MR Elastography Measures of Hippocampal Subfield Viscoelasticity are Related to Relational Memory Outcomes across the Lifespan

Hillary Schwarb[1], Peyton L. Delgorio[2], Lucy V. Hiscox[2], Ana M. Daugherty[3], Matthew D.J. McGarry[4], Neal J. Cohen[1], & Curtis L. Johnson[2]

[1]University of Illinois at Urbana-Champaign [2]University of Delaware [3]Wayne State University [4]Dartmouth College

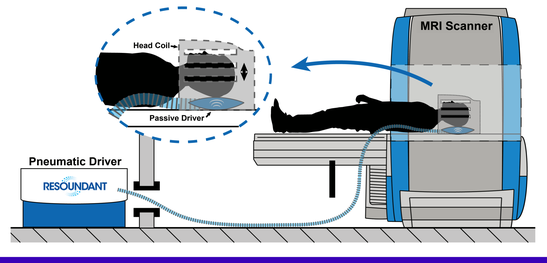
INTRODUCTION

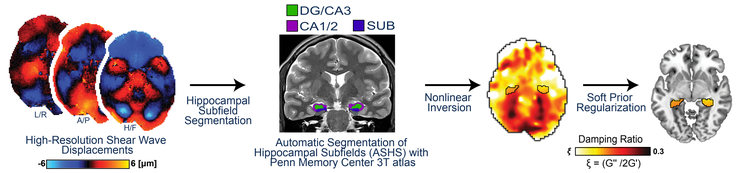
- **Magnetic resonance elastography (MRE) is an emerging technique that provides quantitative measures of viscoelastic mechanical properties indicative of underlying neural tissue health[1]**
- **Previous work has demonstrated that MRE is a sensitive technique for assessing hippocampal integrity that is related to relational memory outcomes[2,3]**
- **The hippocampus, however, is not a homogeneous structure and each of its subfields has a unique cellular organization and unique relationship with episodic memory[4]**
- **While whole brain viscoelastic changes have been assessed across the lifespan[5], hippocampal subfield viscoelasticity has yet to be considered.**

Here, we developed a high-resolution (1.25 mm) MRE protocol specific for analyzing the hippocampal subfields and their relationship with memory across the lifespan

METHOD

- **Hippocampal subfield protocol completed on a 3T Siemens Prisma scanner with 64-channel head coil:**
  - **3D multiband, multishot spiral MRE at 1.25x1.25x1.25 mm³ resolution**
  - **T1-weighted MPRAGE scan at .9x.9x.9 mm³ resolution**
  - **T2-weighted TSE scan with .4x.4x2.0 mm³ resolution aligned to the hippocampus**





OUTCOME MEASURE: **Damping ratio; lower damping ratio measures are indicative of better structural integrity**

PARTICIPANTS: **49 healthy participants (23-81y; mean=55±17; 27 men)**
33 of these participants (23-74y; mean=48y; 18 men) completed task
3 participants (25-29y) were scanned 4 times

TASK: **Short-delay relational memory task**

Response: Does stimulus match the target? Yes or No

At test, lure stimuli shared 0, 1, or 2 overlapping features with the target

OUTCOME MEASURES: **Hit rate & reaction time (RT) to reject lures**

→ **Individuals with better memory abilities are expected to have a higher hit rate and be faster at rejecting lure stimuli**

RESULTS

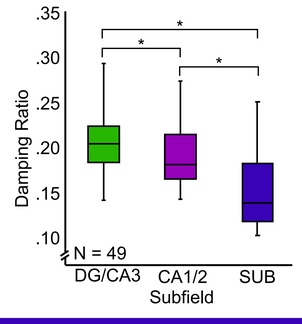
1) Assessing the reliability of hippocampal subfield measures

DAMPING RATIO

	DG/CA3	CA1/2	SUB
Coefficent of Variation	**5.6%**	**6.6%**	**7.4%**

Viscoelasticity data from 3 participants tested 4x each

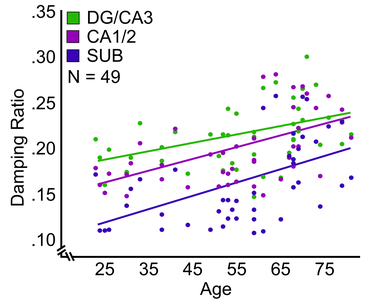
2) Damping ratio significantly differs between the subfields



Repeated Measures ANOVA
Main Effect of Subfield:
F(2, 88) = 130.66, p < .001

Pairwise Comparisons:
DG/CA3 & CA1/2: *t*(44) = 4.40, *p* < .001
CA1/2 & Sub: *t*(44) = 13.23, *p* < .001
DG/CA3 & Sub: *t*(44) = 13.10, *p* < .001

3) Subfields show distinct patterns of age-related changes across the lifespan

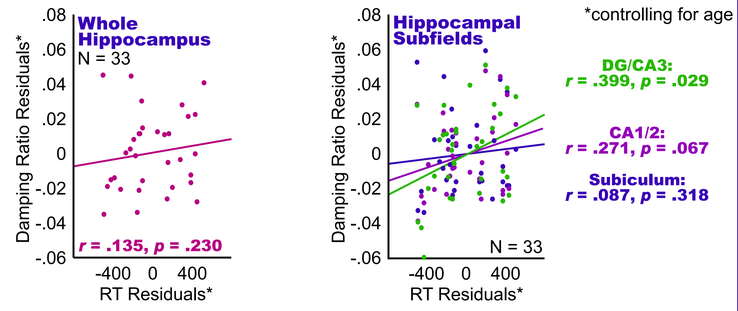


Repeated Measures ANOVA
Age x Subfield Interaction:
F(2, 86) = 3.78, p = .027

Correlations with Age:
DG/CA3: *r* = .453, *p* = .002
CA1/2: *r* = .557, *p* < .001
Subiculum: *r* = .529, *p* < .001

4) Task performance correlates with subfield integrity

Hit Rate: 92.9% (SD = 6.7%) **RT: 1177.2ms (SD = 228.1ms)**



Whole hippocampal damping ratio did not significantly correlate with task performance, but DG/CA3 did; CA1/2 showed trend in the same direction

DISCUSSION

- **MRE damping ratio measures dissociate between the hippocampal subfields and show decline in integrity across the lifespan**
- **MRE-derived measures of integrity in DG/CA3 and CA1/2, typically associated with associative (or relational) memory[6] and delayed recall[7] respectively, selectively correlated with relational memory task performance**

For reprints: schwarb2@illinois.edu

REFERENCES: [1] Murphy et al. (2016) NeuroImage [2] Schwarb et al. (2016) NeuroImage [3] Johnson et al. (2018) NeuroImage [4] Daugherty et al. (2020) JoCN [5] Arani et al. (2015) NeuroImage [6] Daugherty et al. (2017) NeuroImage [7] Bender et al. (2013) JoCN