The relationship between hippocampal subfield volumes and individual differences in navigation

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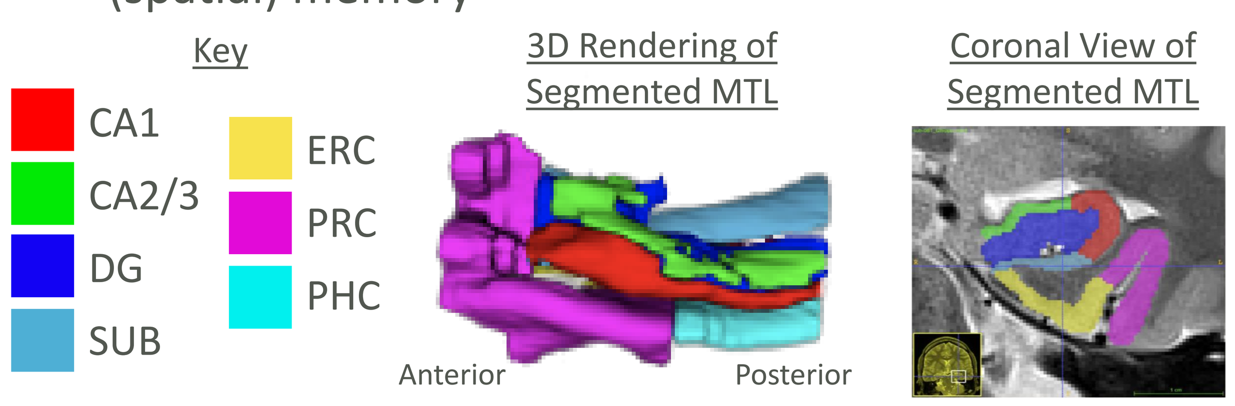
BACKGROUND

- Hippocampal (HC) volumes correlate with navigation ability in extreme populations[1]
  - Correlations between HC volumes and navigation performance in healthy, young adult population are only observed in small samples[2-4]
- HC *subfields* individually relate to aspects of memory
  - Cornu Ammonis 3 (CA3) and dentate gyrus (DG) volumes correlate with pattern separation[5] and memory ability[6]
  - CA1 volumes relate to memory recall ability[6]
- Other medial temporal lobe (MTL) regions are important for successful navigation
  - Entorhinal cortex (ERC)'s grid cells fire as animals navigate space; ERC volume loss relates to poorer (spatial) memory[7]

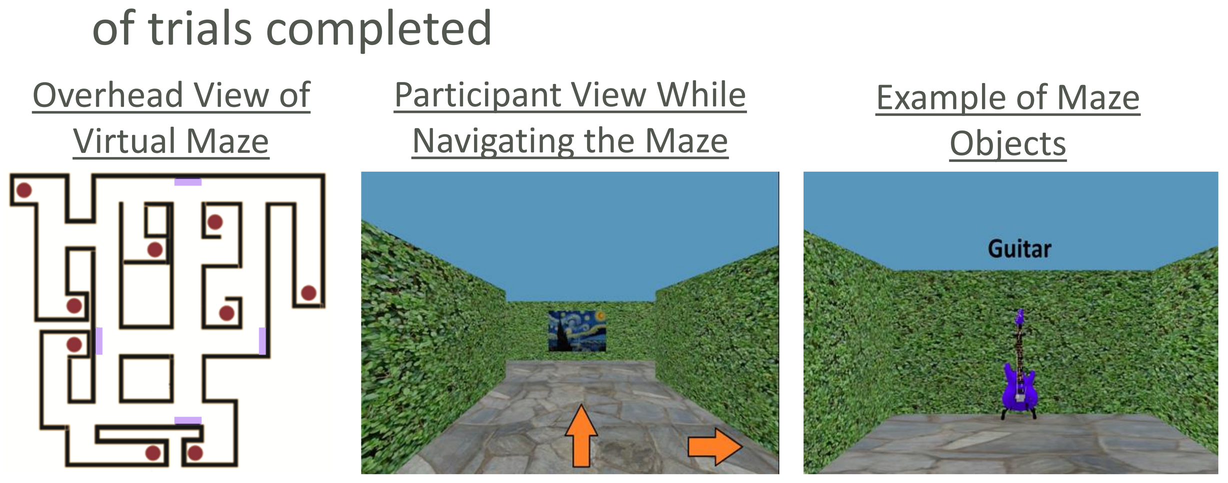


HYPOTHESES

- If pattern separation ability is necessary for successful maze navigation, **CA3** and **DG** subfield volumes are associated with navigation ability in maze
  - Otherwise, **CA1** and **ERC** volumes are related to navigation performance due to participants' reliance on spatial memory ability for successful navigation

METHODS

- 28 participants, 2 excluded → 26 participants in final analysis (13 females, $M_{age} = 21.96, SD_{age} = 4.43$)
- **Maze-Learning Task:** Learn locations of 9 target objects
  - Navigation ability = # of correct trials divided by total # of trials completed



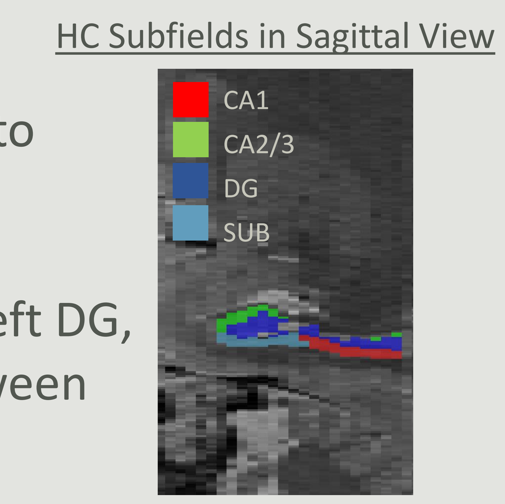
- **MRI scans:** Whole-brain T1w and T2w ($0.9 \times 0.9 \times 0.9\ mm^3$) and high-resolution T2 ($0.4 \times 0.4 \times 2.0\ mm^3$)
  - Image processing: Automatic Segmentation of Hippocampal Subfields (ASHS)[8] pipeline automatically segmented the MTL into 7 subfields per hemisphere; manual clean-up on ITK-SNAP
  - Obtained 14 subfield volume and thickness (volume divided by subfield length) values per participant

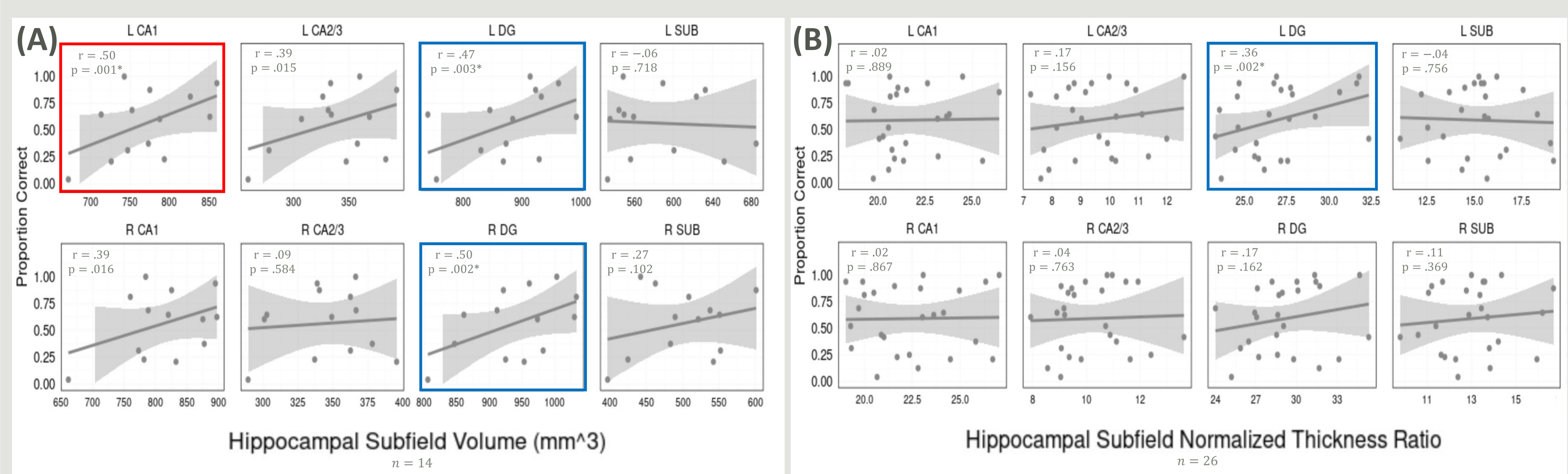
Do volumes of brain regions correlate with our ability to successfully learn and move in a novel environment?

Hippocampal **subfield volumes**, as opposed to *total* hippocampal volumes, relate to **navigation ability** in healthy, young adults.

We conducted partial correlations* between maze accuracy and…

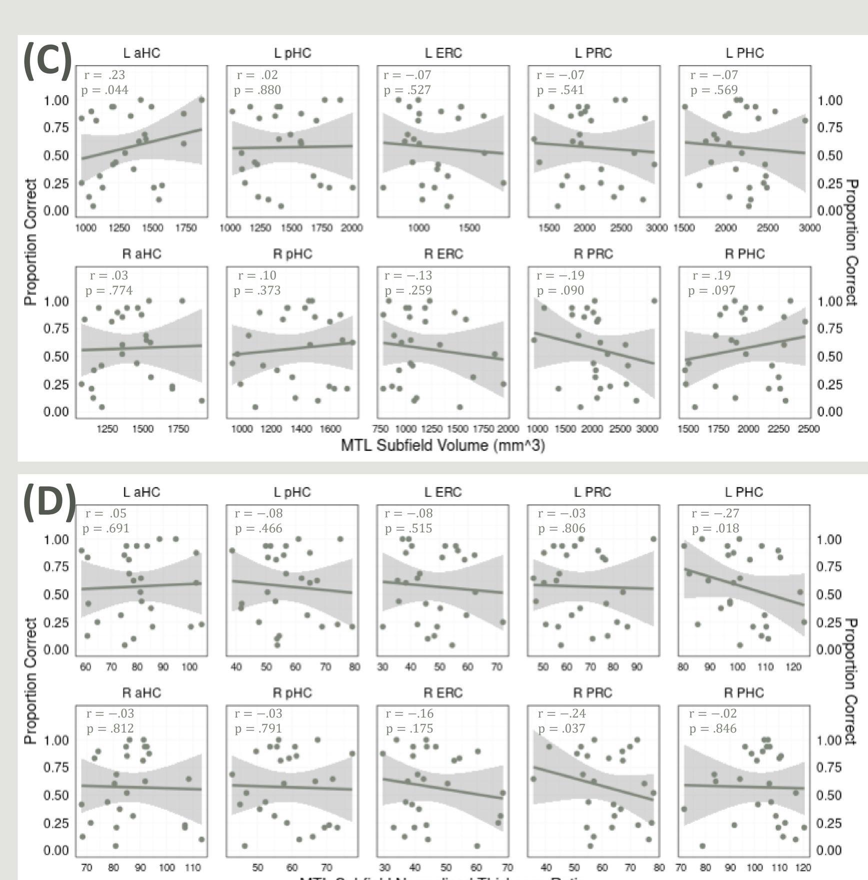
1. Each of the 4 HC subfield **(A)** *volumes* and **(B)** *thicknesses* due to premature posterior cut-offs in 12 high-resolution T2 scans
   - Bonferroni-corrected significance level of $p < .0036$
   - Significant relationships were found **(A)** between left CA1, left DG, and right DG *volumes* and maze accuracy as well as **(B)** between left DG *thicknesses* and maze accuracy

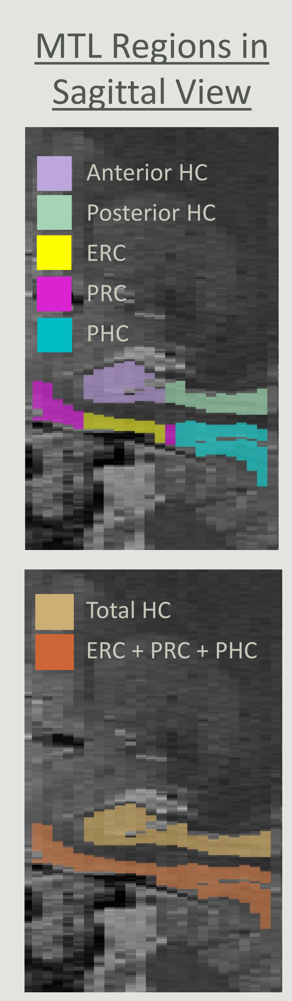


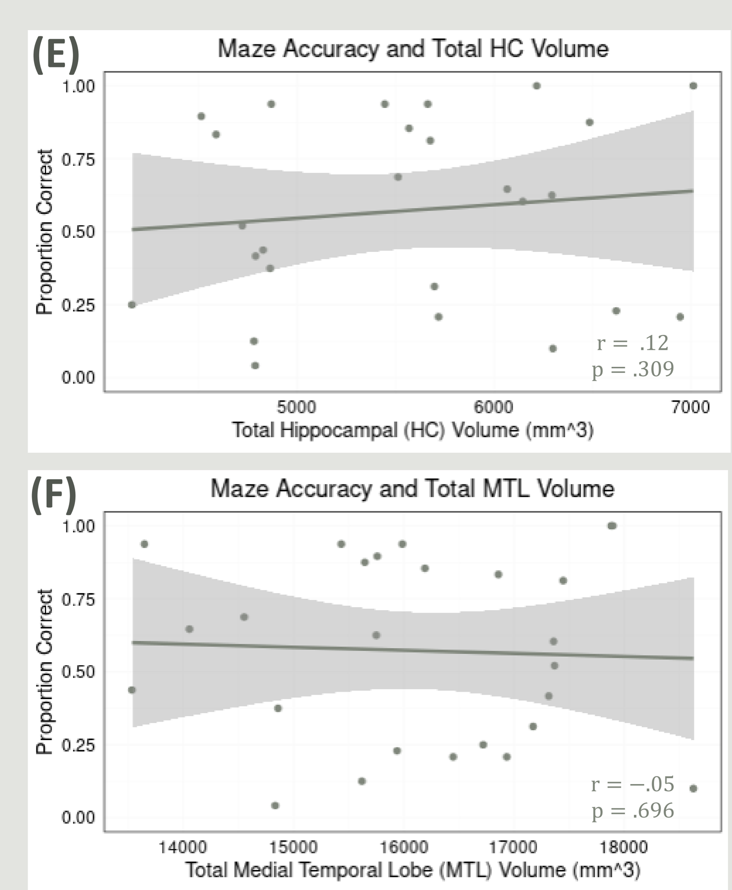


2. Each of the 5 MTL subfield **(C)** *volumes* and **(D)** *thicknesses*
   - Bonferroni-corrected significance level of $p < .005$
   - No significant correlations

3. Total HC **(E)** and total MTL **(F)** volumes
   - No significant correlations
     - Consistent with recent findings from this population[3,4]







* Sex, age, and total intracranial volume were added as covariates to all correlation analyses

DISCUSSION

- Overall, current results suggest that navigation abilities in healthy, young adult population relate to certain hippocampal *subfield* volumes
  - Specifically, CA1 and DG subfield volumes are correlated with successful maze navigation, likely due to their roles in pattern separation and recall
- Limitations include posterior cut-offs in some high-resolution T2 scans of MTL regions, small sample for analysis of sex differences, and challenges with segmentation consistency
- These results add to the possibility of navigation ability being an early behavioral marker of neurodegenerative diseases
- We aim to expand this analysis to include the full data set (>100 participants) and to analyze the relationship between subfield volumes and other aspects of navigation ability

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ACKNOWLEDGMENTS

I thank Dr. Elizabeth Chrastil, Matt Dunne, Caitlin Taylor, You (Lilian) Cheng, and the Jacobs Lab at UCSB for the support for and guidance on this research project. Nicholas Krohn, Olivia Cooper, and Caitlin McIntyre for their segmentation contributions. California NanoSystems Institute, UCSB Academic Senate, Institute for Collaborative Biotechnologies, and US Army Research Office for funding this work.

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