New research explains how we use the GPS inside our brain to navigate

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Credit: Rice University

The way we navigate from A to B is controlled by two brain regions which track the distance to our destination, according to new research funded by the Wellcome Trust and published in *Current Biology*.

The study found that at the beginning of a journey, one region of the brain calculates the straight-line to the destination ('the distance as a crow flies'), but during travel a different area of the brain computes the precise distance along the path to get there.

The findings pinpoint the precise brain regions used and in doing so change how scientists believed we use our brain to navigate. Previously, researchers had disagreed over whether the brain calculates a route or calculates the straight-line to a destination. By revealing that the brain does both this research indicates not only that both ideas were correct, but should also be integrated.

Dr Hugo Spiers and his team at UCL used film footage to recreate the busy streets of Soho in London (UK) inside an MRI scanner. Study participants were asked to navigate through the district, famous for its winding roads and complex junctions, whilst their brain activity was monitored. The researchers analysed brain activity during the different stages of the journey: setting course for the destination, keeping track of the destination while travelling, and decision making at street junctions.

The team found that activity in the entorhinal cortex, a region essential for navigation and memory, was sensitive to the straight-line distance to the destination when first working out how to get there. By contrast, during the rest of the journey, the posterior hippocampus, also famous for its role in navigation and memory, became active when keeping track of the path needed to reach the destination.

The results also reveal what happens in our brain when we use a Sat Nav or GPS to get to a destination. By recording brain activity when participants used Sat Nav-like instructions to reach their goal, the researchers found that neither of the brain regions tracked the distance to the destination and in general the brain was much less active.

Dr Spiers said: "Our team developed a new strategy for testing navigation and found that the way our brain directs our navigation is more complex than we imagined, calculating two types of distance in separate areas of the brain." He also commented on how the results might explain why London taxi drivers famously end up with an enlarged posterior hippocampus: "Our results indicate that it is the daily demand on processing paths in their posterior hippocampus that leads to the impressive expansion in their grey matter".

"These findings help us understand the mechanisms by which the hippocampus and entorhinal cortex guide navigation. The research is also a substantial step towards understanding how we use our brain in real world environments, of which we currently know very little."

Dr John Williams, head of clinical activities, neuroscience and mental health at the Wellcome Trust said: "These findings provide insight into the underlying biology of mental health conditions which affect our memory. The hippocampus and entorhinal cortex are among the first regions to be damaged in the dementia associated with Alzheimer's disease and these results provide some explanation as to why such patients struggle to find their way and become lost. Combining these findings with clinical work could enable medical benefits in the future."

More information: Howard LR, Javadi AH, Yu Y, Mill RD, Morrison LC, Knight R, Loftus MM, Laura Staskute L and Spiers HJ. Hippocampus and entorhinal cortex encode the path and Euclidean distance to goals during navigation. *Current Biology*. June 2014.

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