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SPATIAL CODING

Does the brain know how high it is?

A mammal's awareness of its spatial position depends on the activity of cells in the hippocampus and posterior cortex that encode information such as location and distance. So far, most studies on this system have examined navigation within two-dimensional environments that lack the three-dimensional complexity of the real world. A study by Jeffery and colleagues now shows that the cells that create a horizontal 'map' of the world do not accurately encode vertical position.

In tests in two-dimensional environments, place cells in the rat hippocampus have been shown to fire when the animal is at a specific location, known as a 'place field'. Grid cells in regions of the posterior cortex fire when an animal is at any one of multiple specific locations ('firing fields') that are arranged in a grid-like array across the horizontal environment, and are thus thought to encode distance. Here, the authors asked how these cells responded as rats moved freely over three-dimensional surfaces. For this they used a vertically oriented climbing wall (the 'pegboard') and a spiral staircase (the 'helical track').

By recording from place and grid cells as the animals navigated these environments, the authors discovered that the place fields of place cells had horizontal dimensions similar to those seen in previous studies but were elongated in the vertical plane, thus encoding less spatial information in the vertical dimension than in the horizontal dimension. For grid cells, this dimensional dependence was even more apparent. Although grid cell firing was highly dependent on horizontal position, with firing fields arranged in a grid in the horizontal dimension, the firing was modulated very little by the animal's height: firing fields in this dimension took the form of stripes, suggesting that the cells encode little information about vertical distance.

These results suggest that place cells and grid cells encode much more information about an animal's horizontal position than about its height within an environment. Given that all mammals must negotiate three-dimensional environments, this raises several interesting questions. Are there other mechanisms for encoding height and, if not, how do we navigate our three-dimensional world?

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ORIGINAL RESEARCH PAPER Hayman, R. *et al.* Anisotropic encoding of three-dimensional space by place cells and grid cells. *Nature Neurosci.* 7 Aug 2011 (doi:10.1038/nn.2892)