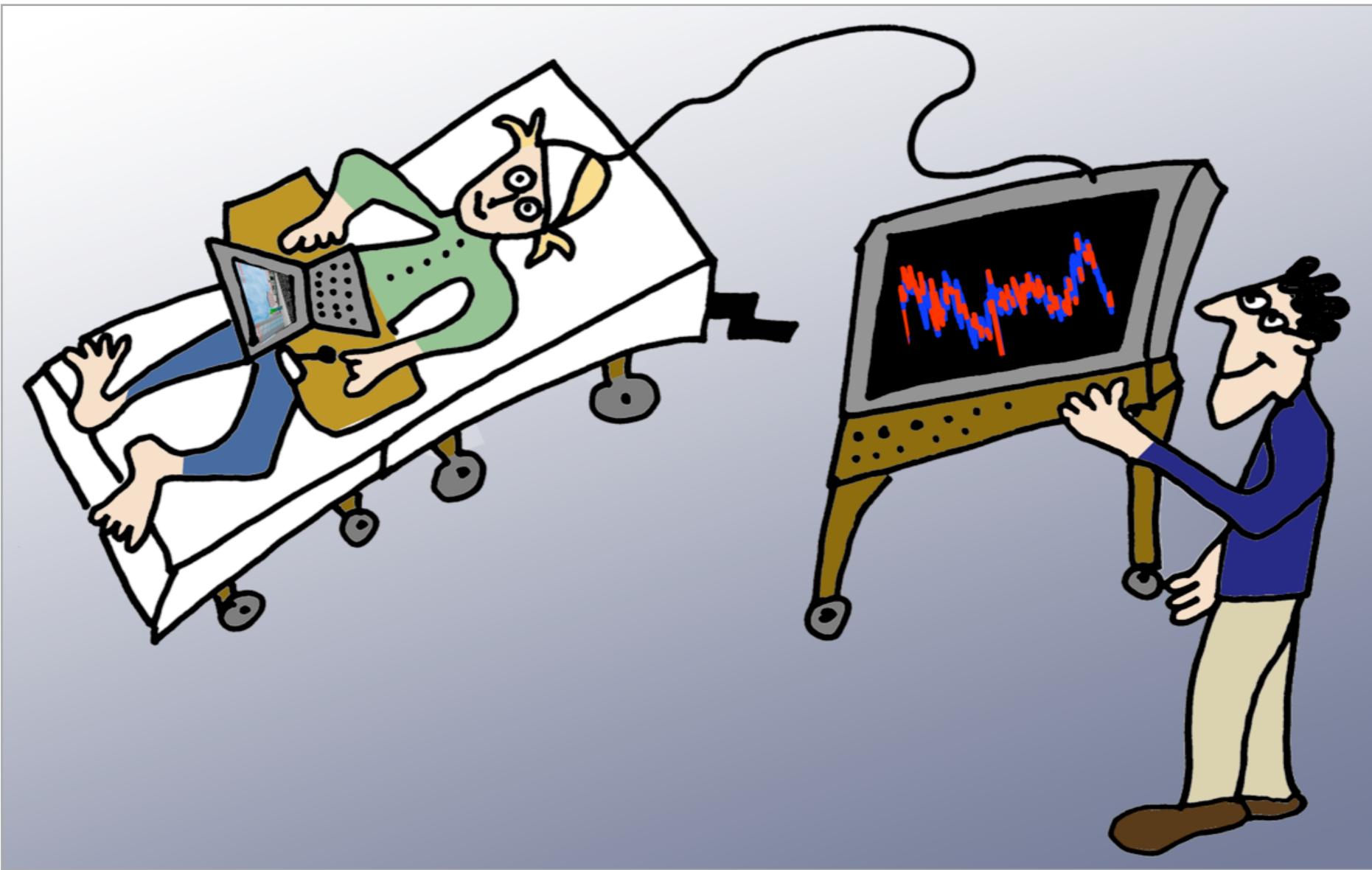


Wilson lab video
O'Keefe and Dostrovsky 1971

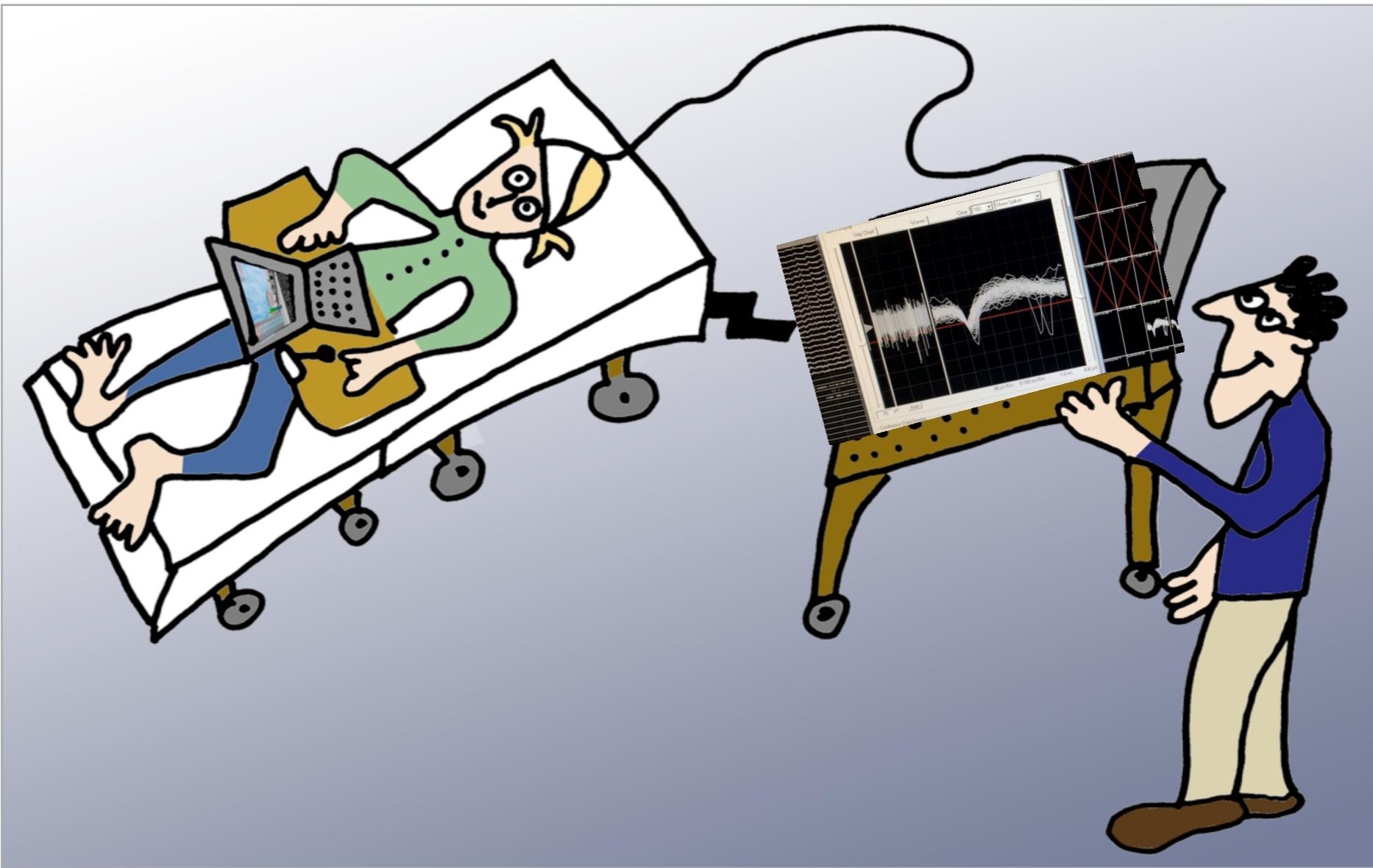
How can we look at these signals in humans?



Combine intracranial EEG with virtual reality task

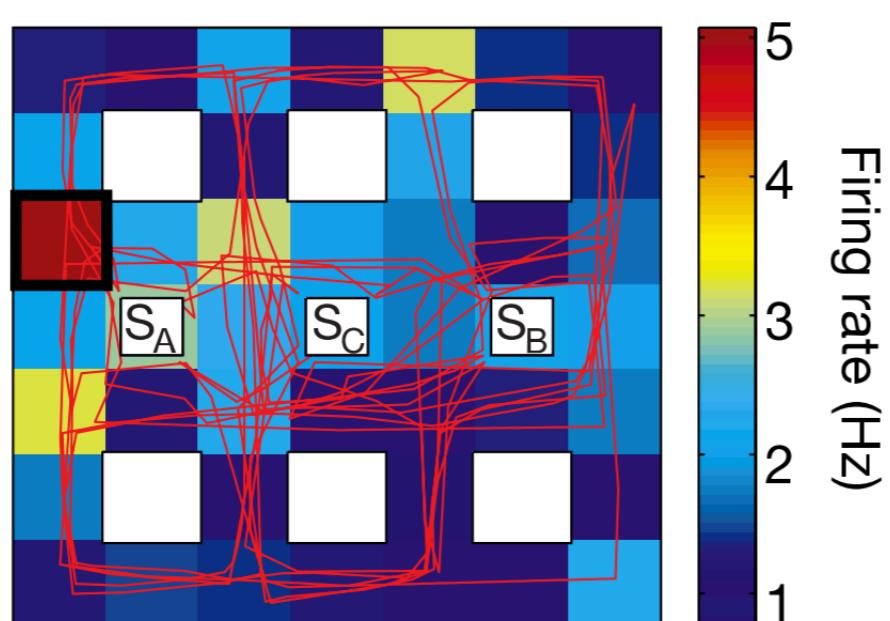


Combine intracranial EEG with virtual reality task



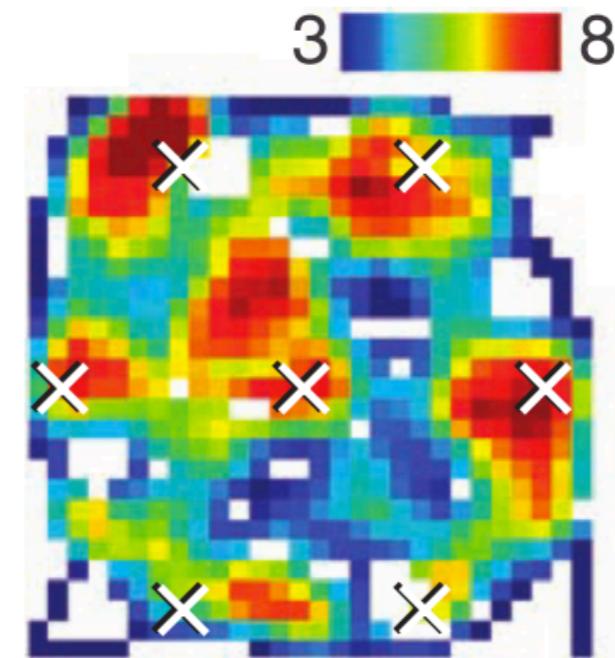
Humans have spatially modulated cells too

- Human place cells



(Ekstrom et al. 2003)

- Human grid cells



(Jacobs et al. 2013)

Question

- Does the human medial temporal lobe (MTL) represent broader aspects of behavior beyond current location?
 - Specifically, in goal-directed navigation, is the relevant remote location reflected in the MTL's representation of space?

Treasure Hunt: a hybrid spatial memory task

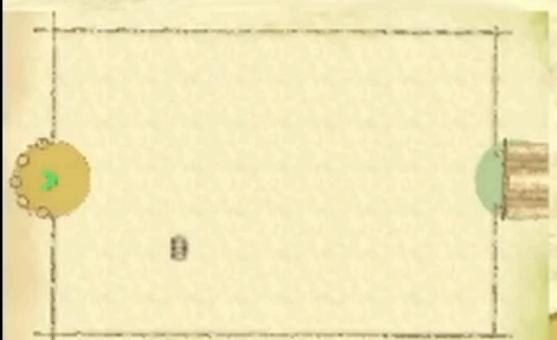


[(B) to Pause]



Points: 900

GO!



[(B) to Pause]



Points: 1300

Do you remember where to find the...
shield ?



YES!

win a lot / lose a lot

[MAYBE]

win some / lose some

NO...

win a little / lose a little

press (X) to select

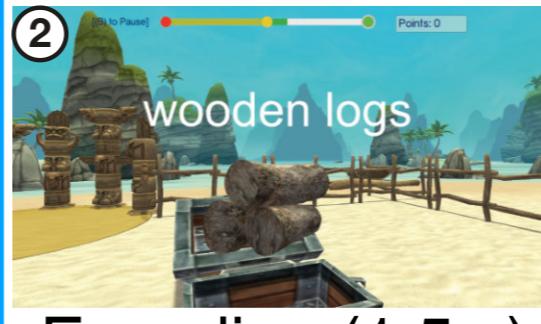
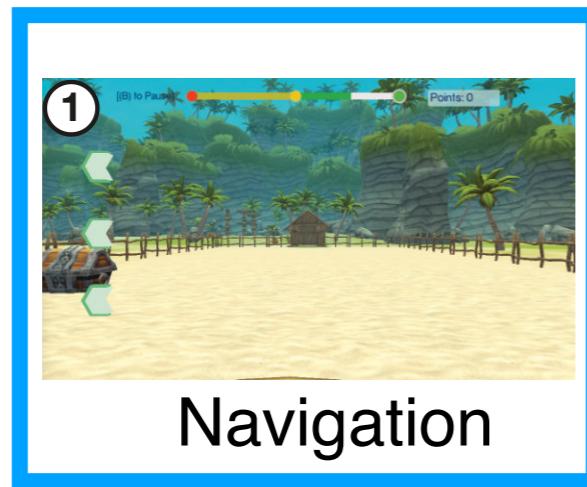
[(B) to Pause]



Points: 1300

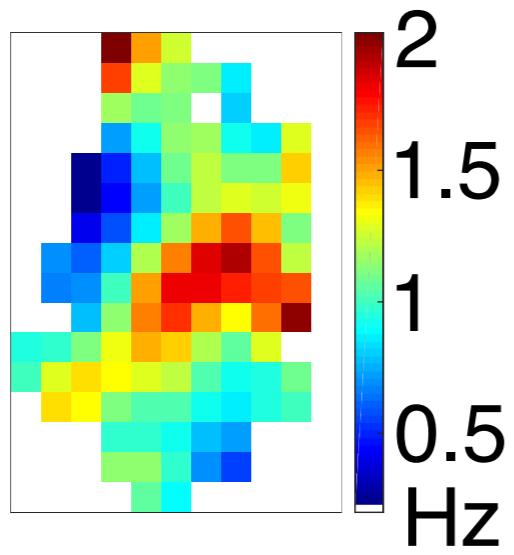


What are individual neurons doing during navigation in this task?

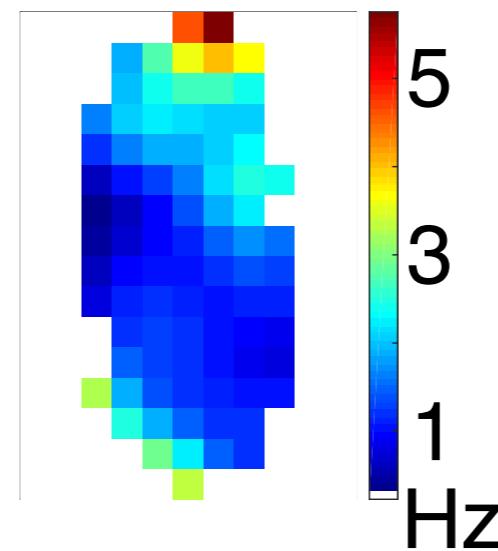


Place-like cells

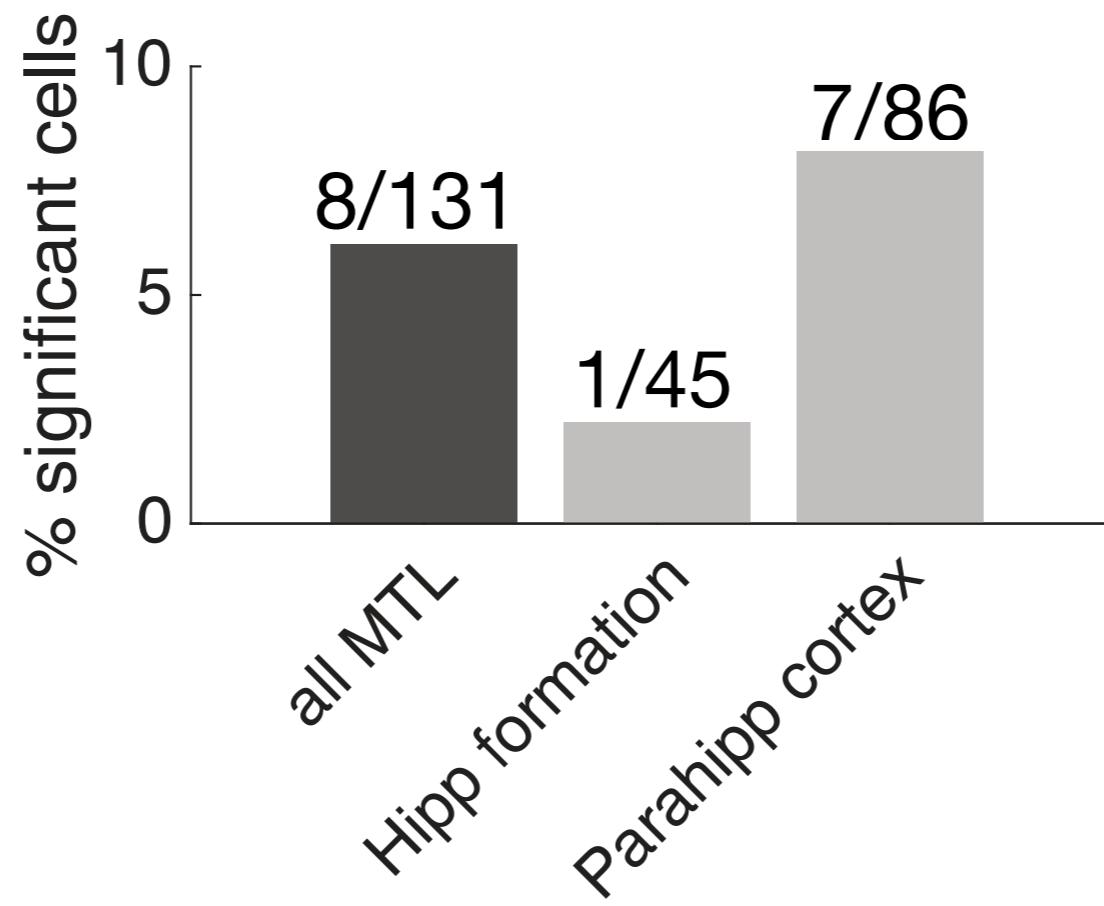
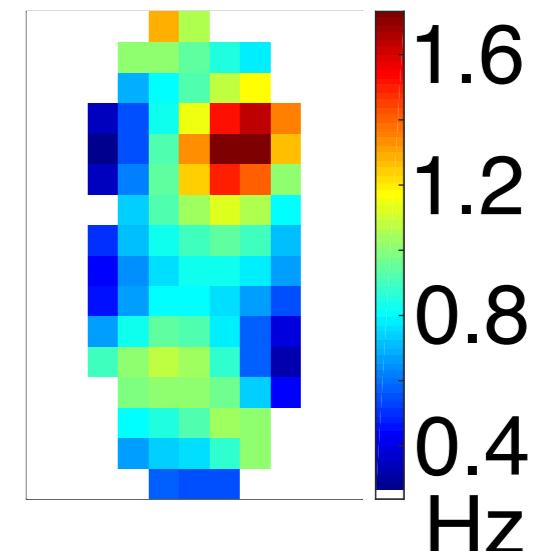
Right parahipp cortex



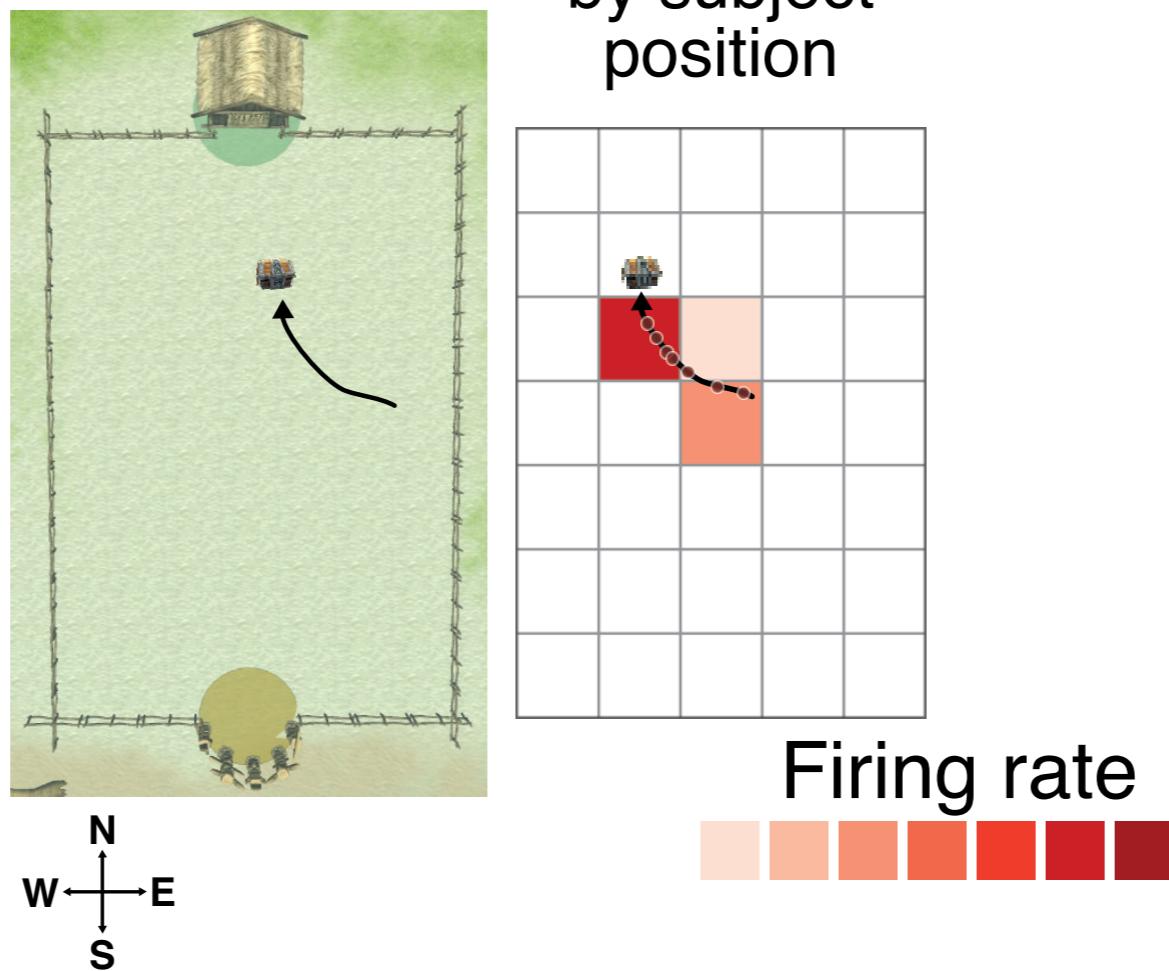
Left EC



Right EC



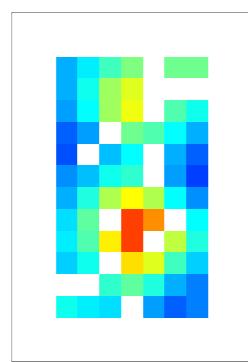
Goal-position cells



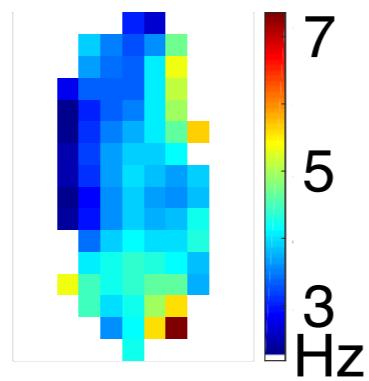
Goal-position cells

Left EC

FR by goal
position

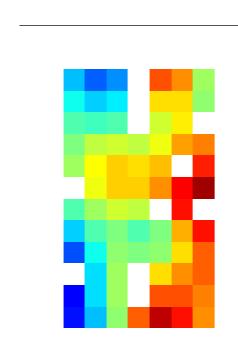


FR by subject
position

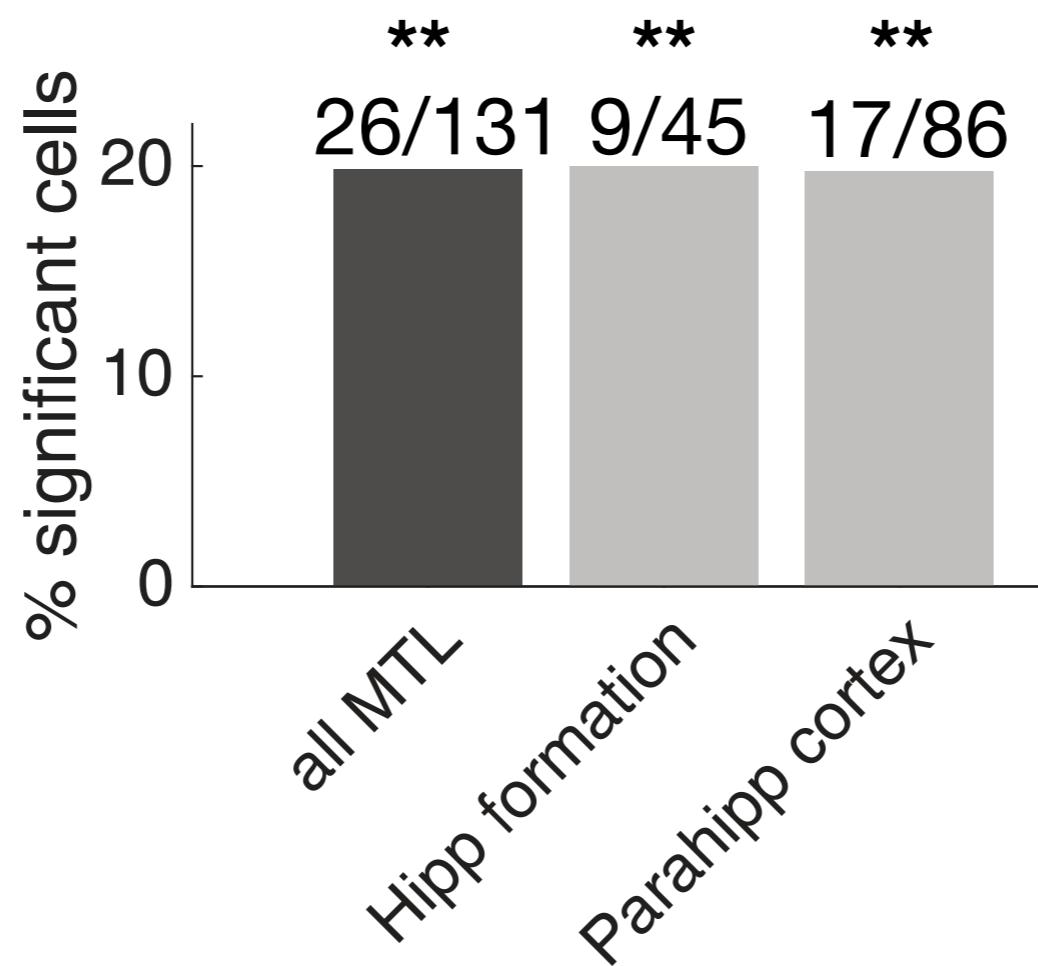
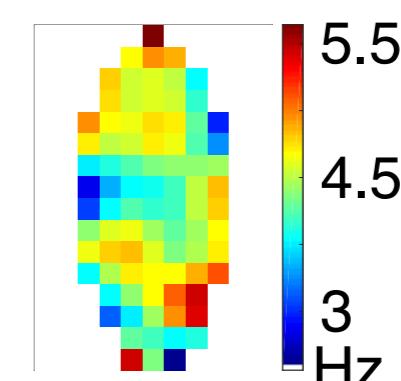


Right EC

FR by goal
position



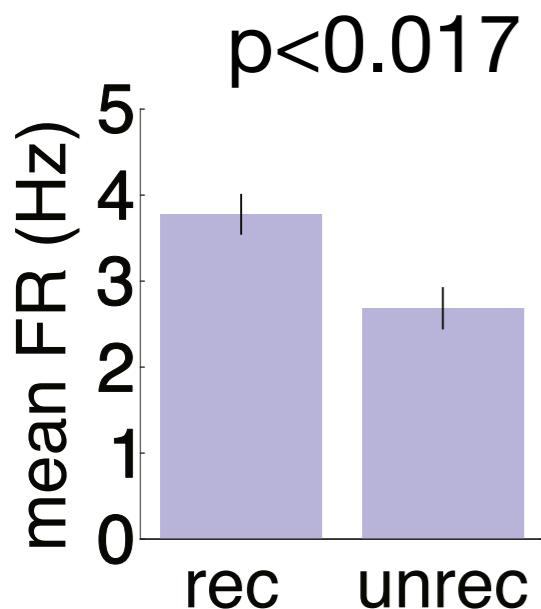
FR by subject
position



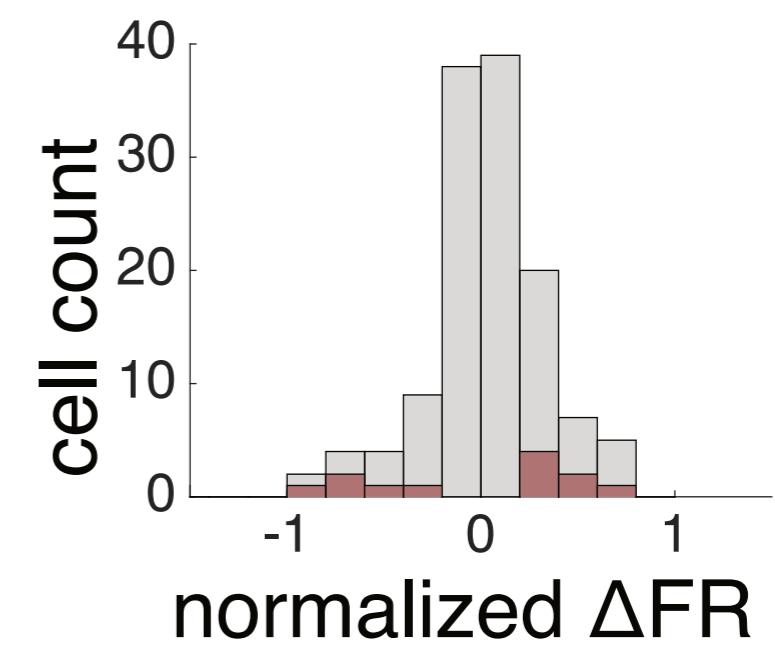
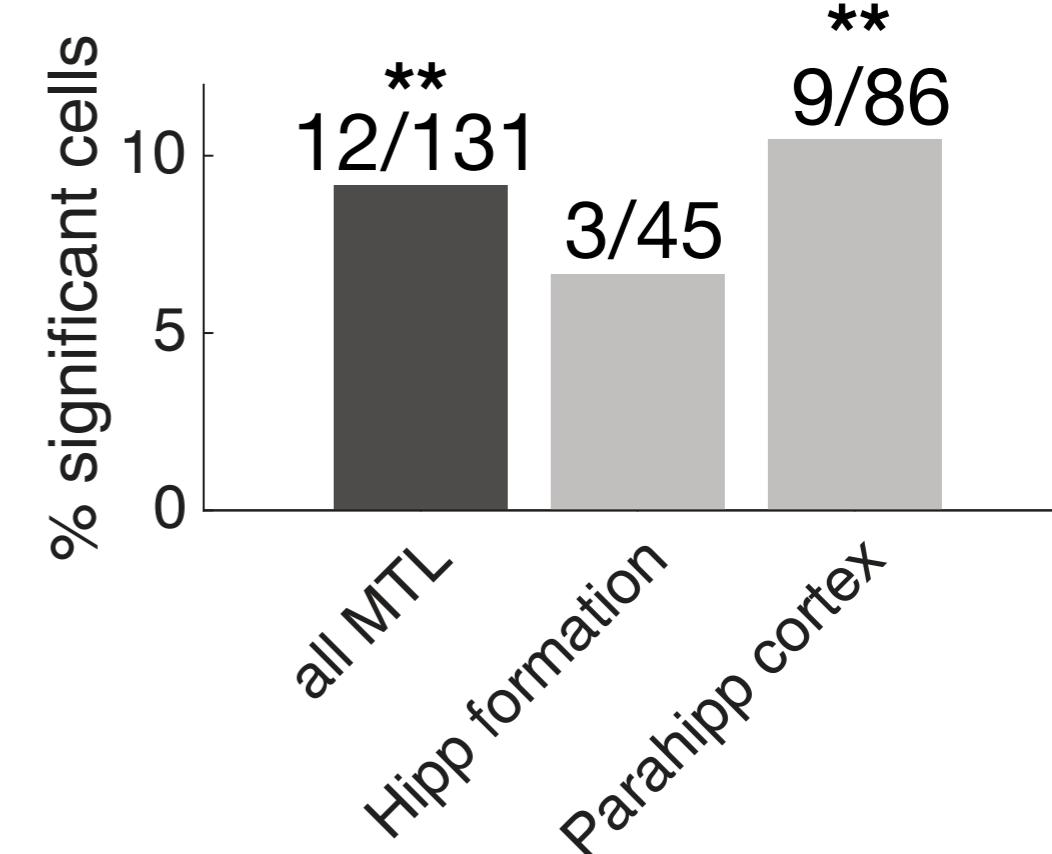
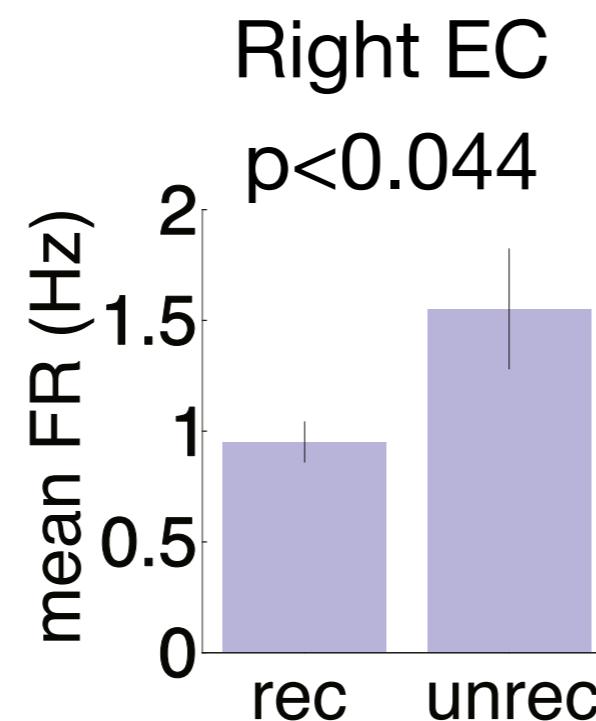
** p<0.01

Memory-related cells

Left perirhinal cortex



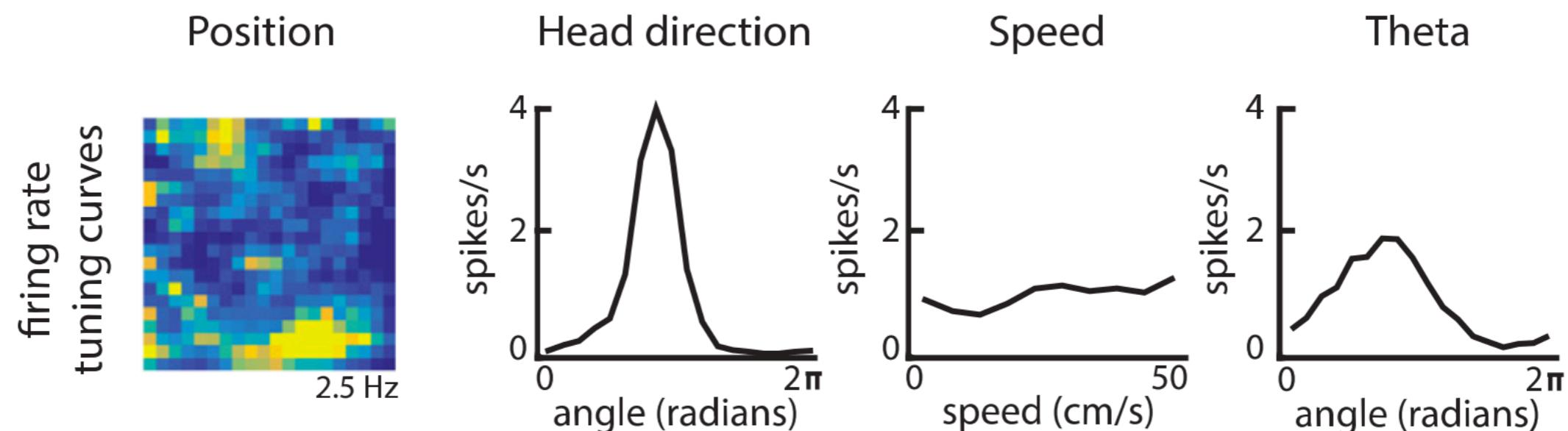
Right EC



Conclusion

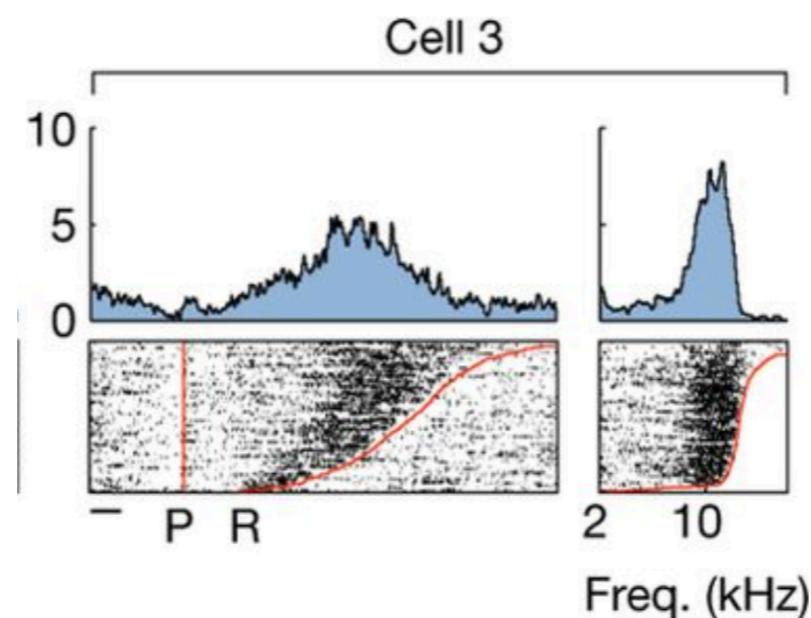
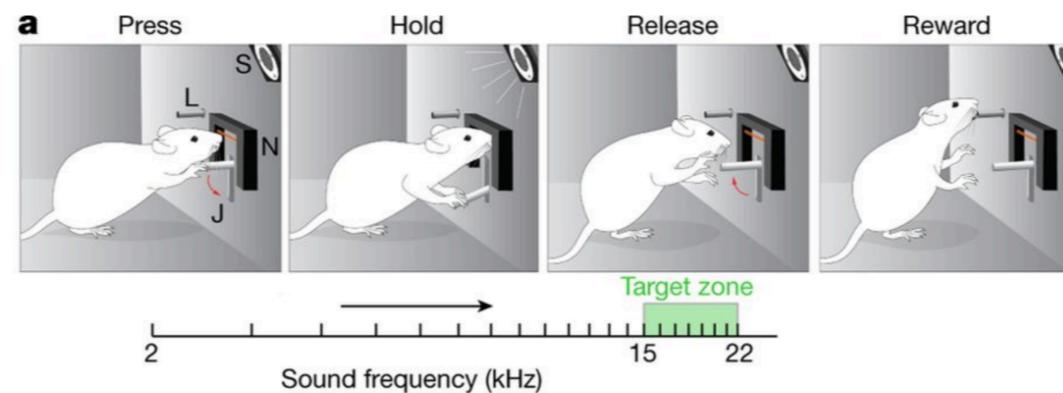
- Medial temporal lobe cells are modulated by goal location and subsequent memory in TH
- Low % of place-like cells because subjects attending to goal while navigating?

Moving forward: multivariate approaches



Moving forward: past spatial dimensions

Rodent frequency cells



Conclusion

- The medial temporal lobe codes for behaviorally relevant aspects of an experience
- Need improved, unbiased statistical approaches to better understand neuronal activity in relation to behavior both at the single cell level and at the population level