Instituts thématiques Inserm
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Institute of Psychiatry and Neuroscience of Paris

Université Paris Cité

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(Host: Belén PARDI)

Mapping the world around us: A topology-preserved schema of space that supports goal-directed navigation

Successful goal-directed navigation requires estimating one's current position in the environment, representing the future goal location, and maintaining a map that preserves the topological relationship between positions. In addition, we often need to implement similar navigational strategies in a continuously changing environment, thereby necessitating certain invariance in the underlying spatial maps. Previous research has identified neurons in the hippocampus and parahippocampal cortices that fire specifically when an animal visits a particular location, implying the presence of a spatial map in the brain. However, this map largely encodes the current position of an animal and is context-dependent, whereby changing the room or shape of the arena results in a new map orthogonal to the previous one. These observations raise the question, are there other spatial maps that fulfill the cognitive requirements necessary for goal-directed navigation?

Using a goal-directed navigation task with multiple reward locations, we observed that neurons in the orbitofrontal cortex (OFC) exhibit distinct firing patterns depending on the goal location, and this goal-specific OFC activity originates even before the onset of the journey. Further, the difference in the ensemble firing patterns representing two target locations is proportional to the physical distance between these locations, implying the preservation of spatial topology. Finally, carrying out the task across different spatial contexts revealed that the mapping of target locations in the OFC is largely preserved and that the maps formed in two different contexts occupy similar neural subspaces and could be aligned by a linear transformation. Taken together, the OFC forms a topology-preserved schema of spatial locations that is used to represent the future spatial goal, making it a potentially crucial brain region for planning context-invariant goal-directed navigational strategies.