Internally generated assembly sequences in the hippocampus and episodic memory

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Conclusions about the function of a brain structure often depend on the observational methods used. Single unit studies in rodents indicate that the hippocampus and associated structures are involved in spatial navigation (O'Keefe and Dostrovsky, 1971; Hafting et al., 2005, McNaughton et al., 1996), whereas studies in humans have provided firm evidence that hippocampal networks are critical in coding and retrieval of episodic memories (Scoville and Milner, 1957). It has been hypothesized that networks that serve spatial navigation may be ideal to represent episodes (Buzsaki, 2005).

A necessary condition for supporting this idea would be the demonstration that hippocampal networks can advance their intrinsic activity in the absence of external control cues, mimicking internally controlled free recall in humans. I provide evidence that cell assembly sequences in the hippocampus evolve perpetually even where rats are 'frozen' in space (i.e., running in a wheel) and suggest the hypothesis that hippocampal cell assemblies can be generated by the internal dynamics of the network. Specifically, I show that (a) the different environmental contexts give rise to unique evolving population sequences while the rat runs in the same wheel, (b) we can identify the conditions that initiate those sequences and (c) we can predict the future choice of the rat in the delayed spatial alternation task from the perpetually shifting sequence episodes during wheel running (i.e. the delay time). These physiological findings provide a link to understanding the mechanisms of episodic free recall and suggest an alternative coding mechanism of working memory, distinct from persistent activity of a circumscribed cell assembly.

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