

Do Hippocampal Place Fields Accumulate at Goal Locations After Extensive Training? 101.27

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Introduction

Is the hippocampal spatial map modified by the presence of goals?

Hollup et al (2001) observed that CA1 place cells fired preferentially near a goal platform location in an annular watermaze. This near-goal preferential firing occurred even during trials when the platform was not present, and thus when that location was not associated with reward (escape).

We reasoned that if goals become over-represented in the hippocampal spatial map in the short/medium term (Hollup et al, 2001), then *after extensive training* place fields should preferentially accumulate at rewarded goal locations. Further, this preferential firing should be apparent during sessions when goal locations were not associated with reward.

To address this issue, we trained 3 rats on a square arena containing 4 sandwells and 4 start boxes. Each goal location (e.g. South sandwell) was associated with a particular food (e.g. banana) presented in the goal sandwell, and in the startbox at the beginning of the trial.

Do place fields accumulate at goal locations after extensive training?

Methods

Apparatus

An 80cm x 80cm sand filled 'event-arena' with 4 possible goal locations, which were sandwells. 4 start boxes were attached to the arena, one at each corner. The arena was surrounded by 14cm high walls and fixed distal cues.



Task

Testing: During a single session (timeline shown below), there are two goal locations, only one of which is correct in a given series of trials. A trial begins with the delivery of a particular flavoured food into a start box. The rat consumes the food. After a 30-second delay, the door of the start box is opened. In order to obtain reward, the rat must proceed to the correct sandwell and dig there to uncover more of the same food that was delivered into the start box (as in Tse et al., 2007). The other 3 sandwells are not baited. On some probe trials, the goal sandwell is also not baited. Navigation to two different goal locations is tested during a session (e.g. South, West, South, West). A trial was scored 'Correct' when the rat's first dig occurred at the goal sandwell.

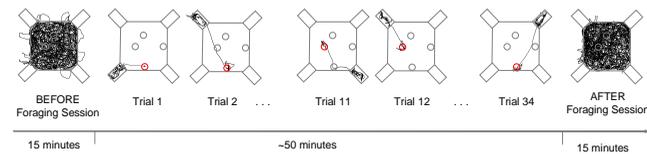
Acquisition: Rats (n=3) were initially trained to a high level of performance (>80% correct) in sessions with a single goal, before introducing sessions combining two different goal locations.

Place cell recording: Two 15-minute 'baseline' foraging trials are given, one BEFORE the navigation task and one AFTER, during which rats searched for rice scattered throughout the arena. CA1 place cells were recorded during task performance and during these baseline foraging trials.

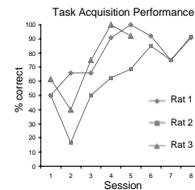
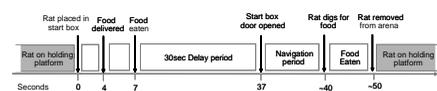
Session Timeline

Event arena walls are marked in grey, rat's trajectory from an example session is marked in black.

Circles indicate the position of sandwells. The red circle indicates the currently rewarded goal in each trial.

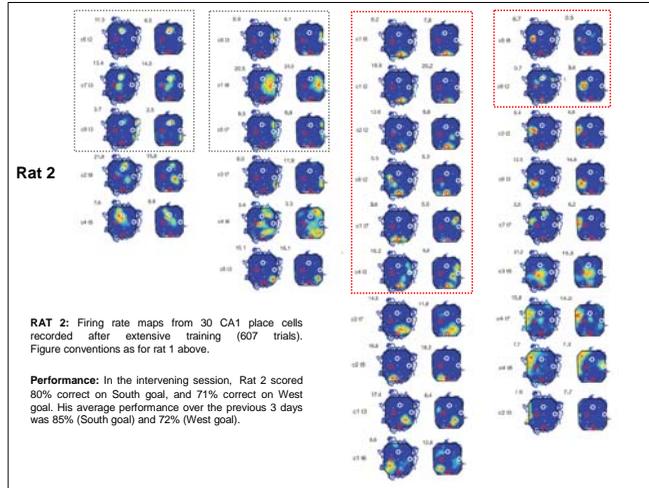
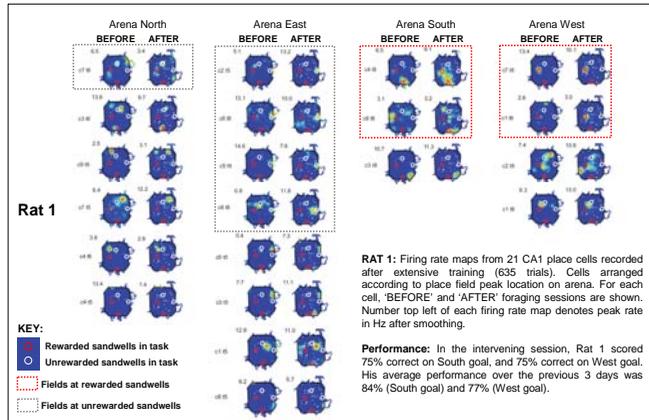


Trial Timeline



Results

Despite very good performance over several weeks, rewarded goal locations did NOT become over-represented in the CA1 spatial map.



Summary

No long-term accumulation

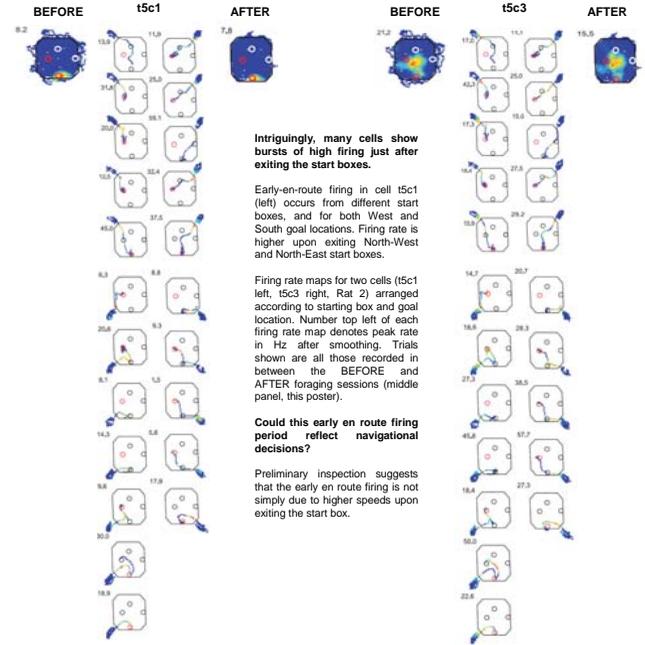
Despite an extensive training period with sustained levels of performance at both goal locations, CA1 place fields did not accumulate near rewarded locations. Place fields occur at unrewarded sandwells as frequently (n = 11 in examples above) as at rewarded sandwells (n = 12 in examples above).

No short-term goal-location changes

We saw no evidence for reliably increased firing near goal locations or extra fields near goal locations in the 'AFTER' session relative to the 'BEFORE' session.

Preliminary Observations

In the navigation-to-goal task, high firing in many cells typically occurs just after exiting the start box.



Conclusions

We find NO compelling evidence for place field accumulation at goal locations, despite extensive training over several weeks and several hundreds of trials.

Preliminary analyses suggest that CA1 neurons show disproportionately high firing early en route to a goal location. We are currently investigating the significance of this result.

References and Acknowledgements

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