

Human Entorhinal Neurons Encode Route Information

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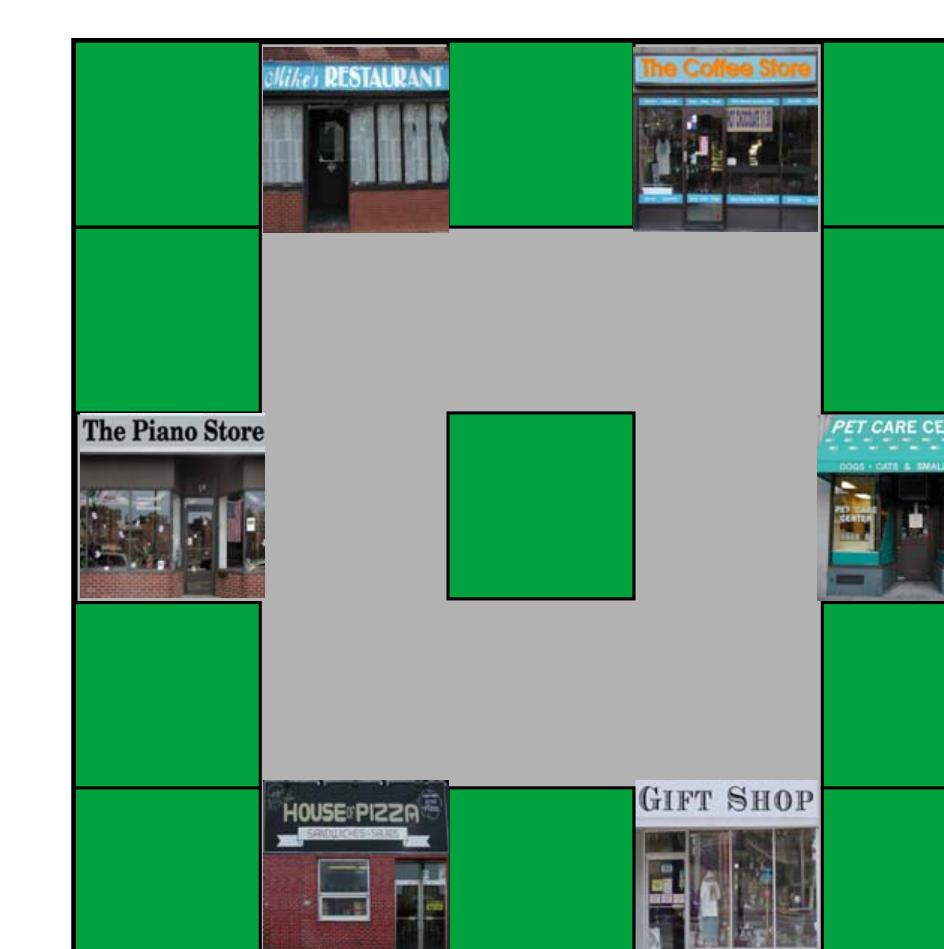
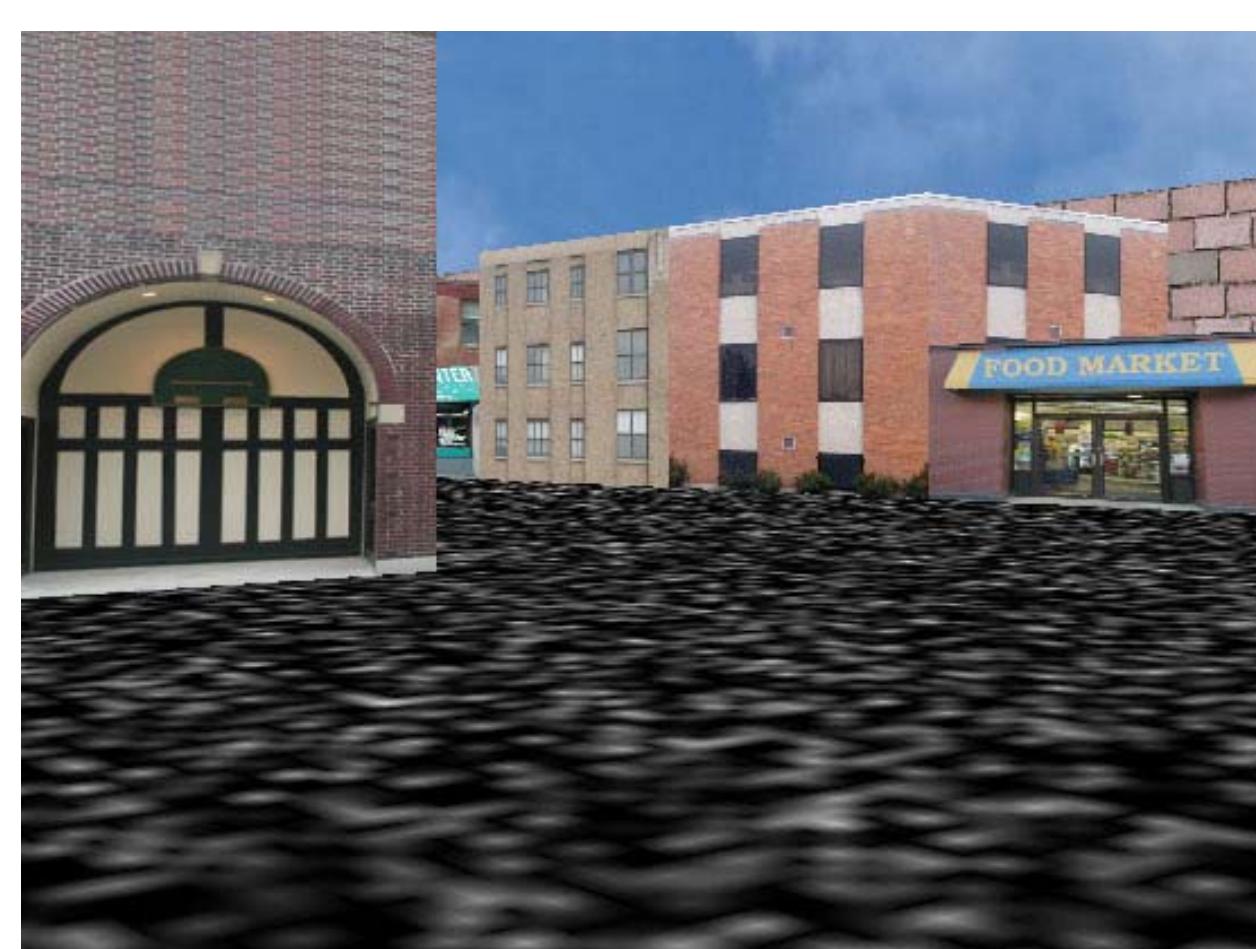
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Introduction

- Rodent navigation studies found both spatial and non-spatial responses in entorhinal cortex (Hargreaves et al., 2005).
- We studied this phenomenon in epilepsy patients playing a virtual taxi-driver video game.

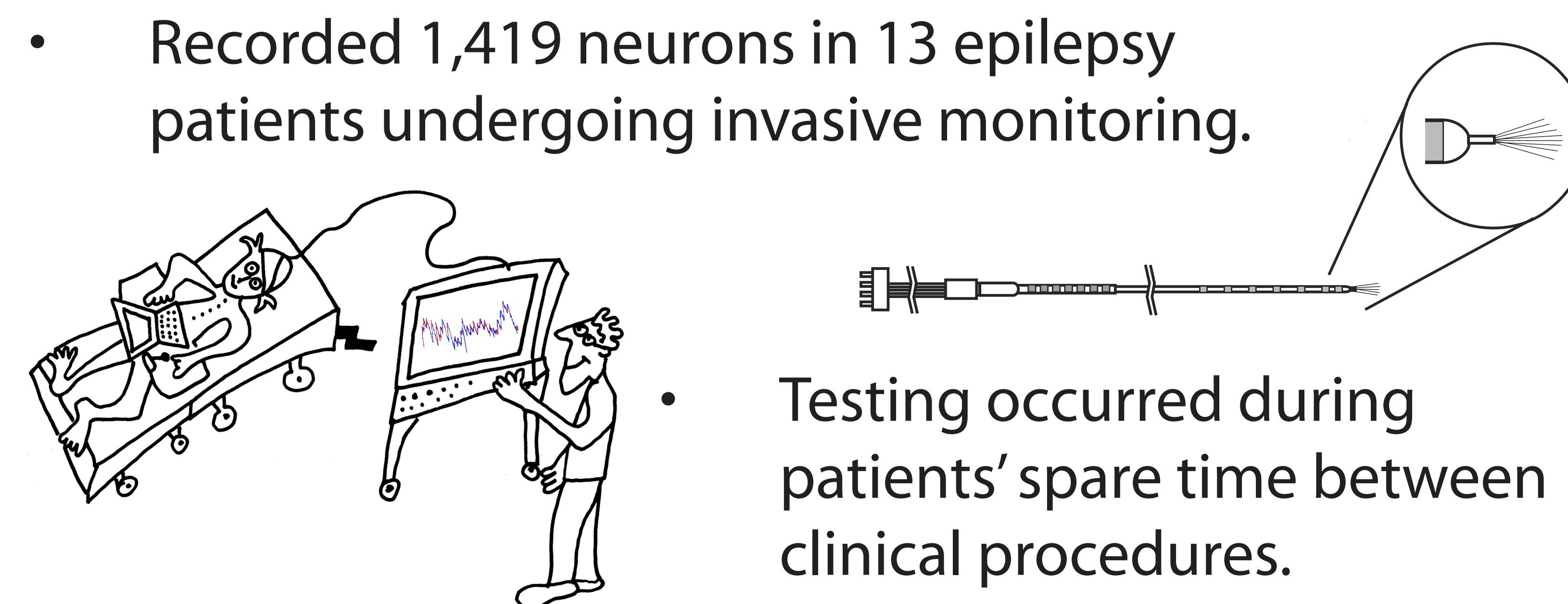
Yellow Cab taxi-driver task

- Patients navigated a virtual narrow square-shaped track on a bedside laptop computer.
- We compared neuronal firing rates in each region across clockwise and counterclockwise movement.
 - ANOVA, 16 (regions) \times 2 (direction), bootstrapped.



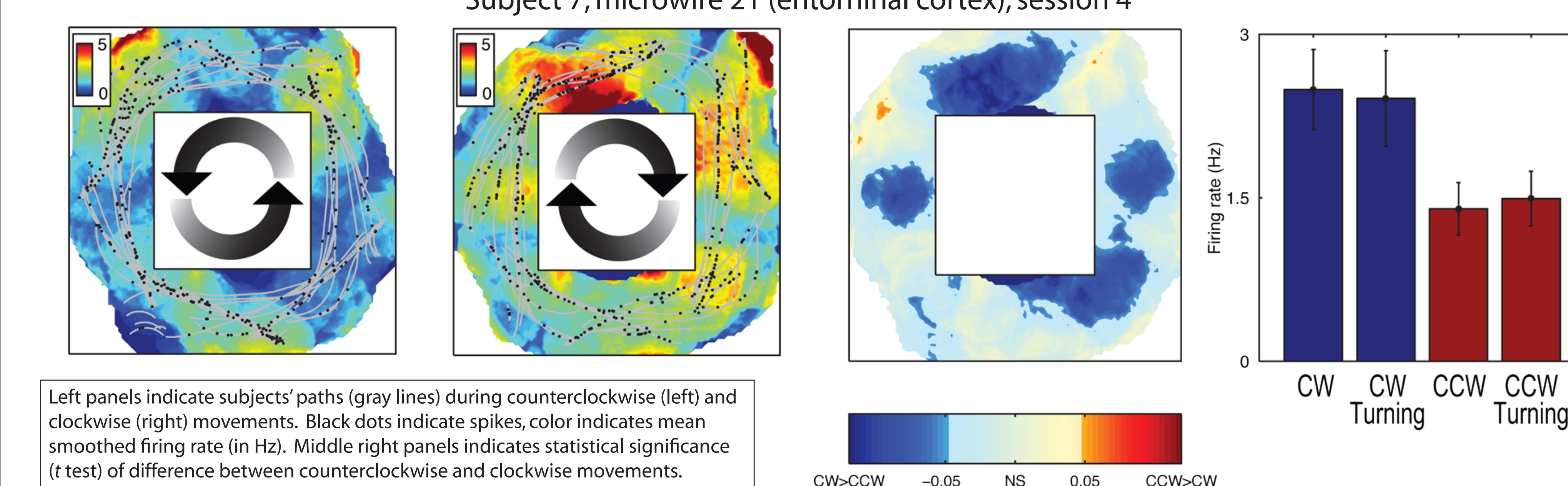
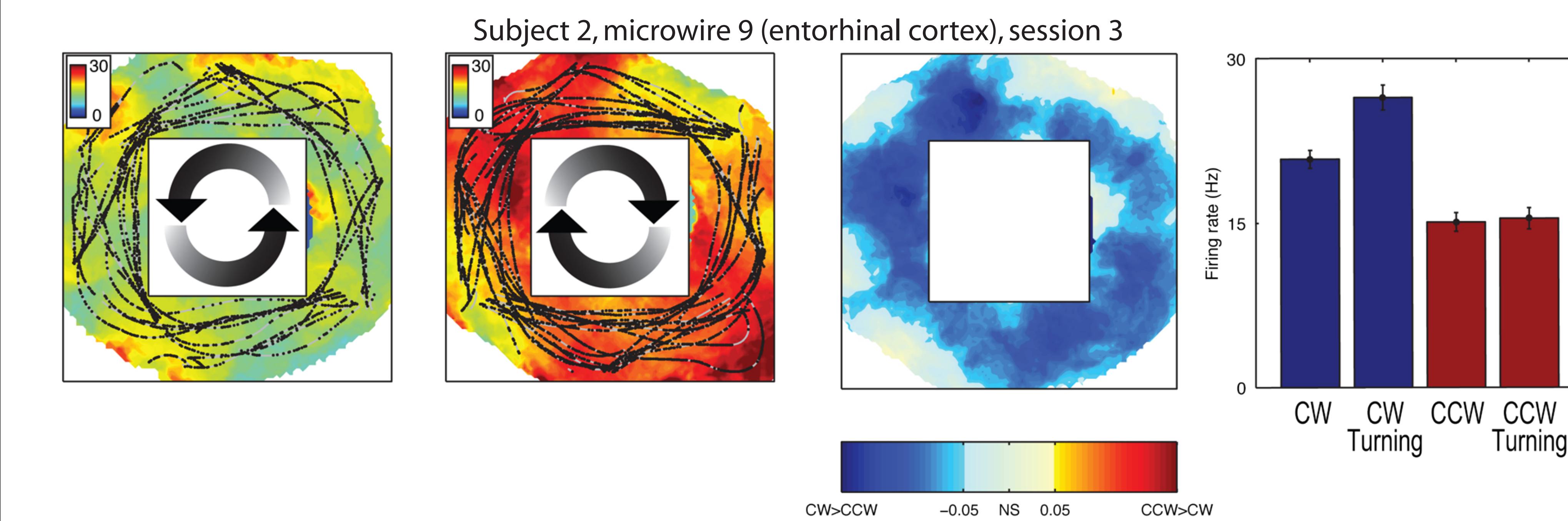
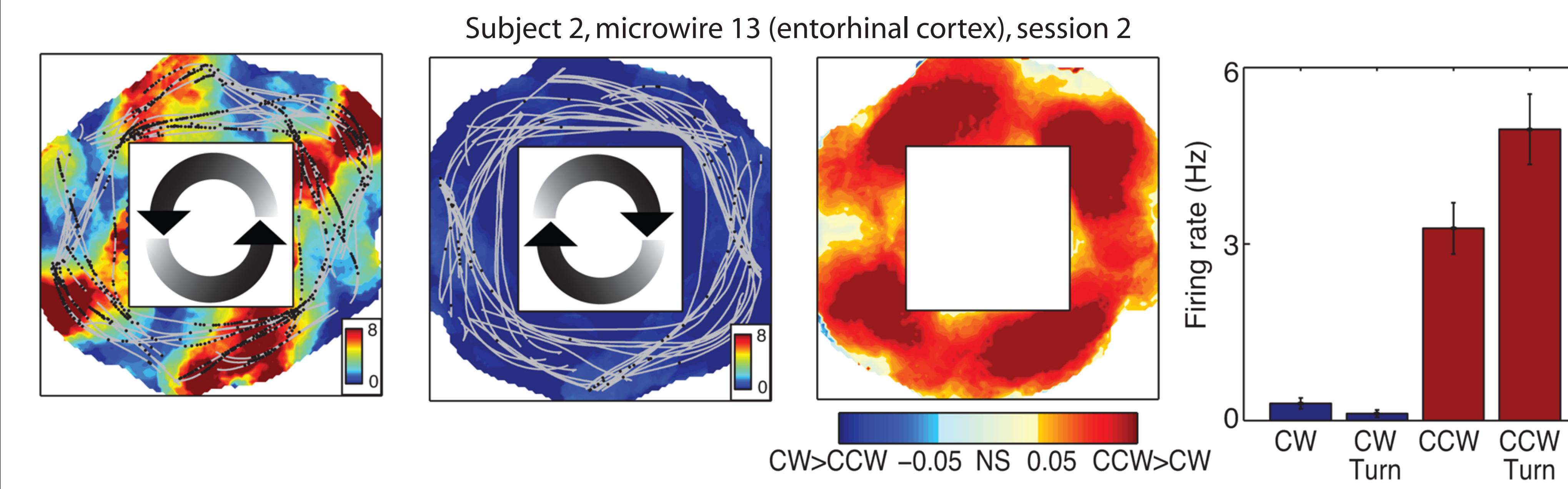
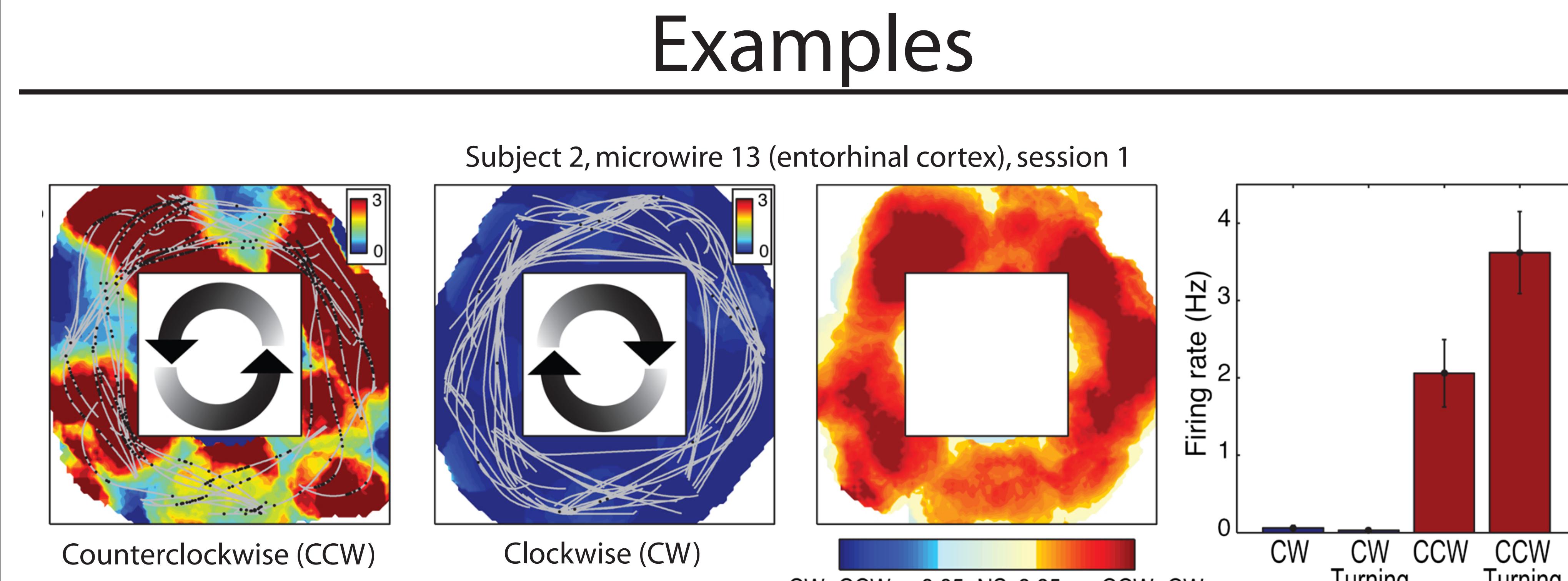
Electrophysiology

- Recorded 1,419 neurons in 13 epilepsy patients undergoing invasive monitoring.



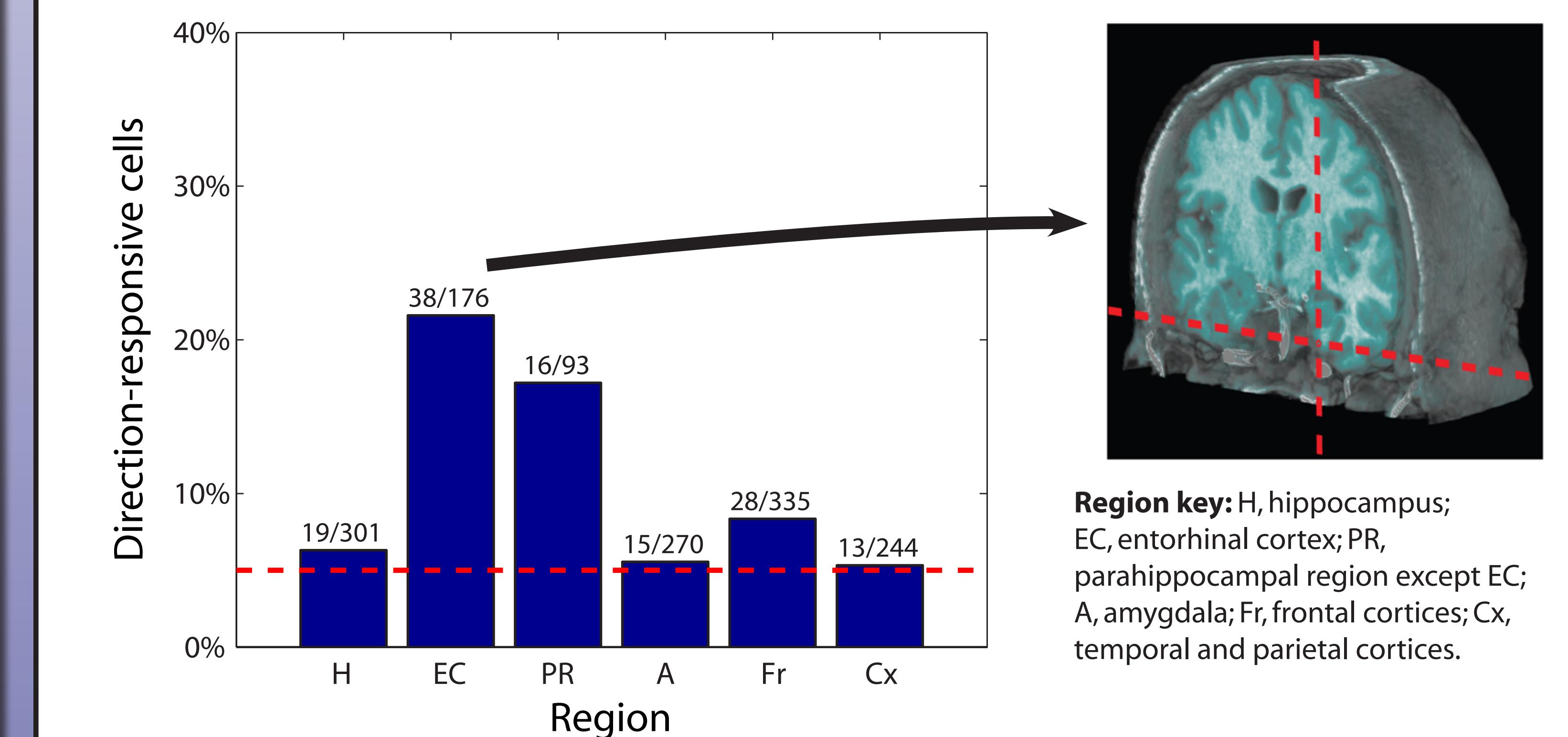
- Testing occurred during patients' spare time between clinical procedures.

Examples



Left panels indicate subjects' paths (gray lines) during counterclockwise (left) and clockwise (right) movements. Black dots indicate spikes, color indicates mean smoothed firing rate (in Hz). Middle right panels indicates statistical significance (*t* test of difference between counterclockwise and clockwise movements).

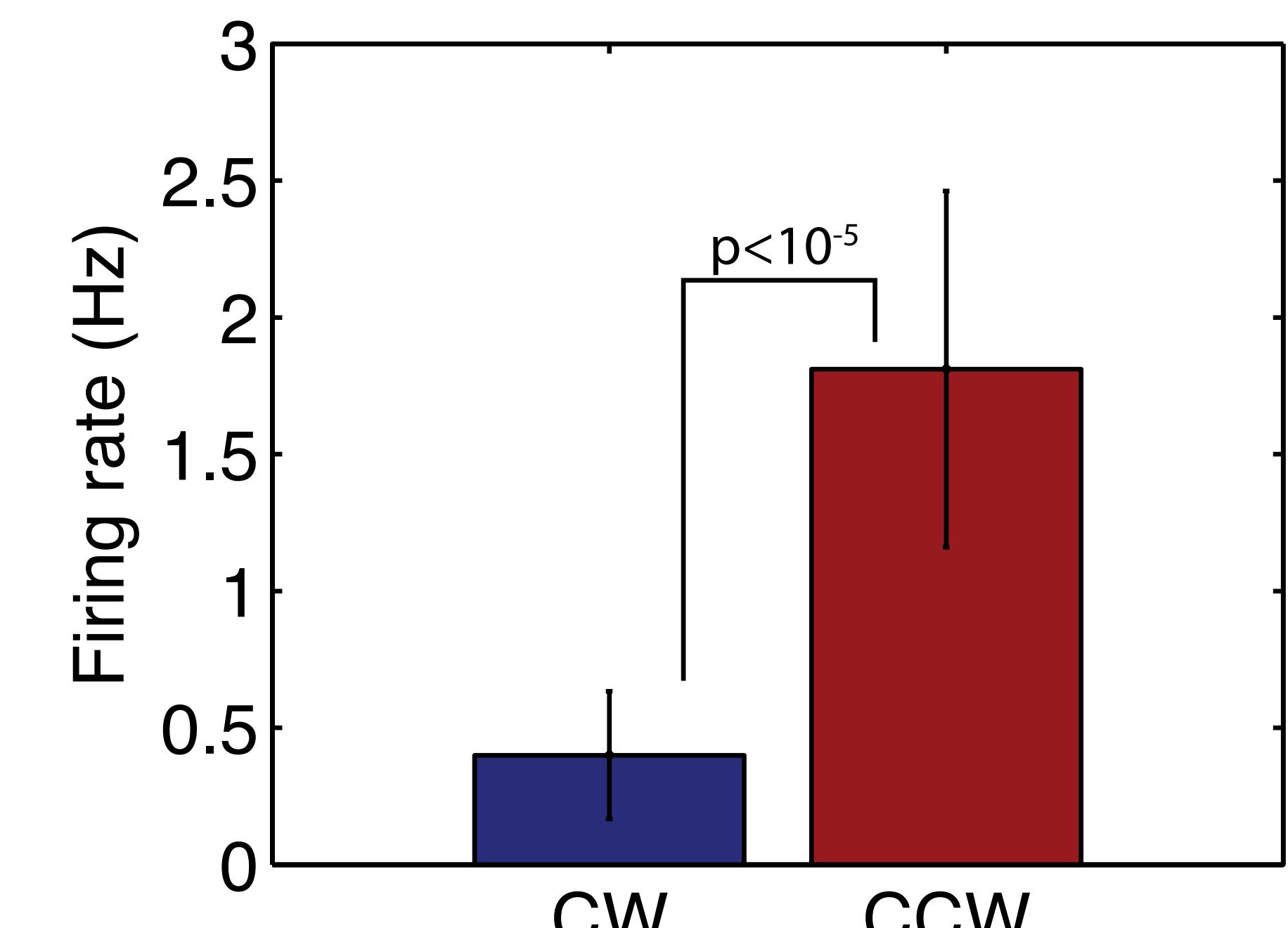
Regional analysis



Final approach

This result was still present when we separately analyzed the final, **straight** approach to the destination. Thus, this phenomenon is not *prospective coding* of an upcoming turn (Frank et al., 2000).

Figure depicts subject 2, microwire 13 (entorhinal cortex), session 2.



Conclusions

- Movement direction is an additional variable encoded in the human entorhinal cortex.
- Thus, entorhinal neurons may represent abstract cognitive information, in addition to spatial and perceptual information (Hafting et al., 2005; Suzuki et al., 1997).
- It remains unclear how this relates to the path integration occurring in networks of entorhinal grid cells (McNaughton et al., 2006).