SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

People spend a lot of time navigating through their environment, so this study discusses how functional magnetic resonance imaging (fMRI) has shown how the hippocampus/parahippocampal gyrus can differentiate between important spatial information and ambiguous/misleading information for navigational purposes.

A Neural Wayfinding Mechanism Adjusts for Ambiguous Landmark Information

Janzen, G., Jansen, C.

2010 | NeuroImage
Volume 52, Issue 1, Pages 364-370

Key Concepts/Context

In order to find their way through their surroundings, people need to adapt to different and changing environments. Objects placed in strategic locations can serve as helpful navigational cues. Using functional magnetic resonance images (fMRI) to monitor brain activity, this study investigates how the brain is able to distinguish and process helpful information from the environment for navigational purposes.;

It is critical for the brain to filter useful information from the environment to help subjects in the wayfinding process. Past fMRI evidence indicates that the part of the brain called the parahippocampal gyrus automatically distinguishes between objects placed at navigationally relevant locations (decision points) and irrelevant locations (non-decision points). In this context, decision points are locations where subjects face having to make a navigational decision. In the study, brain activity was monitored as identical objects were placed twice in a virtual labyrinth at places with the same as well as with a different navigational relevance.

After experimenting with 28 left-handed women in their mid-20s, results showed that activity in the parahippocampal gyrus was increased for objects placed at one decision and one non-decision point as compared to objects placed at two non-decision points. When two objects are placed at two decision points, there is an increase in neural activity in the prefrontal cortex, the area responsible for executive functioning. The frontal gyrus helps play an important role in this process by monitoring and selecting contextually relevant information and by managing spatial working memory.

This change in neural activity mapping shows how adaptive the brain is to processing wayfinding cues and their function.

DESIGN IMPLICATIONS

Using unique landmarks at relevant locations within healthcare settings can help patients and visitors navigate easily through the space. It is important to place a different unique landmark at each decision-making point (at each point where a person has to make a navigational decision).

Methods

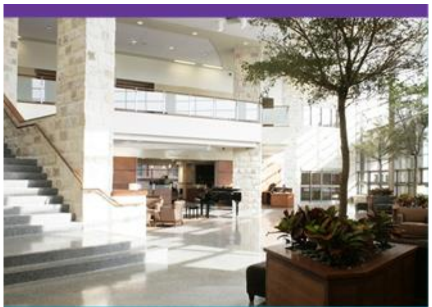
Twenty healthy adults, with a mean age of 25 years old, participated in this study. The study had two parts: one study phase outside the scanner and one inside the scanner, where functional imaging (fMRI) was taken of the brain. Before the brain scan was taken, women were given a virtual maze (different than the one given during the study phase) to navigate through until they were familiarized with the maze.

Right before the second phase, the subjects were given written instructions in Dutch explaining the purpose and instructions for the experiment. The experiment would take place virtually, using computer software called Unreal Tournaments. Subjects were to be exposed to a photo-archive of famous people's favorite objects. They were asked to pay attention to the materials used in the photograph to suggest suitable materials for future expositions. The objects were assigned to either "decision points" (DD) or "non-decision points" (ND). A decision point is defined as the intersection of right- and oblique-angled turns, where the subject has to make a decision of which way to go. A non-decision point is also an intersection of right- and oblique angled turns, but the subject does not have an opportunity to choose a path. They viewed the same object either at two different decision points, at two different non-decision points, or at a decision as well as at a non-decision point.

The virtual museum consists of four floors with 144 photographs shown twice in two different locations, resulting in 288 total color photographs. Objects were also defined as either attended objects (e.g., toys) or non-attended objects (e.g., non-toys). Attended and non-attended objects were equally assigned to both DD and ND situations, and each object was shown twice. The experiment had eight sets of 18 objects each, belonging to a 4x4 ANOVA analysis of DD/ND objects and toy/non-toy combinations.

Once the study phase started, the subjects walked through the four-floor maze once, having time to observe each object for about four to five seconds. The subjects were to become familiar with the maze, the objects, and to pay particular attention to objects that children would be interested in (e.g., toys). Subjects who navigated the maze correctly (as intended by the experimenters) were included in the next phase of the study.

The final 20 subjects who navigated the maze properly were shown a range of objects once and were asked if they recognized any objects from the maze. A series of fMRI images were taken of the subjects as they performed this task using a 3 Tesla MRI system (Siemens TRIO). These fMRI images went through 36 axial slices for each participant, to visualize the brain activity while subjects tried to recall the objects.



The Center for Health Design: Moving Healthcare Forward

The Center for Health Design advances best practices and empowers healthcare leaders with quality research providing the value of design in improving patient and performance outcomes in healthcare facility planning, design, and construction, optimizing the healthcare experience and contributing to superior patient, staff, and performance outcomes.

Learn more at www.healthdesign.org

Findings

Parahippocampal gyrus selectively responds to objects placed at one navigationally relevant location only.
When observing objects placed twice at two different relevant locations, increased neural activity in the prefrontal cortex (responsible for executive decision-making functions) was observed.
No activity was observed in the parahippocampal gyrus when an object was placed twice at decision points or twice at non-decision points.
If two objects are placed, one at a decision point and one at a non-decision point, then an increase in neural activity is observed.
For the comparison between objects placed twice at decision points and objects placed twice at non-decision points, increased activity in an area involved in cognitive control was observed.
There was a shift in activity from temporal regions to prefrontal regions when participants suddenly decided to change their navigational plans.

Limitations

Authors identified no limitations of the study.