SPATIAL CODING

Neurons know the limit

A cell type that was predicted to exist by computer models has now been discovered in the entorhinal cortex. In a study published recently in *Science*, the Moser laboratory showed that these newly identified 'border cells' fire when an animal is close to the boundary of an environment.

The authors recorded the activity of multiple cells simultaneously in the medial entorhinal cortex, which provides input to the hippocampus, and in the adjacent parasubiculum in rats that were exploring their environment. They found that in all layers of the medial entorhinal cortex ~10% of the recorded cells fired specifically when the rat was moving along one of the walls surrounding the enclosure.

To determine whether the walls of the enclosure rather than other environmental cues determined the activity of the border cells, the authors manipulated the size of the enclosure. Lengthening the north and south walls or the east and west walls of the box resulted in an increase in the size of the firing fields of border cells with fields along those walls. Furthermore, introducing a new, partial wall in the middle of the enclosure (parallel to an existing wall) caused border cells with firing fields along the existing parallel wall to fire; in other words, it caused an additional firing field to appear in the relevant border cells.

Next, the authors removed the walls of the enclosure — which was placed on a table — so that the boundary of the environment now consisted of a 60 cm drop. Interestingly, this did not change the border cells' behaviour, indicating that the cells respond to the animal approaching physical boundaries in general rather than walls specifically. Moving the enclosure to different rooms and/or changing the shape of the enclosure from square to circular also did not change the border cells' firing fields, with each field covering a similar proportion of the area regardless of the shape of the enclosure.

The newly discovered border cells probably function in concert with place cells, grid cells and head direction cells in the entorhinal–hippocampal system to encode the 'cognitive map' of an animal's environment; how information is transferred between the different cell types will no doubt be the subject of future research.

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ORIGINAL RESEARCH PAPER Solstad, T., Boccara, C. N., Kropff, E., Moser, M.–B. & Moser, E. I. Representation of geometric borders in the entorhinal cortex. *Science* **322**, 1865–1868 (2008)