The hippocampus is involved in memory for recently learned, but not highly familiar environments

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Introduction

• There is much evidence to support a role for the hippocampus in learning the layout of a new environment; however, it’s role in the long-term storage and retrieval of such memories is disputed.

• Some studies report hippocampal activation (Spiers & Maguire, 2006) while other studies do not report hippocampal activation during mental navigation tasks (Rosenbaum et al., 2004).

• This study aims to test the hypothesis that a spatial representation of a large-scale environment, that is sufficient to support mental navigation, can exist independently of the hippocampus. In particular, they wish to test the idea that spatial representations that are initially dependent on the hippocampus can become independent of the hippocampus over time.

• To test this hypothesis, they compare brain activation during mental navigation tasks in a large-scale environment, downtown Toronto, at two time-points: once when participants are newly-arrived to Toronto, and after a year of living and navigating within the city.

Methods

Participants

Session 1

• Thirteen participants (5 male; mean age 26.7 yrs, SD = 4.0; 2 left-handed) who had less than one year of experience living and navigating in downtown Toronto.

Session 2

• Eight participants from the initial set (1 male; mean age X years; 1 left-handed) repeated the experiment after one year of living and navigating in downtown Toronto.

Toronto Public Places Test

• Task 1: Distance judgments. Estimate the distance between two landmarks. (< 2.5 km ?)

• Task 2: Proximity judgments. Select which of two landmarks is closest to a reference landmark.

• Task 3: Blocked-route navigation. Imagine an alternative route between two landmarks if the most direct route is blocked.

Image Acquisition

• Participants were scanned with a GE Signa 3 Tesla MRI scanner.

• Anatomical: 3D T1-weighted pulse sequence image (124 axial slices, 1.4 mm thick, FOV = 22 cm).

• Functional: single-shot T2*-weighted pulse sequence with a spiral readout (26 axial slices, 5 mm thick, TR = 2000, TE = 30 ms, flip angle = 30 degrees, FOV = 20 cm).

Data Analysis

• AFNI, version 2.0 software package

• Head motion correction, physiological motion correction, signal normalization

• Activation maps were transformed to Tairairach coordinates & smoothed with a Gaussian filter of 6-mm FWHM

Results

Figure 1. Accuracy data for the three mental navigation tasks is shown for the eight participants who were available for both sessions.

Table 1. Regions of common activation in all three mental navigation tasks (p<0.005)

Table 2. Regions of common activation in all three mental navigation tasks (p<0.005)

Figure 2. The right hippocampus and left precuneus are activated by all three mental navigation tasks in session 1.

Figure 3. The right parahippocampal gyrus and right precuneus are activated by all three mental navigation tasks in session 2.

Figure 4. Mean percentage signal change in the right hippocampus for sessions 1 and 2. (p< 0.005)

Figure 5. Activation unique to session 2 is seen in the right lingual gyrus.

Comparison Across Sessions

ROI Analysis of the Right Hippocampus

Table 3. Brain regions that were active during session 2, but not session 1 (p< 0.001).

Table 4. Regions of common activation in all three mental navigation tasks (p<0.001).

Table 5. Regions of common activation in all three mental navigation tasks (p<0.005).

Conjunction analysis across tasks

Results Continued

Session 1 (N=13)

Conjunction analysis across tasks

Session 2 (N=8)

Conjunction analysis across tasks

Comparison Across Sessions

Disjunction Analysis: Activations unique to Session 2

Table 6. Brain regions that were active during session 2, but not session 1 (p< 0.001).

Contact

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References


Further reading:

Hirshhorn, M.1,2, Moscovitch, M. 1,2, Grady, C.L.2, Rosenbaum, R.S. 2,3, Winocur, G 2.

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Disjunction Analysis: Activations unique to Session 2

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