Study demonstrates how humans navigate through doorways and not into walls

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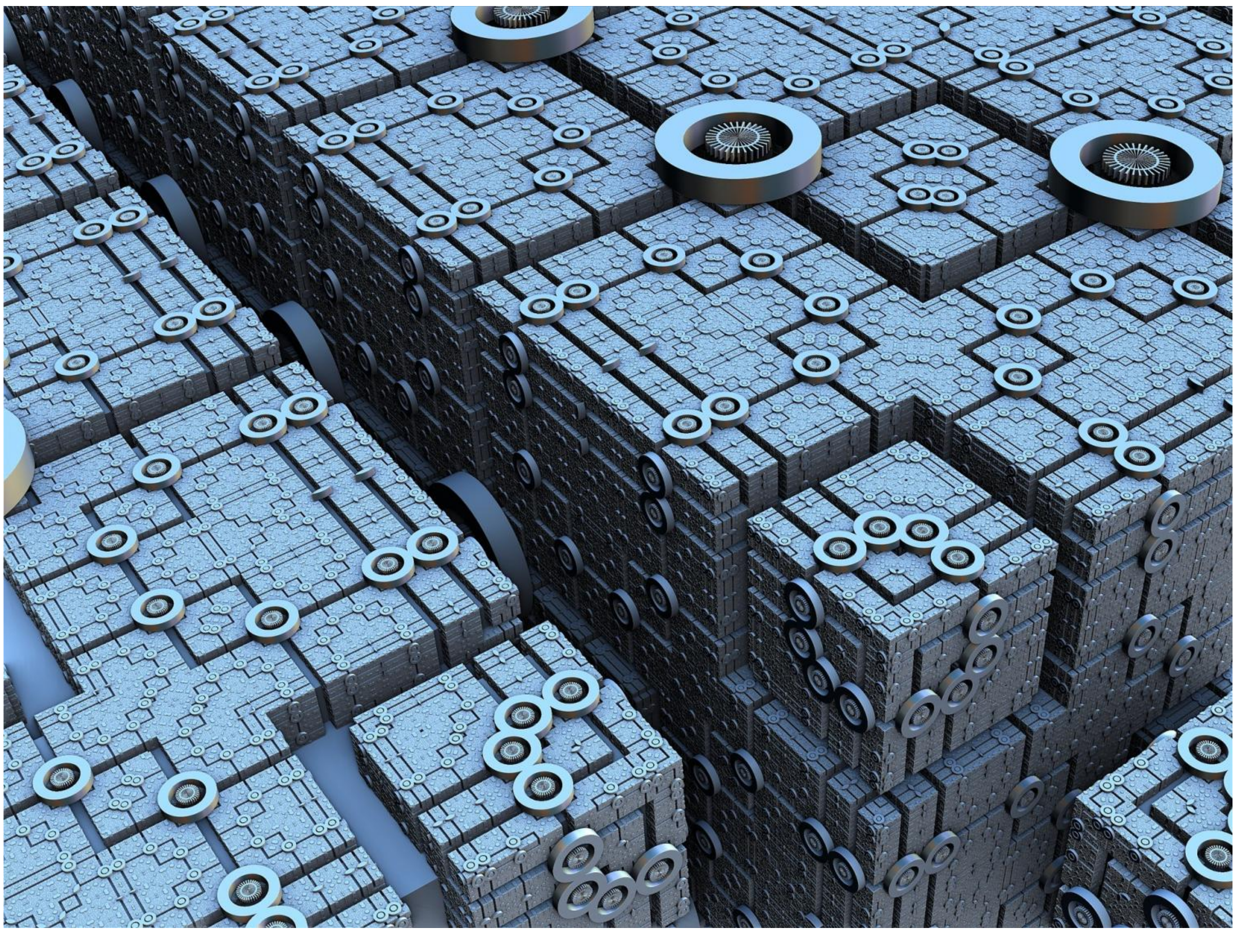

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(Medical Xpress)—You walk into a wedding reception at a hotel. To your left, you see the entrance to the ballroom. To the right, there's an enormous painting of an evergreen forest. Behind you is the exit to the hotel lobby. But without stopping to think, you walk through the door straight ahead, into the event's open bar.

Researchers know that there is no cognitive load for navigating new spaces—the human visual system instantly determines the navigational possibilities. But given all the spatial information presented by a new environment, how does the brain know it can walk through the door to the bar, but that it cannot navigate through the painting?

A pair of researchers at the University of Pennsylvania recently conducted a study consisting of two experiments to explore the hypothesis that perceptual systems are optimized to process spatial features that afford navigational possibilities—they refer to these features as "affordances," and they've published the results of their study in the *Proceedings of the National Academy of Sciences*.

Previous studies have established that an observer can determine the overall navigability of a space in a fraction of a second. But this is the first study to explore how fine-grained navigational affordances are encoded in the brain. The researchers designed a pair of experiments using multivoxel pattern analysis of fMRI data. In the first experiment, they scanned subjects looking at artificially rendered images of rooms with exits that varied in location. In the second experiment, subjects were scanned while viewing photographs of actual rooms with varied navigational pathways.

Throughout both experiments, the subjects performed tasks that made no reference to the affordances in the photosets and that were totally unrelated to navigation. The researchers predicted that the navigational affordances would be extracted and encoded in the visual system even while subjects were engaged in non-navigational activities. The fMRI data analysis strongly established that navigational representations were, in fact, automatically extracted and represented in a scene-selective region of the visual cortex called the occipital place area (OPA).

They found that scenes with similar navigational possibilities elicited very similar activation patterns in the OPA and that scenes that differed in such affordances elicited identifiably separate activation patterns. "Indeed," they write, "in experiment two, is was possible to reconstruct the affordances of novel environments using the multivoxel activation patterns of the OPA."

Previous studies have demonstrated that visual processing of objects automatically activates the visuospatial and motor regions associated with those objects; similarly, the authors argue, spatial scenes afford a set of potential actions that are automatically extracted and processed.

"This proposed mechanism also aligns well with a recent theory of action planning known as the affordance-competition framework," the authors write, "which suggests that observers routinely encode multiple, parallel plans of the relevant actions afforded by the environment and then rapidly select among those when implementing a behavior."

More information: Coding of navigational affordances in the human visual system. *PNAS* 2017; April 17, 2017, DOI: 10.1073/pnas.1618228114

Abstract
A central component of spatial navigation is determining where one can and cannot go in the immediate environment. We used fMRI to test the hypothesis that the human visual system solves this problem by automatically identifying the navigational affordances of the local scene. Multivoxel pattern analyses showed that a scene-selective region of dorsal occipitoparietal cortex, known as the occipital place area,

represents pathways for movement in scenes in a manner that is tolerant to variability in other visual features. These effects were found in two experiments: One using tightly controlled artificial environments as stimuli, the other using a diverse set of complex, natural scenes. A reconstruction analysis demonstrated that the population codes of the occipital place area could be used to predict the affordances of novel scenes. Taken together, these results reveal a previously unknown mechanism for perceiving the affordance structure of navigable space.

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