A Study in Grid Cells and Conceptual Learning

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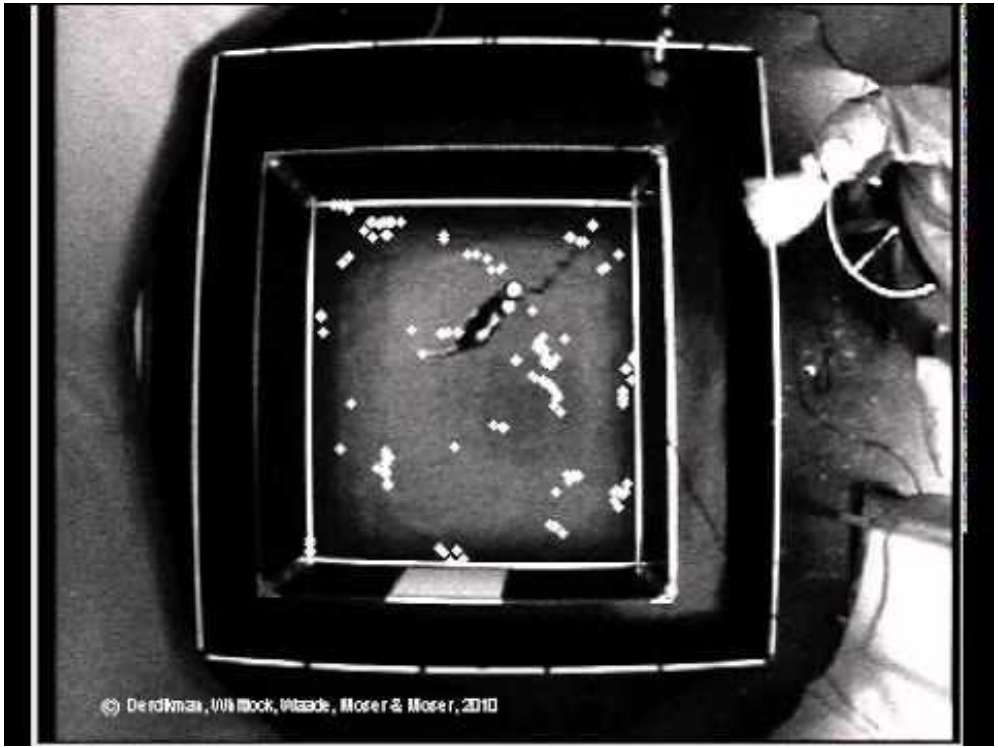
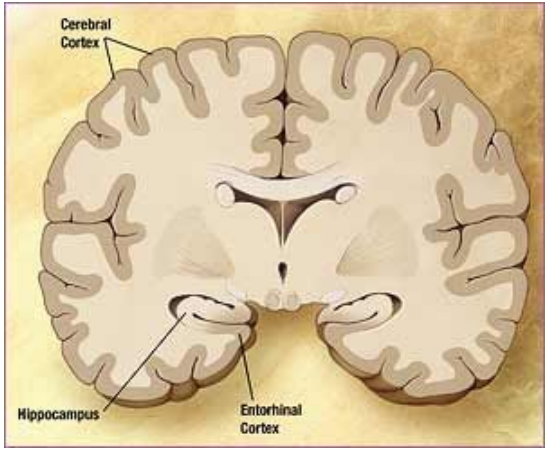
What is Grid Cell?

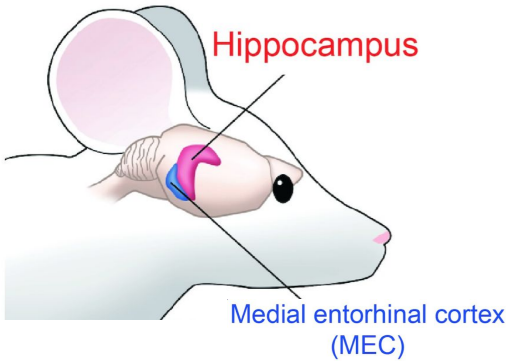


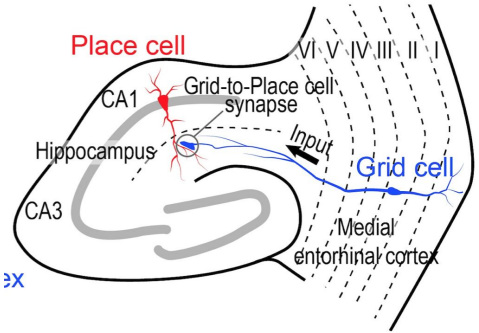
- 2004, May-Britt Moser and Edvard I. Moser
- 2014, Nobel Prize in Physiology or Medicine

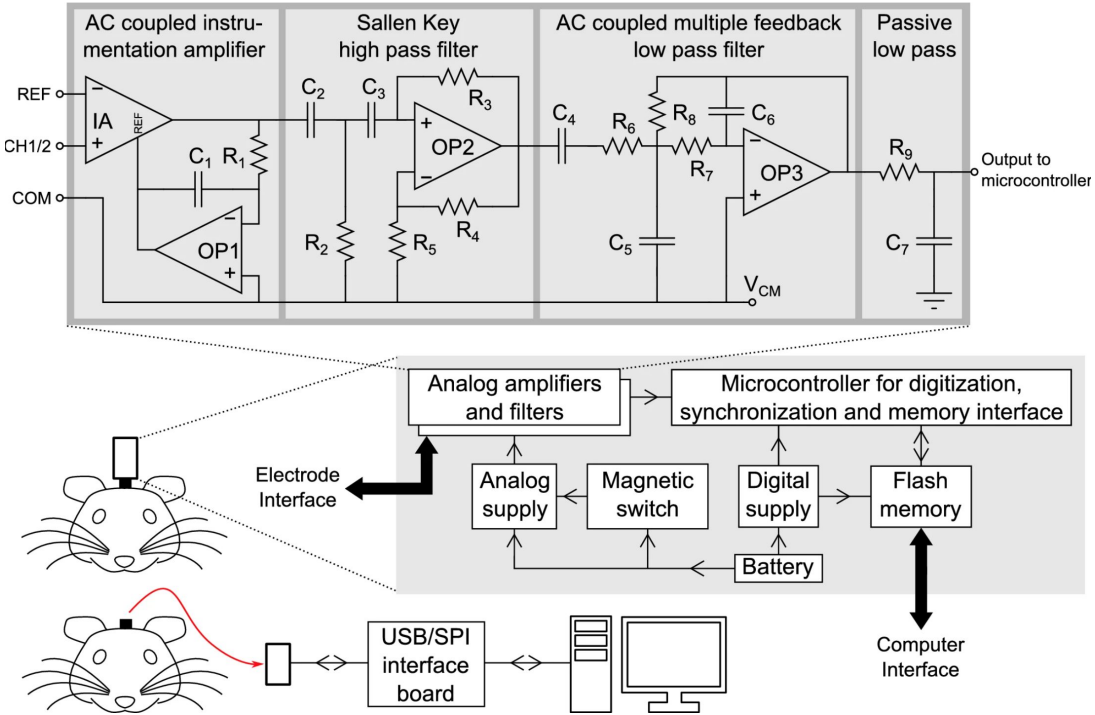
Pyramidal Neuron



Environment Setup

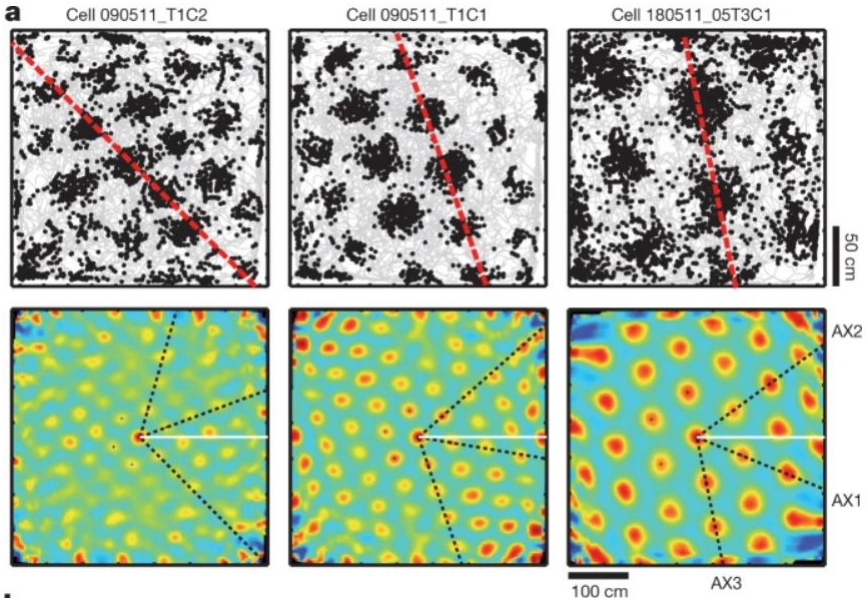






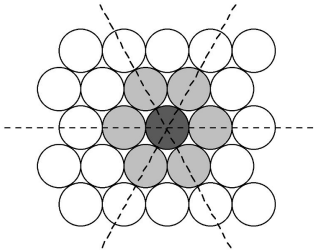
OSERR: an open-source standalone electrophysiology recording system for rodents

Grid Cell Features

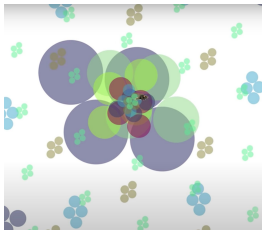


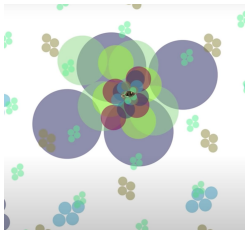
Discretized

- Orientation
- Wavelength
- Phase



Hexagonal





Small # Neurons -> Unique Space

Grid Cell and Conceptual Learning

What does it takes to learn a new concept?

Time

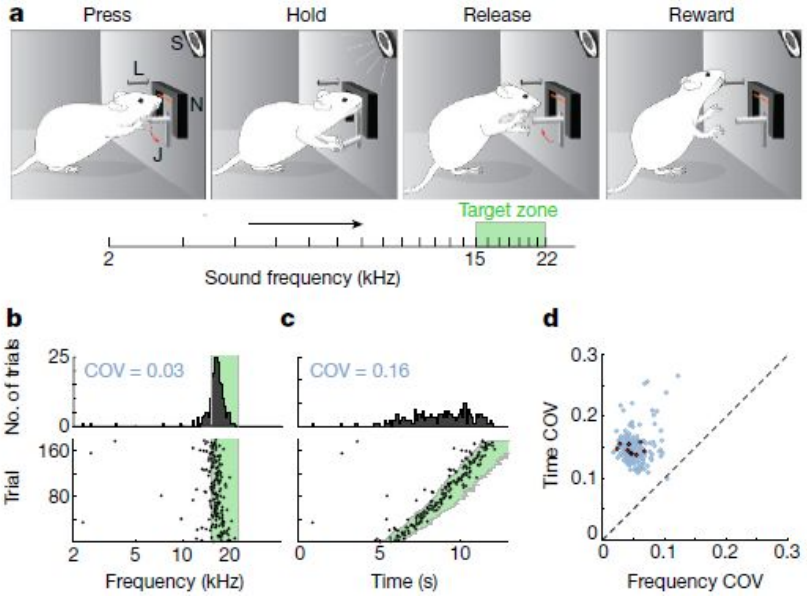
Sound

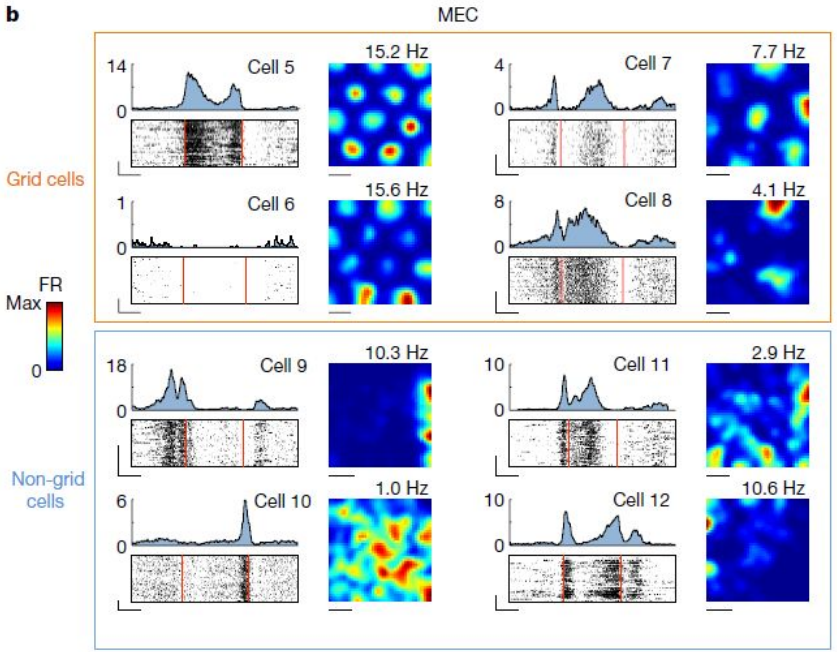
Feeling

Spatial term → **non-spatial things**

Conceptual Map of space → **ideas**

Approaches I

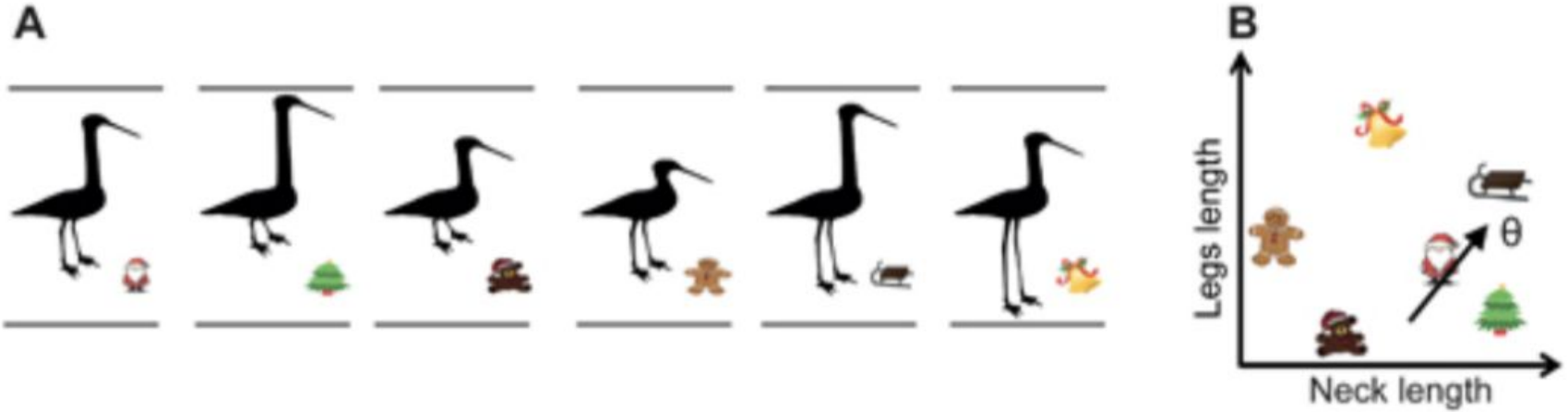




‘Sound manipulation task’ (SMT)

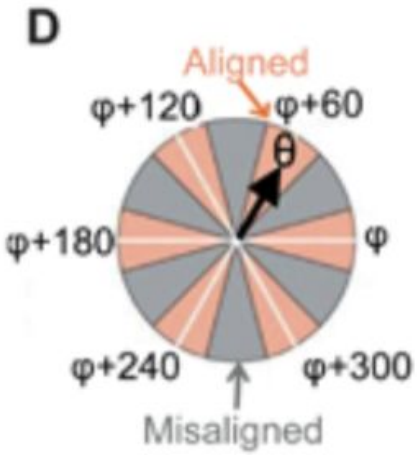
any arbitrary continuous variables that are relevant to an animal can be represented by the hippocampal–entorhinal activity using a common circuit mechanism

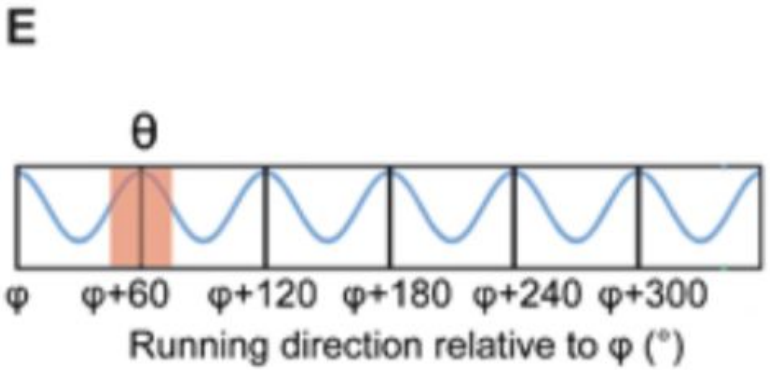
Approaches II

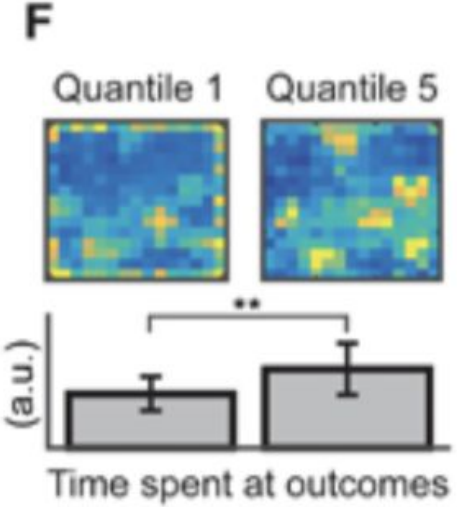


Abstract space exploration task

Approaches II

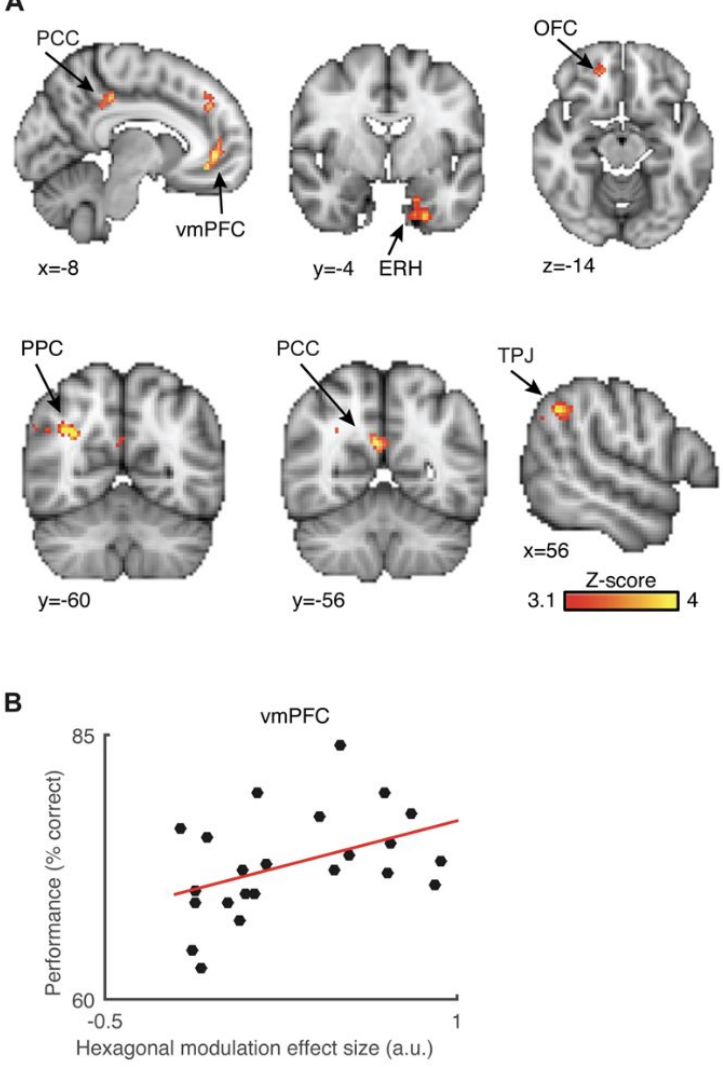






Approaches II

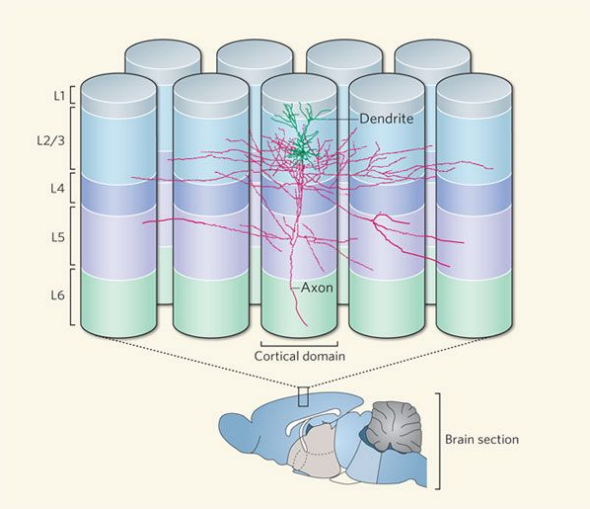
Participant with higher Hexagonal modulation effect size will have a higher performance (%correct)



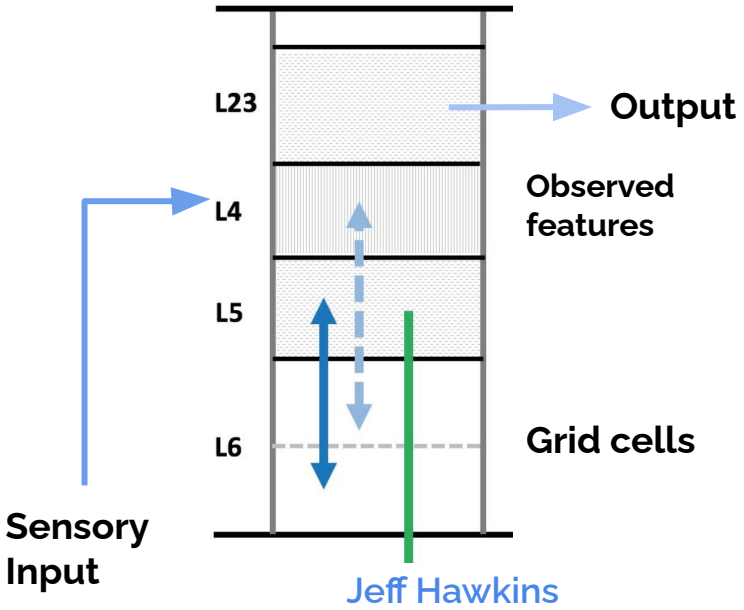
Grid Cells in Neocortex (Hypothesis)

Intelligence?

Capability of creating predictive models for objects

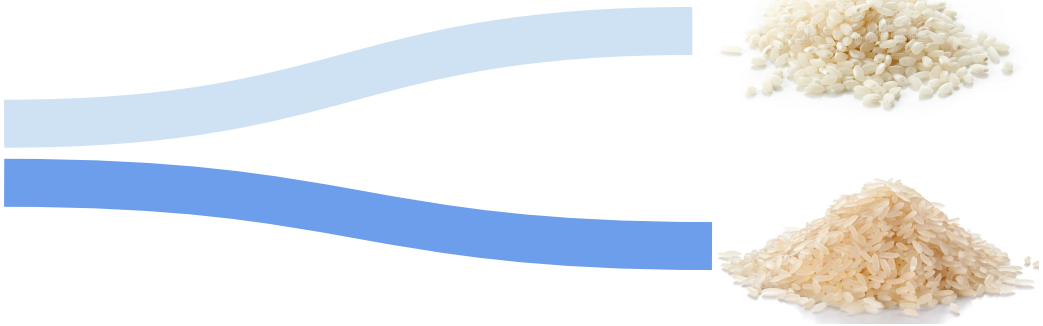


Cortical Column



Experimental Design -- Calculation

neocortex



Road Color

Amount of Rice

1 grams ~ 10 grams

Conclusion

grid cell or grid-like abstract space effect conceptual learning is evidential.

- Grid cell has multifunctional capability
- It could be a model for general purpose memory process
- The actually mechanism of causing grid cell to behave in such way is still an opening question.

References

- The emergence of grid cells: intelligent design or just adaptation? Emilio Kropff and Alessandro Treves, 2008. DOI 10.1002/hipo.20520
- Hafting, Torkel, et al. "Microstructure of a spatial map in the entorhinal cortex." Nature 436.7052 (2005): 801-806.
- Constantinescu, A. O., OReilly, J. X., & Behrens, T. E. (2016). Organizing conceptual knowledge in humans with a gridlike code. *Science, 352*(6292), 1464-1468. doi:10.1126/science.aaf0941