Flexible Integration of Other Individuals into the Human Cognitive Map

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Synopsis

Decades of research have shown that successful spatial navigation requires the so-called “cognitive map,” an internal representation of the surrounding space and one’s own location in it. However, how the human brain forms this map in real-world settings is rarely investigated in mechanistic works. Humans in everyday life often occupy a social environment: whether it be an office or a busy street, we keep track of who is where, and where they may be headed. These complexities of real-world navigation are necessarily omitted in most studies, focusing instead on single animals in highly controlled, minimalistic environments or on immobile humans. To fill this critical gap in knowledge, we leverage our mobile multimodal neurophysiology platform to investigate how other individuals in a shared environment are integrated into the human cognitive map. We recorded oscillatory electrophysiological activity from medial temporal lobe (MTL) regions in nine freely moving participants with chronically implanted deep-brain electrodes as they navigate and observe a real-world scene. We found that the power of MTL theta oscillations (~4-7 Hz) was tuned to various features related to other individuals, effectively encoding information such as another person’s location, speed, and interpersonal distance. Furthermore, the encoded spatial feature strongly depended on task demands, with only behaviorally relevant features being represented at a given point in time. These results suggest that the human brain uses a flexible repertoire of spatial representations to track other individuals in a shared environment and switches between them depending on current behavioral goals and task demands. Together, these findings provide novel insight into the neural mechanisms by which the human brain integrates other individuals into their cognitive map during real-world navigation and natural everyday experience.