

ARTICLE

doi:10.1038/nature12112

Hippocampal place-cell sequences depict future paths to remembered goals

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Future Reflections

Past, present and future represented in hippocampus

Loïc Matthey

Tea Talk n°12

19th April 2013

Introduction

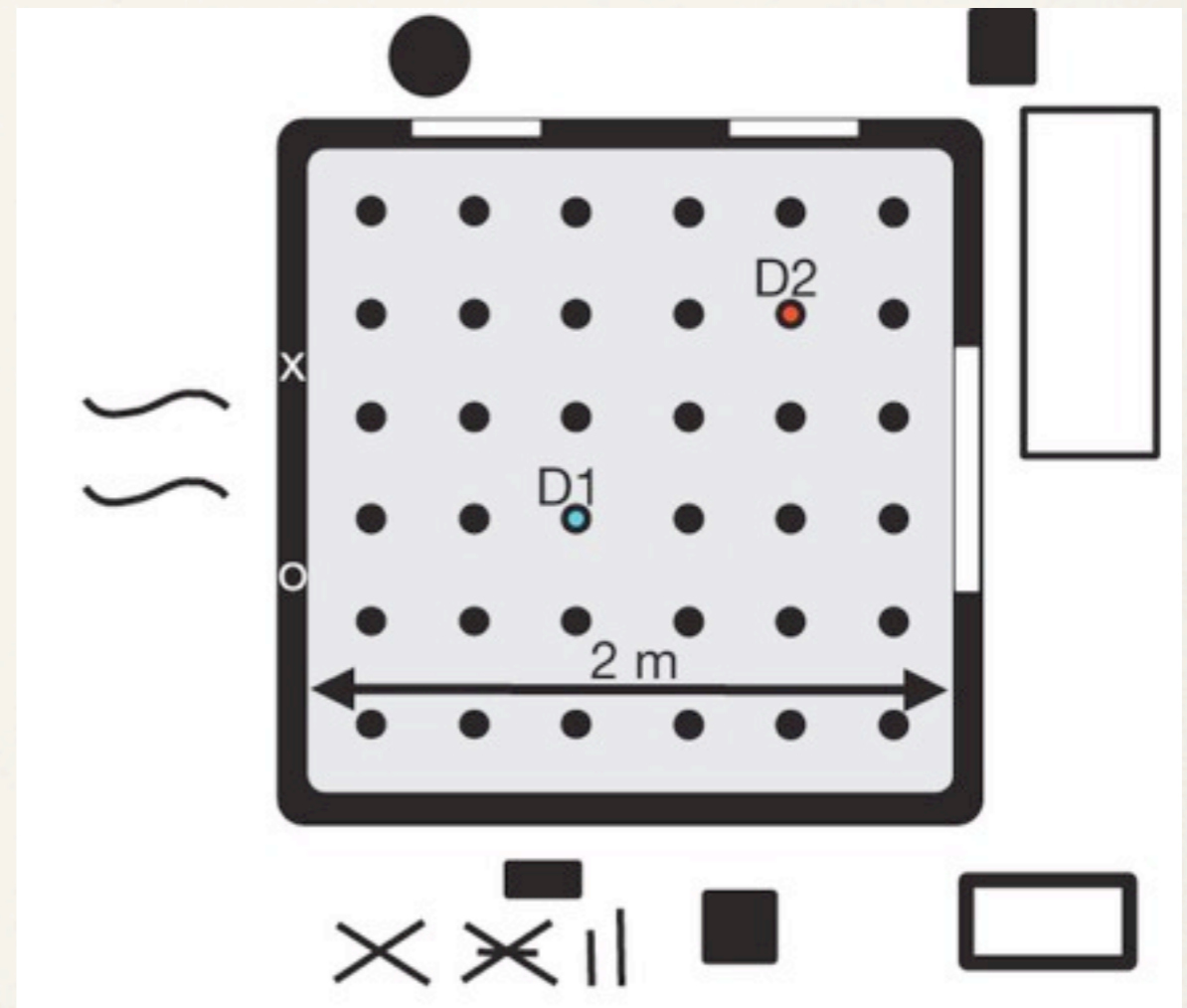
- ❖ Hippocampus place cells
 - ❖ Represents animal location
 - ❖ Firing with respect to theta rhythm: theta sequences
- ❖ Place cells replay
 - ❖ Sequences of place cells reactivations. Correspond to prior behavioural trajectories.
 - ❖ During sleep and non-exploratory awake periods. Associated with Sharp-wave ripple events in LFP.
- ❖ What are they used for?
 - ❖ Remember goal? Past experiences? Define new routes?

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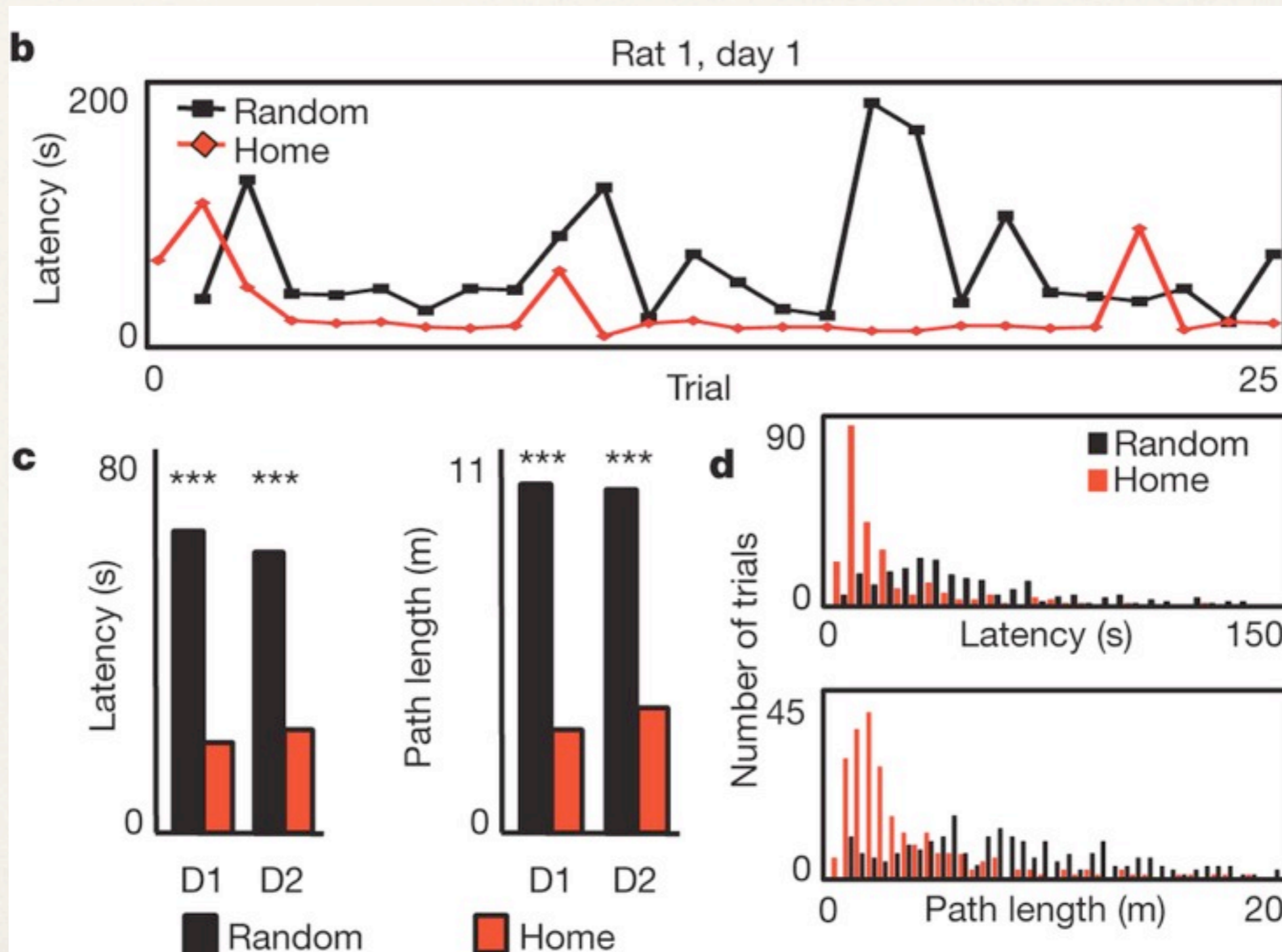
**“Hippocampal place-cell sequences depict future paths to remembered goals”
Nature, April 2013**

Task

- ❖ Rats foraging for rewards
 - ❖ 2 phases:
 - ❖ Reward at Random location
 - ❖ Reward at Home location
 - ❖ Home kept fixed per day
 - ❖ Many trials, alternate Random/Home/Random/Home/etc
- ❖ Implant 4 rats with 40-tetrode microdrive.
 - ❖ Record around 150-200 units.



Behaviour

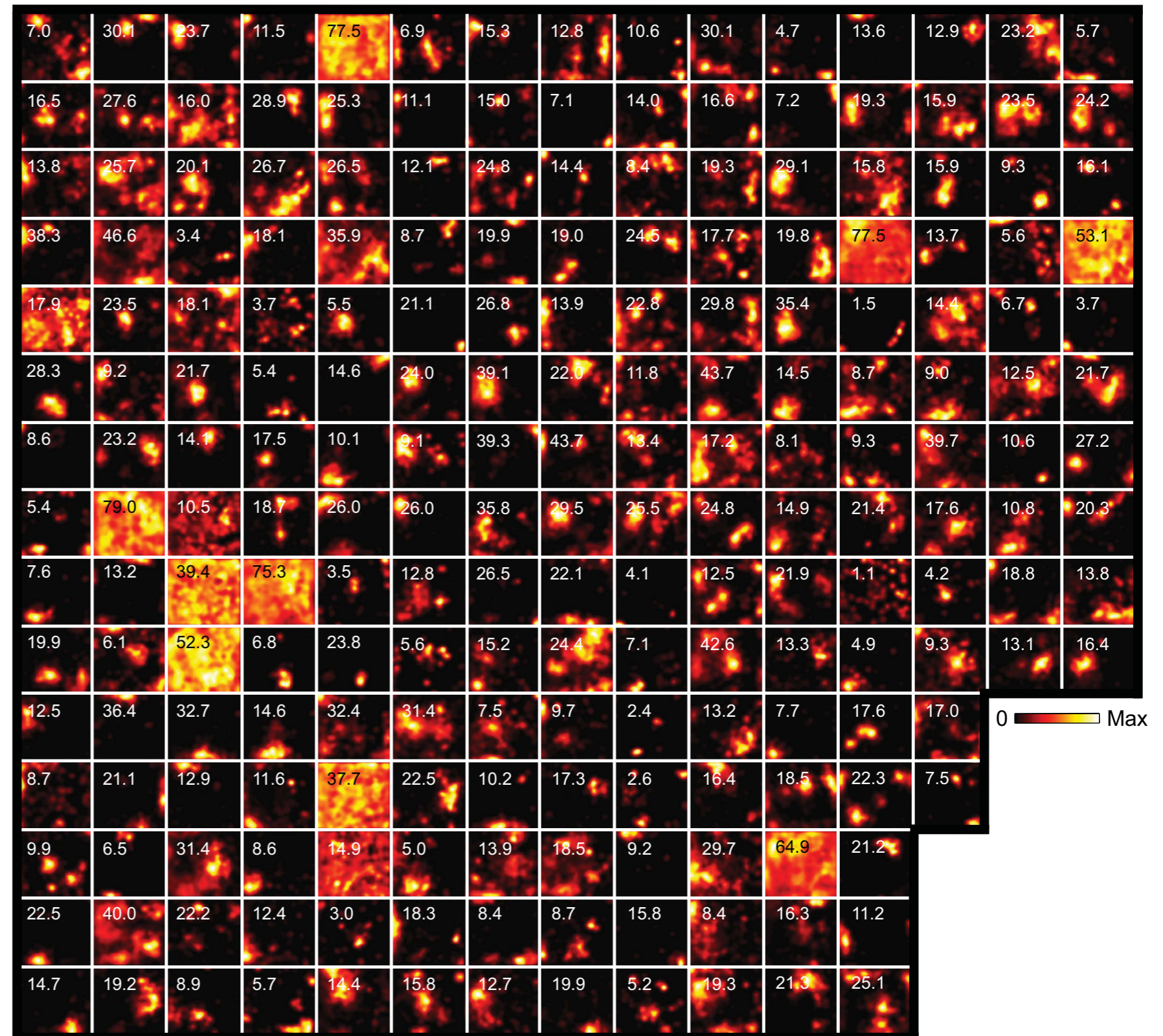


Place fields

- ❖ Place cells

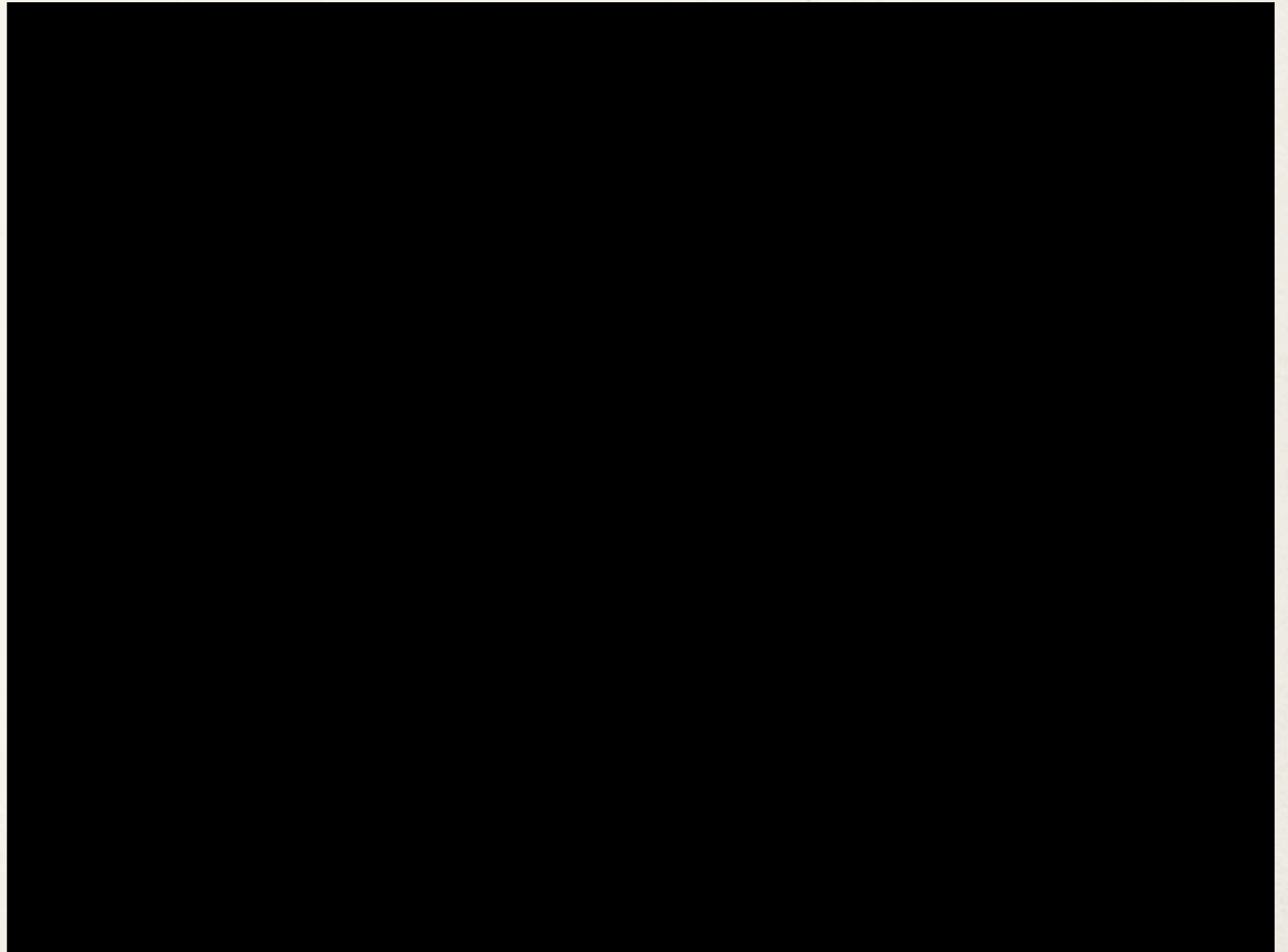
- ❖ Smooth histograms (2cm bins, 4cm gaussian kernel)

- ❖ Restrict to movements $> 5\text{cm/s}$

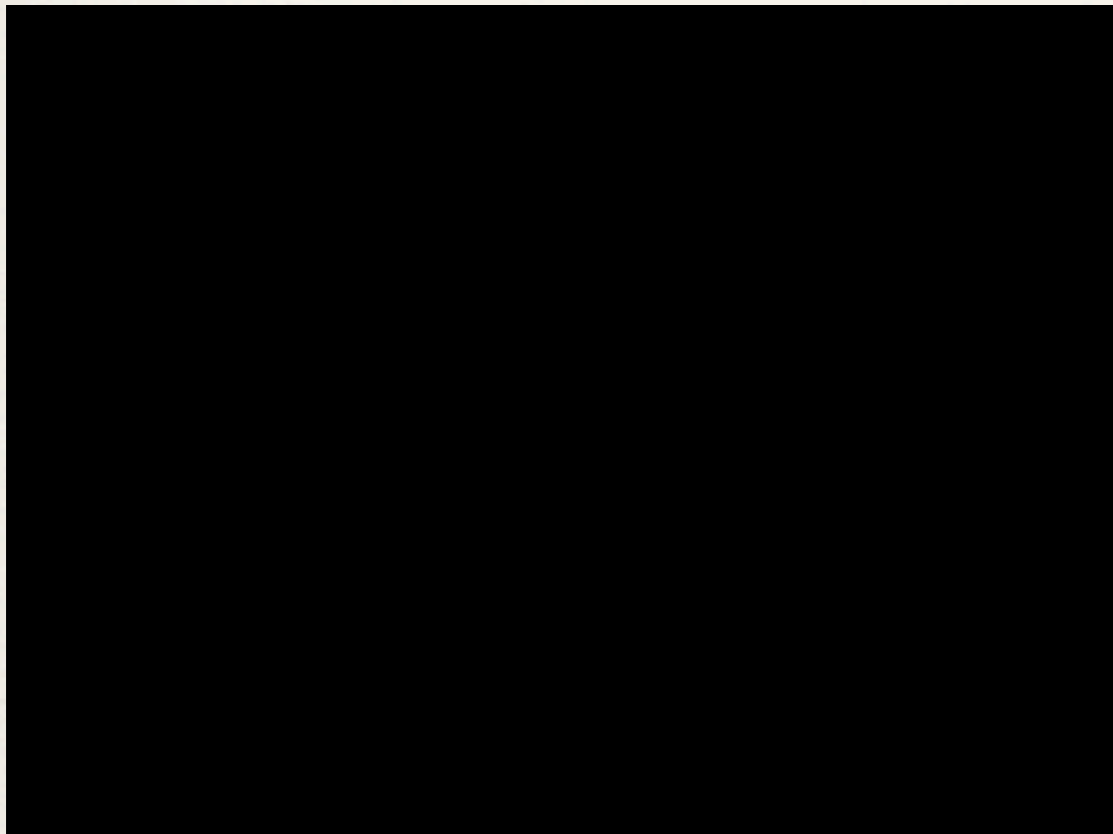
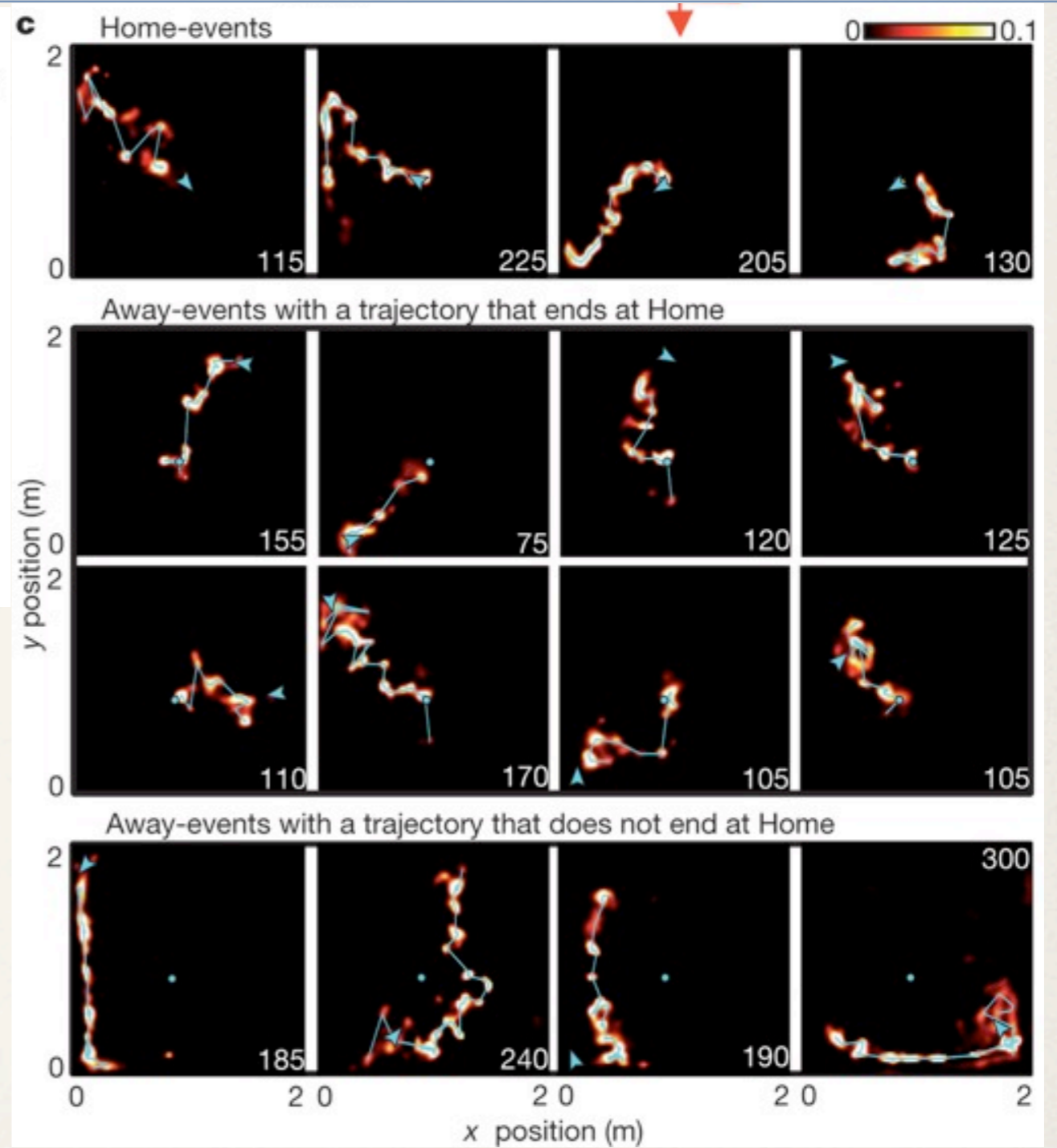
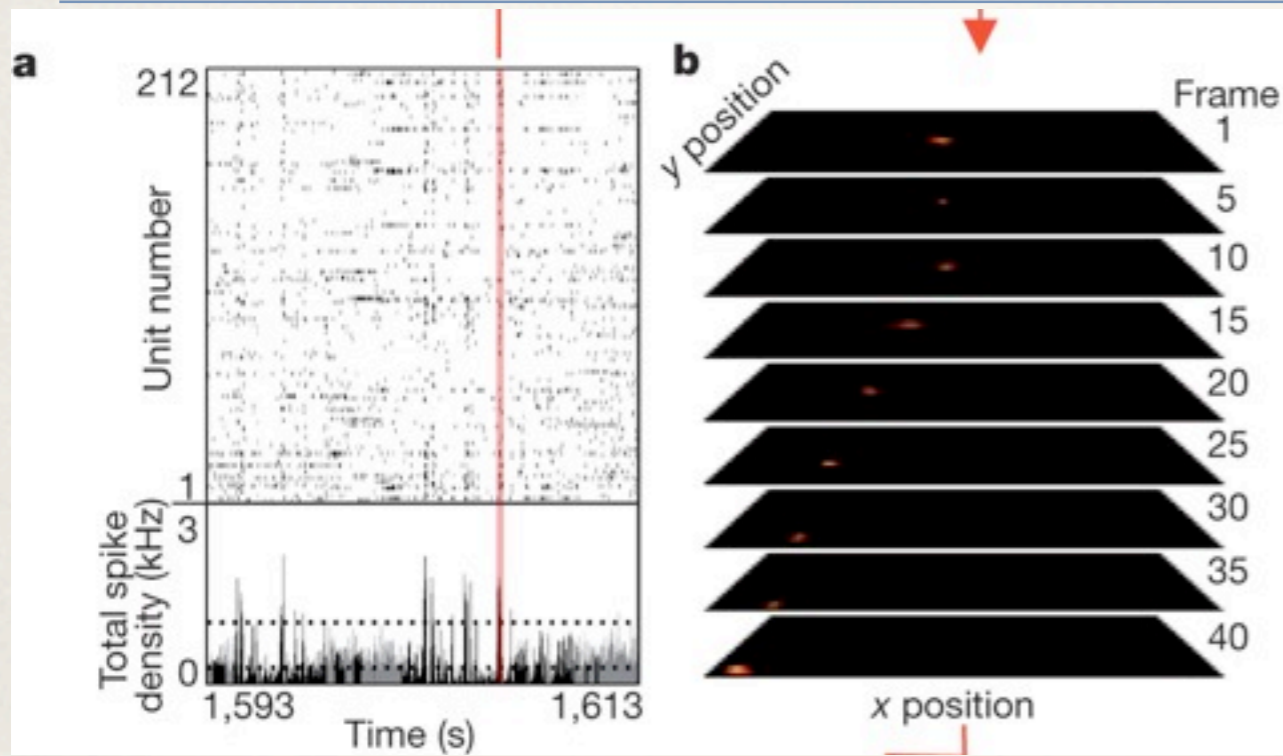


Place fields

- ❖ Bayesian decoding
 - ❖ Poisson likelihood, independent units, using estimated tuning curves
 - ❖ Time constants:
 - ❖ 250ms behaviour
 - ❖ 20ms events

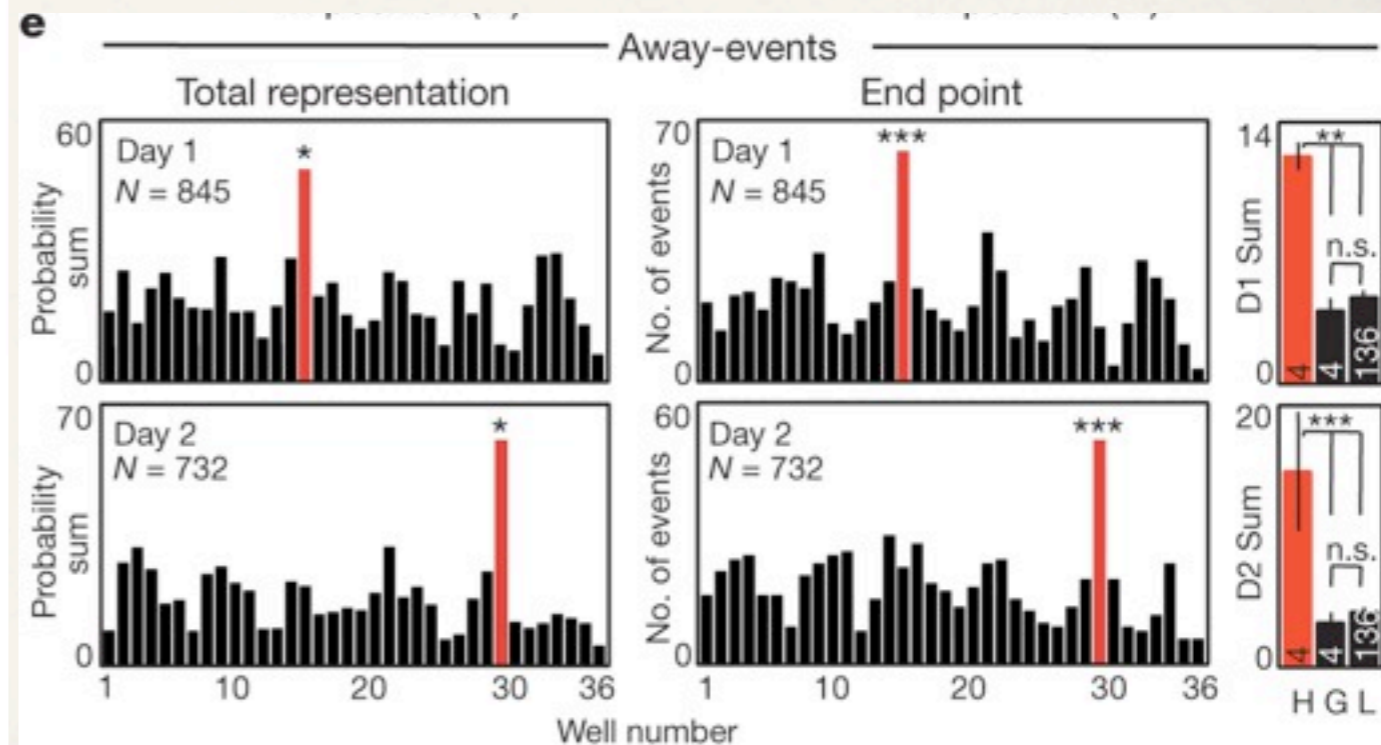
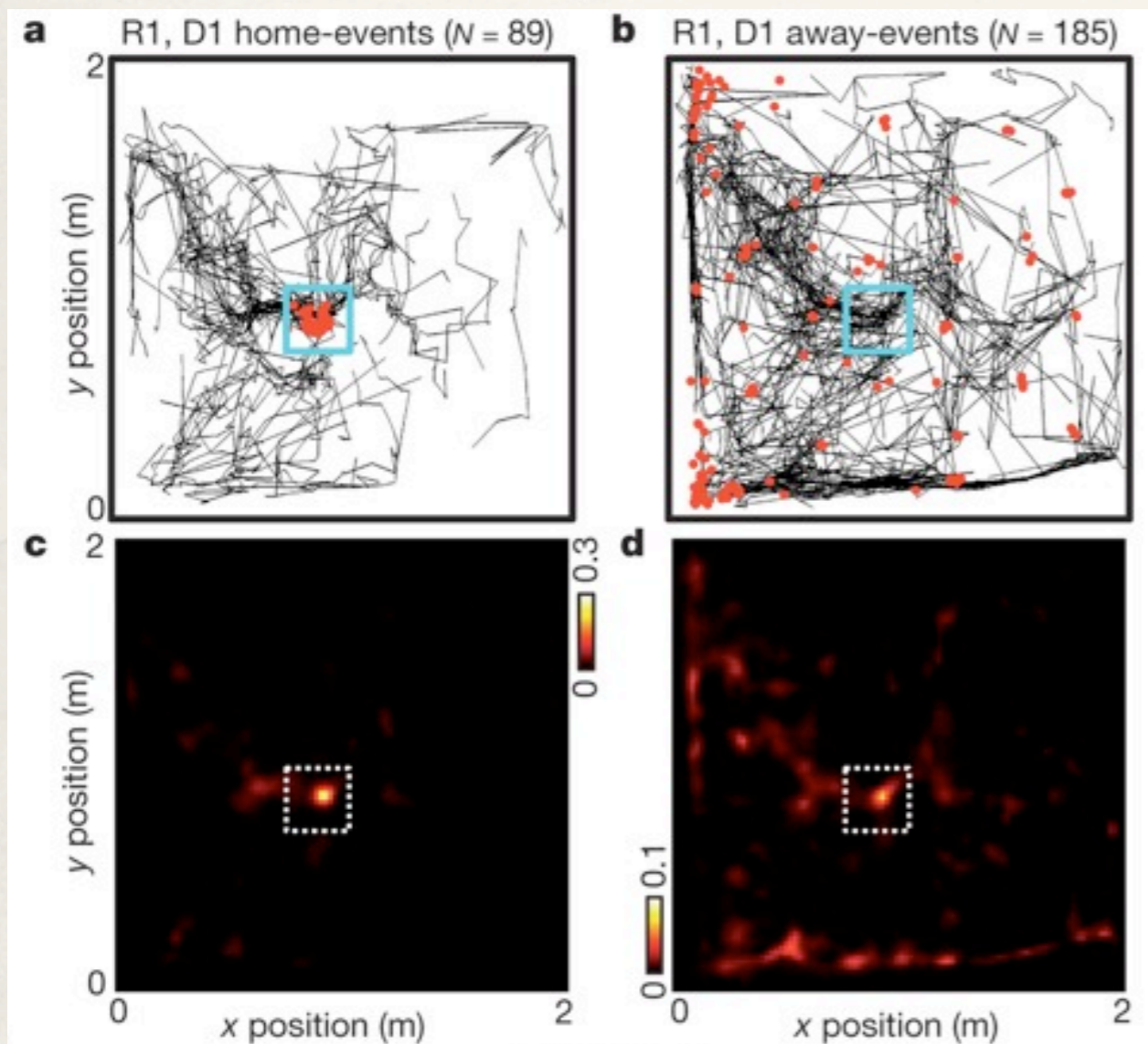


Events analysis

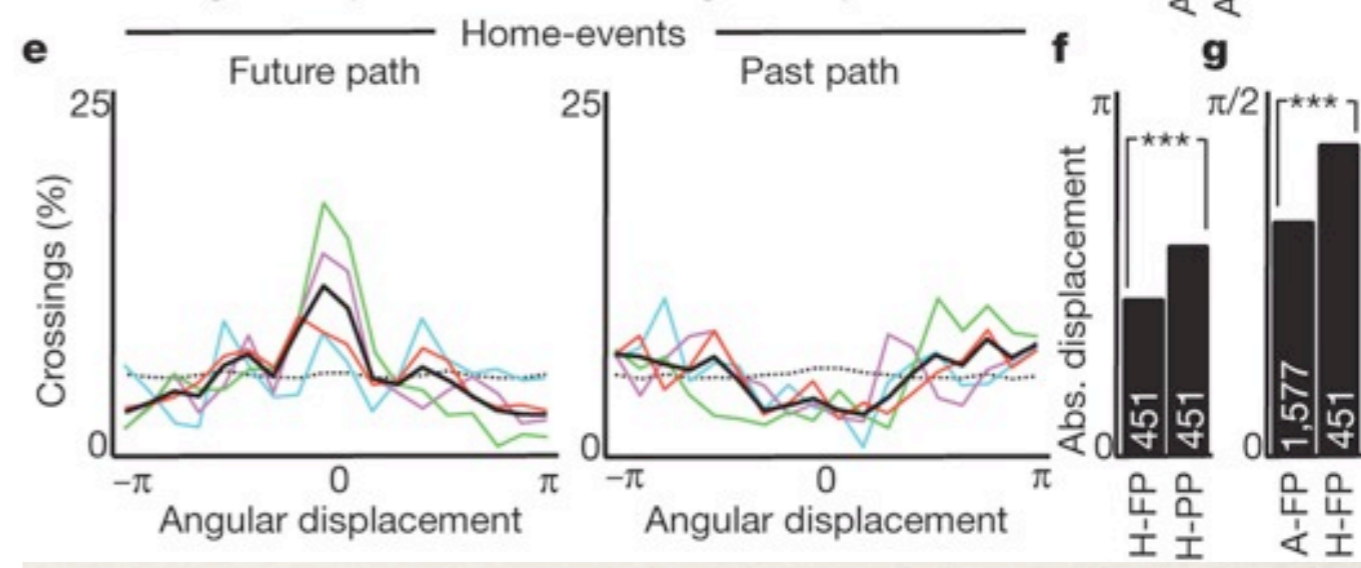
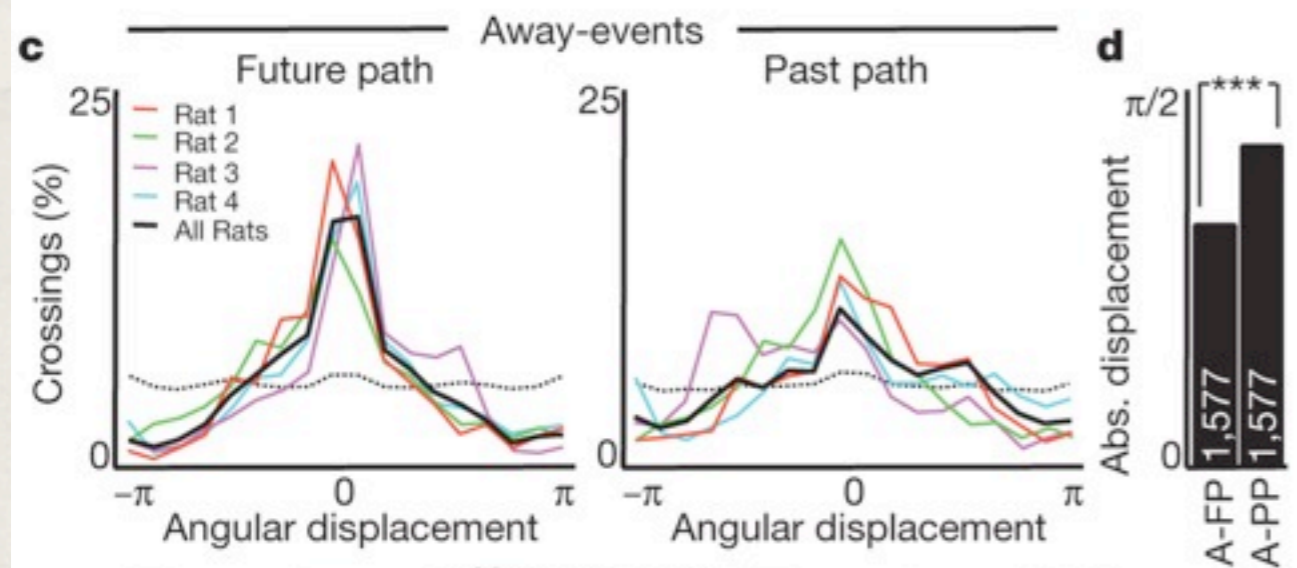
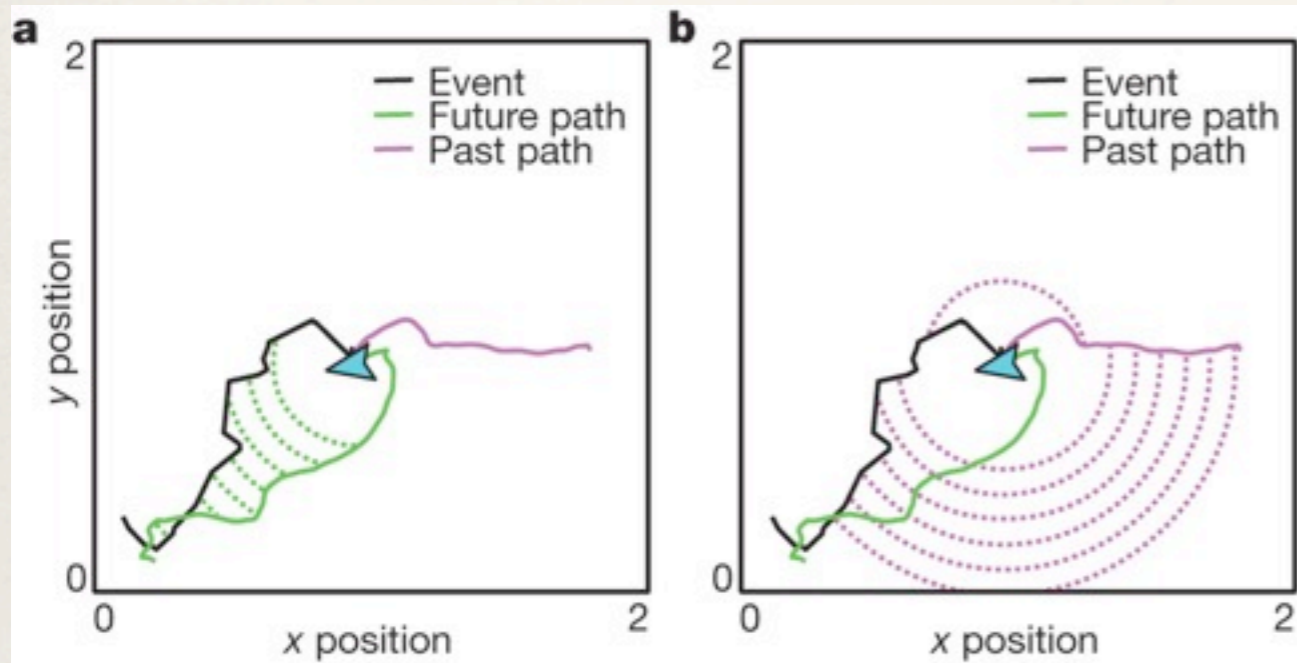


Events over-represent Home

- ❖ Home-event: initiated while at Home
- ❖ Expected initiation bias.



Events reflect future behaviour



Conclusion

- ❖ Observed hippocampal trajectory sequences predicting future behaviour
- ❖ Over-representation of goal location
- ❖ Indications for role of hippocampus in planning
 - ❖ Flexible cognitive map?
 - ❖ Substrate for inference?

The End

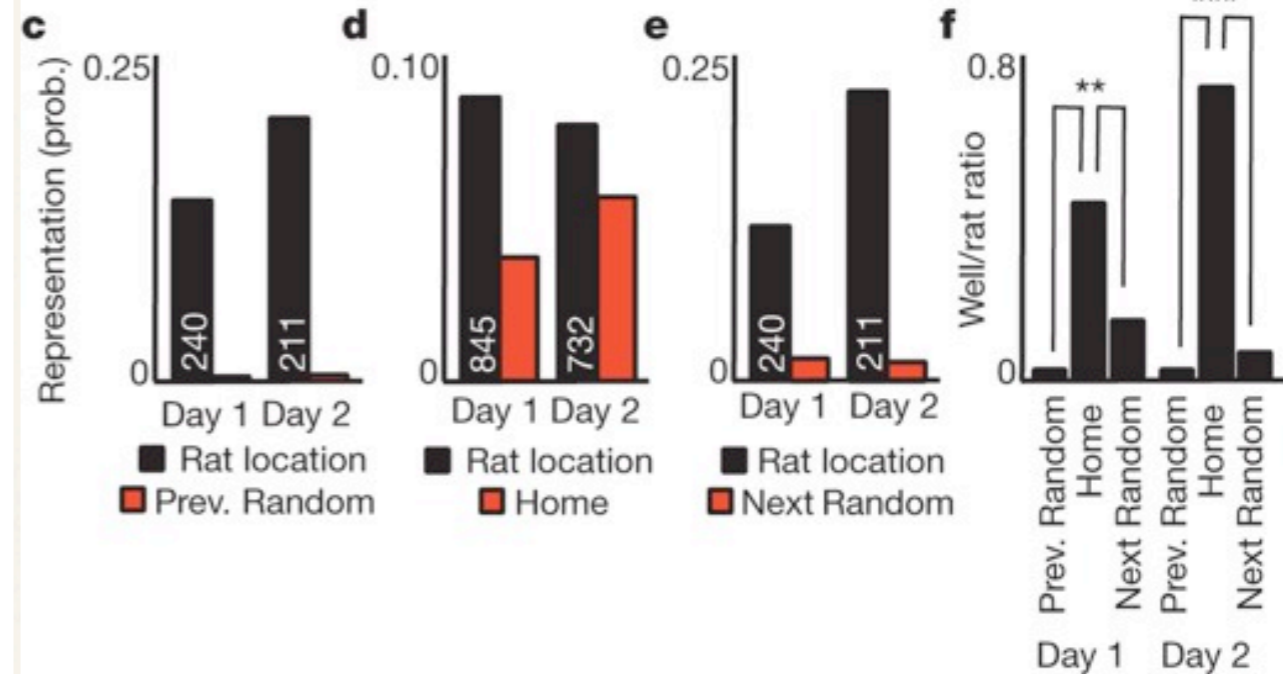
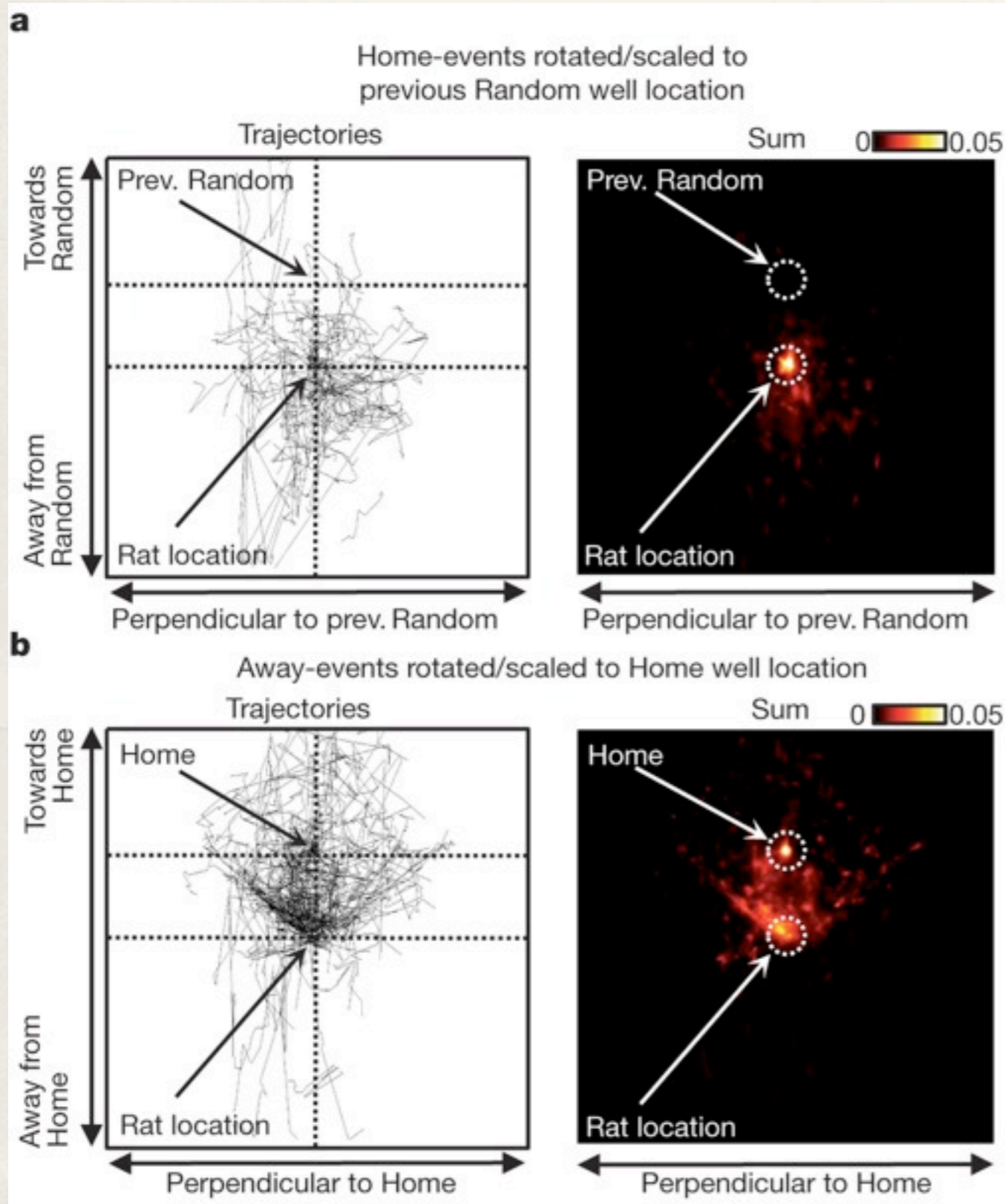
- ❖ Questions?

- ❖ References:

- ❖ Pfeiffer, B. E., & Foster, D. J. (2013). Hippocampal place-cell sequences depict future paths to remembered goals. *Nature*.

❖ Supplementary slides

Events over-represent relevant locations



Events reflect future behaviour

- Events reflect current goal, depending on task

