

 SPATIAL AWARENESS

A goal for place cells

DOI:

10.1038/nrn2101



The hippocampus contains place cells, which are neurons whose firing frequency increases dramatically when an animal is in a specific location in an environment. This location is known as the place cell's place field. Reporting in the *Journal of Neuroscience*, Hok and colleagues show that these cells can also fire when a rat is in an area associated with a particular goal, even if this area is outside a cell's place field.

The researchers trained rats in a place navigation task within a circular enclosure. An overhead food dispenser released a food pellet each time a rat had stayed in a pre-determined 'goal location' within the enclosure for at least 2 seconds. The food pellet could land anywhere

within the enclosure (usually outside of the goal zone), ensuring that the goal zone was not directly associated with the food reward. In the uncued version of the task, the goal zone was invisible and rats had to determine its position relative to a marker on the enclosure wall. In the cued version, the goal zone was marked by a metal disk on the floor of the enclosure.

The researchers found that 84% of place cells whose place field did not overlap with the goal zone fired when a rat entered this zone, indicating that the place cells had a 'secondary' place field. Place cells only fired when the rat was in the goal zone while waiting for food to be released, and not when the rat was searching for the food pellet in that area. This indicates that

goal-specific firing was not associated with finding a reward.

Most place cells showed a gradual increase in activity that peaked 1–1.2 seconds after the rat entered the goal zone, which was followed by a second activity peak upon food release. In the cued version of the task, the activity of the cells increased as soon as the rats had entered the goal zone. The authors speculate that place cell firing might therefore indicate the rat's expectancy that it was correctly located at the goal.

The authors next determined whether the synchronous goal-specific activity of many place cells could be explained by an elevated excitability in the whole hippocampal network. However, electroencephalograms that were recorded in the hippocampal CA1 region during the task showed that sharp waves/ripples, which are thought to reflect increased hippocampal excitability, were not associated with goal-specific firing.

The authors speculate that goal-specific firing of hippocampal place cells signal that the animal is in the correct place in a given context. Their work suggests that place cells could indicate the relevance of a location as well as the location itself.

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ORIGINAL RESEARCH PAPER Hok, V. et al.
Goal-related activity in hippocampal place cells.
J. Neurosci. 27, 472–482 (2007)