Entorhinal cortex acts independently of the hippocampus in remembering movement, study finds

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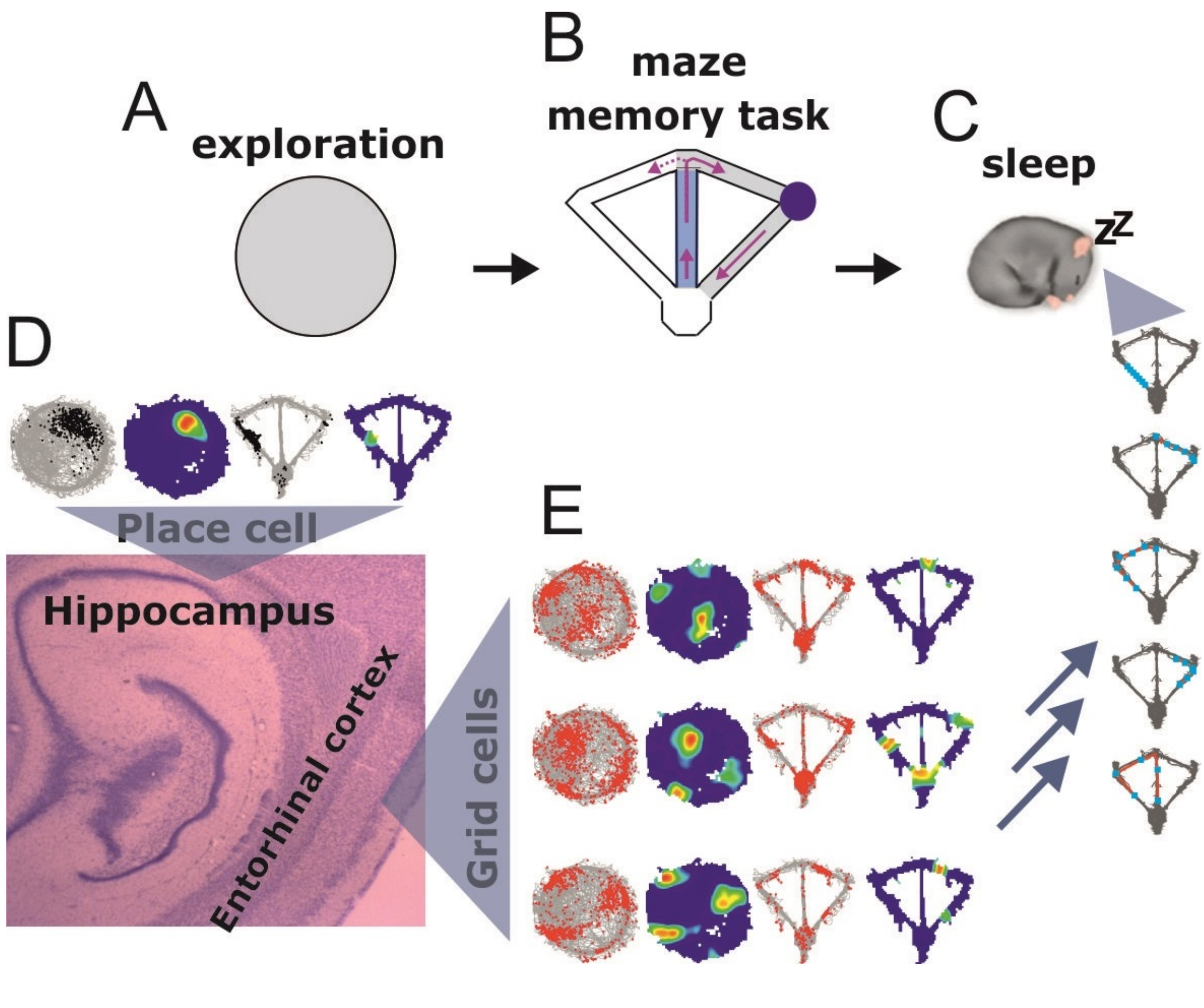

Rats roam around an arena (A) before tackling a maze memory task. A reward awaits them in the T-maze placed in the arena (B). While it sleeps, the rat consolidates the memory of where the reward was located (C). A place cell emits an action potential every time the rat is in one particular location in the arena (D). A dot is placed at each point a grid cell emits an action potential. The firing location of grid cells (see dots) form a grid over the arena (E). While the rat is asleep, grid cells replay this firing pattern (C). Credit: IST Austria

Until now, the hippocampus was considered the most important brain region for forming and recalling memory, with other regions only contributing as subordinates. But a study published today in *Science* finds that a brain region called entorhinal cortex plays a new and independent role in memory. A team of researchers led by Jozsef Csicsvari, Professor at the Institute of Science and Technology Austria (IST Austria), showed that, in rats, the entorhinal cortex replays memories of movement independent of input from the hippocampus.

"Until now, the entorhinal cortex has been considered subservient to the hippocampus in both memory formation and recall. But we show that the medial entorhinal cortex can replay the firing pattern associated with moving in a maze independent of the hippocampus. The entorhinal cortex could be a new system for memory formation that works in parallel to the hippocampus", Jozsef Csicsvari explains.

When a spatial memory is formed, cells in the medial entorhinal cortex (MEC), especially grid cells, act like a navigational system. They provide the hippocampus with information on where an animal is and give cues as to how far and in what direction the animal has moved. Rats encode location and movement by forming networks of neurons in the hippocampus that fire together. When a memory is recalled for memory stabilization, the MEC has been considered as secondary to the hippocampus. In the hippocampus, such recall occurs during the so-called "sharp wave/ripples", when neuronal networks fire in a highly synchronized way. According to the view prevailing until now, the hippocampus is the initiator of this replay and coordinates memory consolidation, while the MEC is just a relay post that spreads the message to other brain areas.

To ask whether replay also occurs in the MEC, the researchers studied memory recall in rats moving in a maze. They showed that neurons in the superficial layers of the medial entorhinal cortex (sMEC), a part of MEC that sends input to the hippocampus and contain the grid cells, fire during the memory task and encode routes as bursts of firing. Surprisingly, the authors find that replay firing in the sMEC is not accompanied by replay firing in the hippocampus. During both sleep and waking periods, the sMEC triggers its own replay and initiates recall and consolidation independent of the hippocampus. Joseph O'Neill, first author and postdoc in the group of Jozsef Csicsvari, explains how these results change the way we see memory formation: "The hippocampus alone does not dominate how memories are formed and recalled. Instead, the entorhinal cortex and the hippocampus are probably two systems for memory formation and recall. Despite being interrelated, the two regions may work in parallel. They may recruit different pathways and play different roles in memory."

More information: "Superficial layers of the medial entorhinal cortex replay independently of the hippocampus" *Science*, science.sciencemag.org/cgi/doi … 1126/science.aag2787

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