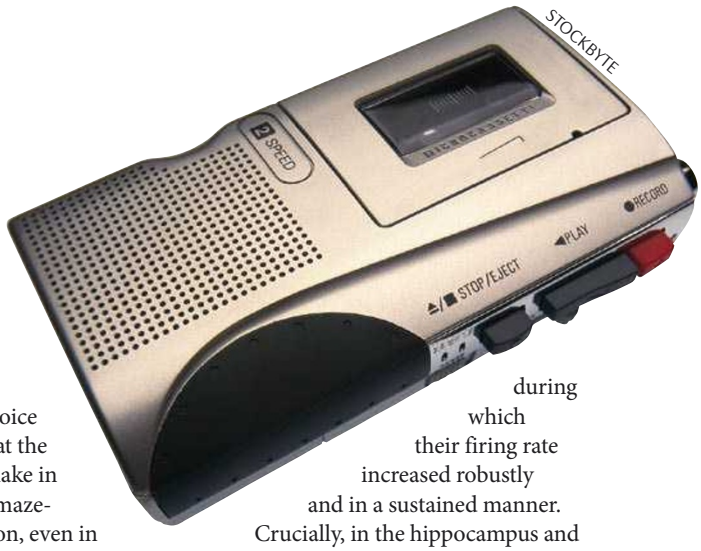
LEARNING AND MEMORY

Replay that track



STOCKBYTE

A proportion of human hippocampal neurons increase their activity in response to specific objects, scenes, categories or people, and in rats a similar set of neurons fire when the animal is in a particular position in its environment. Now, two studies published in *Science* show that activity in these cells can also be internally generated, and that it might be involved in memory recall.

Buzsaki and colleagues trained rats to run through a maze with two choice arms in which the rats were required to alternately turn left or right to obtain a reward. On each trial the rats had to remember which way they had turned during the previous trial, and choose the opposite direction. Between trials the rats ran for 10–20 seconds in a running wheel. As expected, recordings from hippocampal neurons revealed pyramidal cells that showed transient activation while the rats were navigating the maze — so-called 'place cells'. However, approximately half of the recorded pyramidal cells showed the same kind of transient activity while the rats were running in the wheel between trials: different assemblies of neurons fired at specific times, so that each assembly of 'episode neurons' had a specific 'episode field'. Thus, the specific activity of hippocampal cells that was observed during maze navigation also occurred when the animals were not navigating. Importantly, this episodic activity was related to the recall and planning aspects of the task, because it did not occur in control wheel-running sessions that did not have a memory component.

Moreover, the authors showed that cell-assembly activity during wheel running predicted the choice (left or right) that the animal would make in the subsequent maze-navigation session, even in trials in which the choice was incorrect. These findings show that, as well as being triggered by environmental cues, sequential neuronal-assembly activity can be internally triggered and maintained. It could be speculated that during wheel running the rats were recalling their previous maze run in order to plan which direction to take in the next one.

In a related study, Fried and colleagues provided direct evidence that internally triggered hippocampal cell activity is associated with memory recall. They studied patients with epilepsy who had had electrodes implanted into their brain. The patients watched a series of short audio-visual clips showing famous people, television characters, events or animals. The clips were shown several times, and afterwards the subjects verbally recalled the clips that they had just seen.

Over half of the recorded neurons in the medial temporal lobe showed temporarily elevated firing in response to one or more clips. A proportion of these responsive neurons seemed to have a 'preferred' clip, during which their firing rate increased robustly and in a sustained manner.

Crucially, in the hippocampus and in the entorhinal cortex, selective neurons also increased their firing an average of 3 seconds before the subjects verbally recalled watching the clip, but remained silent during the recall of 'non-preferred' clips.

Both studies showed that selective activity of hippocampal neurons not only occurs in response to a specific environmental cue, but also can be generated internally, possibly when recalling the memory of the cue that triggered the neurons' earlier activity. The internally generated reactivation of individual hippocampal neurons might thus represent a neural correlate of memory recall, although future studies will have to establish what aspects of environmental cues (or audio-visual clips) the neuronal activity represents.

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ORIGINAL RESEARCH PAPERS
Pastalkova, E. *et al.* Internally generated cell assembly sequences in the rat hippocampus. *Science* **321**, 1322–1327 (2008) | Gelbard-Sagiv, H. *et al.* Internally generated reactivation of single neurons in human hippocampus during free recall. *Science* 4 Sep 2008 (doi:10.1126/science.1164685)