Medical Xpress

Do mammals think in 3-D?

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A team of neuroscientists at University College London (UCL) has begun to discover how the brain maps three-dimensional space. The work could one day aid in the understanding and treatment of Alzheimer's disease, which involves the same area of the brain as encodes space.

The results of the research are to be presented today (Sunday 13 July) at FENS 2008 by Dr Kate Jeffery of UCL.

It's long been known that humans and other mammals have "cognitive maps", spatial representations in their brains that map their environment and enable them to find their way around. These maps are made up of types of brain cells (neurons) known as place cells and grid cells, which are found in the hippocampus and entorhinal cortex, the memory regions of the brain. Place cells each represent a particular place, firing when the animal is at that place, while grid cells are thought to provide place cells with information about distances and directions. "We've learned quite a lot about how neurons represent flat spaces," says Dr Jeffery. "What we don't really know is how that information extends to the third dimension – are our maps really just flat or are they actually three-dimensional?"

To find out, the team at UCL placed rats on a spiral staircase which they had to run up and down to collect food. The team recorded the activity of individual neurons while the rats performed this task. They found that the place cells are sensitive to height, while grid cells are not. "This raises the possibility that the vertical dimension is encoded differently from the horizontal ones, a possibility that we are exploring on tilted surfaces, and by using mazes that the rats can climb through freely in all directions," says Dr Jeffery. This idea that vertical and horizontal space are encoded differently may also explain some aspects of human behaviour, such as the fact that people get lost easily in multi-storey buildings.

Dr Jeffery is also interested in how non-spatial cues help the animal to map its environment – for example it's known that specific smells and colours and even the animal's intentions and expectations can contribute to the cognitive map. "It's slightly more complicated than just a spatial map, also incorporating what the animal might expect to happen there," she says. Essentially the map is using knowledge from the animal's memory to help it understand its environment. And in fact the connection between the map and memory is very close indeed – the same brain areas that encode space in the rat and human brain are also important in episodic memory, or remembering past events.

"We're trying to build up a picture of how space and memory are woven together," says Dr Jeffery. Alzheimer's disease illustrates just how closely these two concepts are linked. The disease involves the degeneration of the hippocampus, where the place cells are located, and the entorhinal cortex, which contains the grid cells. "The big symptom of degeneration of those structures is the loss of episodic memory," Dr Jeffery explains, "but in fact one of the first symptoms Alzheimer's sufferers experience can be loss of memory for places".

Dr Jeffery now aims to find out more about how 3-D space is represented in the brain, and it's to be hoped that research like hers may one day help us to better understand not only how we navigate, but also diseases such as Alzheimer's.

Source: FENS 2008/PhysOrg.com