

Reverse Replay of Hippocampal Place Cells Reflects Most Recent Sequential Experience

Kamran Diba¹, Eva Pastalkova¹, David Robbe¹, Asohan Amarasingham¹ and György Buzsáki¹

¹Rutgers University at Newark,

Sharp Wave/Ripples (SWR) in the hippocampus are accompanied by activity bursts of large percentages of CA1 neurons. These events are a salient feature of hippocampal activity, yet their function and supporting mechanism are largely unknown. Recently, Foster and Wilson[1] have shown that sequences of place-cells, corresponding to places traversed by rats during a run, are replayed in reverse during SWRs. Here, we record from CA1 and CA3 regions in rats running on a linear track. We confirm that reverse replay (RR) is indeed a robust phenomenon, as predicted[2], and demonstrate that the replayed sequence binds neurons that co-fired during preceding theta cycles to neurons that did not co-fire during any theta cycles (i.e. non-overlapping fields). This represents a type of pattern completion. We compare replay events on opposite ends the track, where a different sequence of place-cells are encountered on outgoing versus incoming trials. We find that, consistent with an experiential role for RR, only the sequence experienced in the immediately preceding trial is reverse replayed, rather than simply the replay of a fixed or potentiated pattern. Csicsvari et. al.[3] have more recently argued that residual place-related firing during SWRs is a potential mechanism, and furthermore, necessary for RR. Nevertheless, we demonstrate that cells participate in RR well beyond their 95% peak-rate place boundaries. Thus, RR may reflect transient (short-term) potentiation of selective synapses or related mechanisms that enhance excitability during SWRs.

References

- [1] Reverse replay of behavioural sequences in hippocampal place cells during the awake state. D. J. Foster and M. A. Wilson, *Nature* 440(7084): 680-683, March 2006.
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