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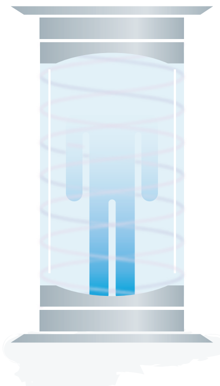
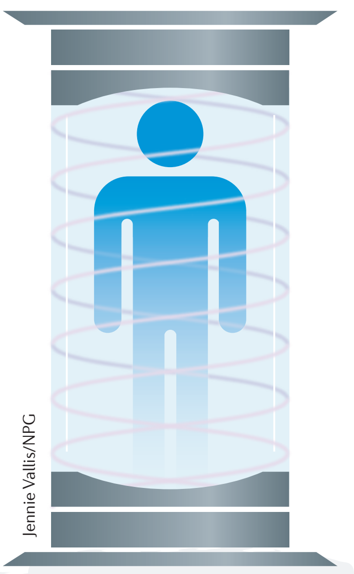
NAVIGATION

The long and short of teleporting



Low-frequency oscillations (LFOs) in the hippocampus have been observed in many studies of spatial navigation; however, it is unclear what kind of information may be coded by these oscillations. By recording hippocampal LFOs from people navigating a virtual environment including teleporters, Ekstrom and colleagues provide evidence that these oscillations represent spatial information.

Several possible explanations for the function of these LFOs have been previously suggested: some models propose that they represent the processing of sensorimotor cues, whereas others propose that they carry task-related (and therefore memory-associated) information or a mixture of navigational and mnemonic information.



Jennie Vallis/NPG

In this study, the authors instructed participants who were undergoing seizure monitoring to navigate a virtual plus maze and simultaneously carried out electrophysiological recordings from a total of 42 intracranial electrodes placed in the participants' hippocampi. The participants were asked to navigate to target 'shops' at the ends of each arm of the plus maze, which had two long-distance teleporters (placed near the ends of two of the plus arms) and two short-distance teleporters (placed about half way along the other two arms). Participants could use these teleporters to return back to the centre of the maze. Importantly, the duration of the teleportation event was varied in such a way that participants could not estimate, and instead had to remember, the distance that each teleporter would take them.

The authors reasoned that if sensorimotor processing contributes to LFOs, removing visual cues by presenting a black screen during teleportation would lead to a decrease in LFO activity. The authors measured the proportion of time that LFOs occurred ($P_{Episode}$) in the periods before, during and immediately after teleportation. LFO activity was observed in all three periods, and there was no change in $P_{Episode}$ during teleportation in most of the hippocampal areas that were sampled, suggesting that sensorimotor processing is not necessary for LFO activity.

By contrast, when participants were shown the black screen but were not teleporting or actively navigating the maze (and were therefore not processing motion-related information or task-related information stored in their memory), the prevalence of LFO activity markedly decreased. Furthermore, $P_{Episode}$ values immediately after teleportation, when the participants' speed was transiently reduced, were lower than during navigation or teleportation. These findings indicate that hippocampal LFOs are influenced by movement processing and/or mnemonic information.

Next, the authors asked whether the LFOs that persisted during teleportation might drive 'spatial updating'. Interestingly, they found that $P_{Episode}$ values during teleportation could be used to predict whether participants had teleported long or short distances — largely because $P_{Episode}$ was higher during long-distance teleportation than during shorter-distance teleportation. The authors propose that the relative increase in LFOs during teleportation over longer distances may result from the need for more spatial updating to maintain the participants' orientation.

This study provides evidence in humans that hippocampal LFOs are not associated with sensorimotor processing, but instead code spatial — for example, distance-related — information.

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ORIGINAL ARTICLE Vass, L. K. *et al.* Oscillations go the distance: low-frequency human hippocampal oscillations code spatial distance in the absence of sensory cues during teleportation. *Neuron* http://dx.doi.org/10.1016/j.neuron.2016.01.045 (2016)

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