

# Relations between Memory Measures and Hippocampal Volumes in Early Childhood

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## Introduction



*Mental time-travel abilities dramatically improve in early childhood<sub>1</sub>!*

Behavioral performance could be due to development in brain regions that support memory<sub>2</sub>, such as the hippocampus<sub>3,4,5</sub>.

**We often try to assess brain-behavior relations in the lab, but relations between real-world and lab memory are less understood.**

## Research Questions

**Do autobiographical and temporal order memory performance relate to...**

- 1) age
- 2) each other
- 3) the hippocampus



## Methods

**Participants:** 4-8 years of age, ( $n=200$ ,  $M=6.31$ ,  $SD=1.49$ ), 50% female

|                                      | Variable                         | Measure                                                                         | Mean  | SD    | Range      |
|--------------------------------------|----------------------------------|---------------------------------------------------------------------------------|-------|-------|------------|
| <b>Autobio Memory</b><br>( $n=190$ ) | <b>Total Episodic Details</b>    | Event-internal details across two events, AMI Coding Scheme <sub>6</sub>        | 54.46 | 30.51 | 6-173      |
|                                      | <b>Morphemes/Utterance (MLU)</b> | [Verbal Development] CLAN <sub>7</sub> output of speech units per phrase length | 6.29  | 1.93  | 2.37-11.91 |
| <b>Temporal Order</b><br>( $n=199$ ) | <b>All Adjacent Pairs</b>        | Proportion of adjacent pictures correctly ordered across two 9-item sequences   | .47   | .24   | 0-1.00     |

Note. Outliers ( $\pm 4$  SDs) were excluded from analyses, resulting in the removal of one data-point.

## Autobiographical Memory

Rich, open-ended autobiographical memory interview (AMI) examining recall for real-world personal experiences and events

### Three Phases of AMI

**Free Recall**

What do you remember about... going to the beach?

**Prompted Recall**

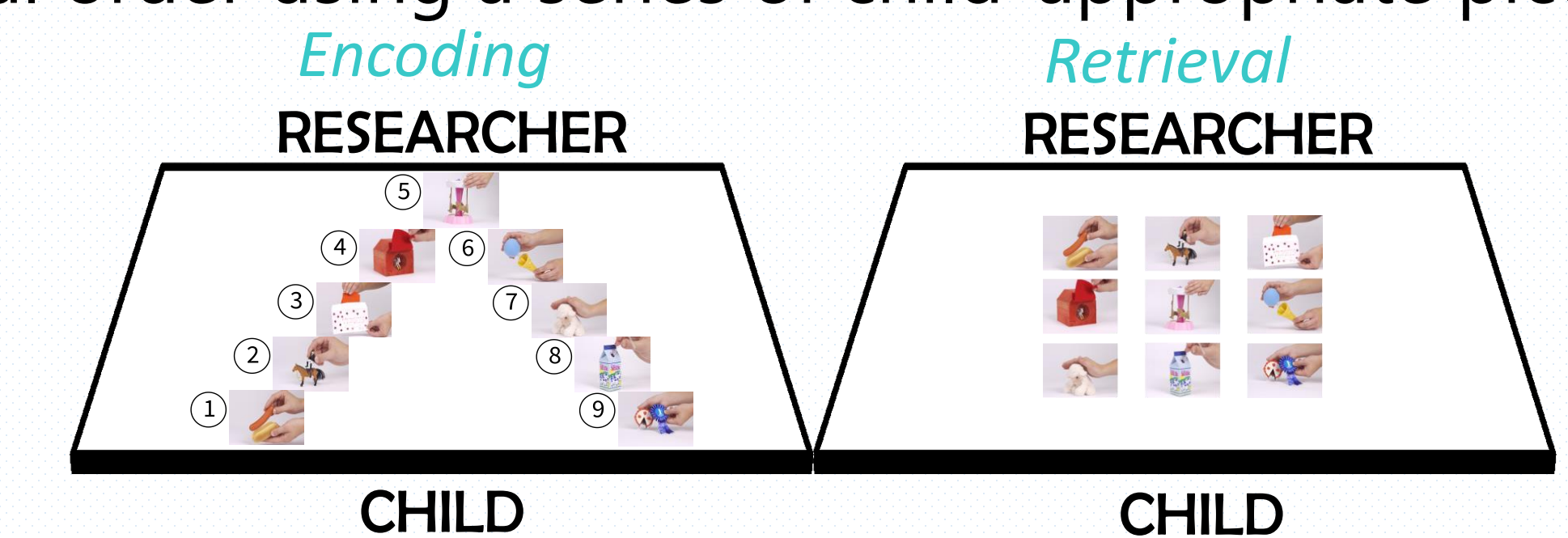
Your mom said you played in the sand. What can you tell me about that?

**Specific Probes**

Who was with you at the beach? Where was the beach?

## Temporal Order Memory

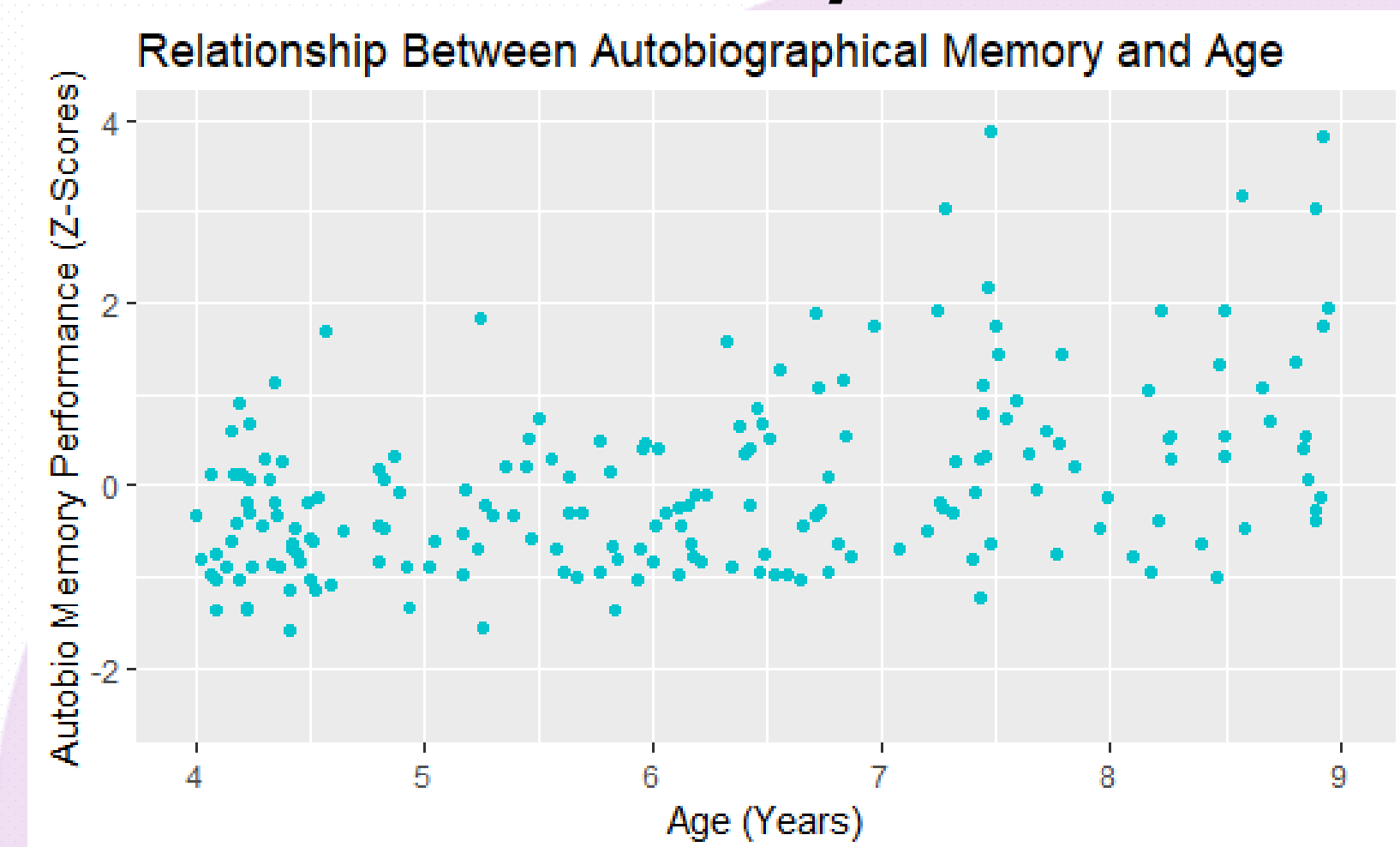
Controlled, laboratory-based assessment examining memory for temporal order using a series of child-appropriate pictures<sub>11</sub>



## Autobiographical Memory

Better in older versus younger children

$$r(190) = .446^*, p < .001$$



Hippocampal volume did not significantly relate to autobiographical memory

| Predictor Variables | <i>B</i> | <i>p</i> |
|---------------------|----------|----------|
| Age                 | .048     | .427     |
| Sex                 | -.059    | .244     |
| MLU                 | .738     | .000     |
| Hippocampal Body    | -.085    | .093     |
| Adj. R <sup>2</sup> | .579     |          |
| F(4,165)            | 59.10    | <.001    |

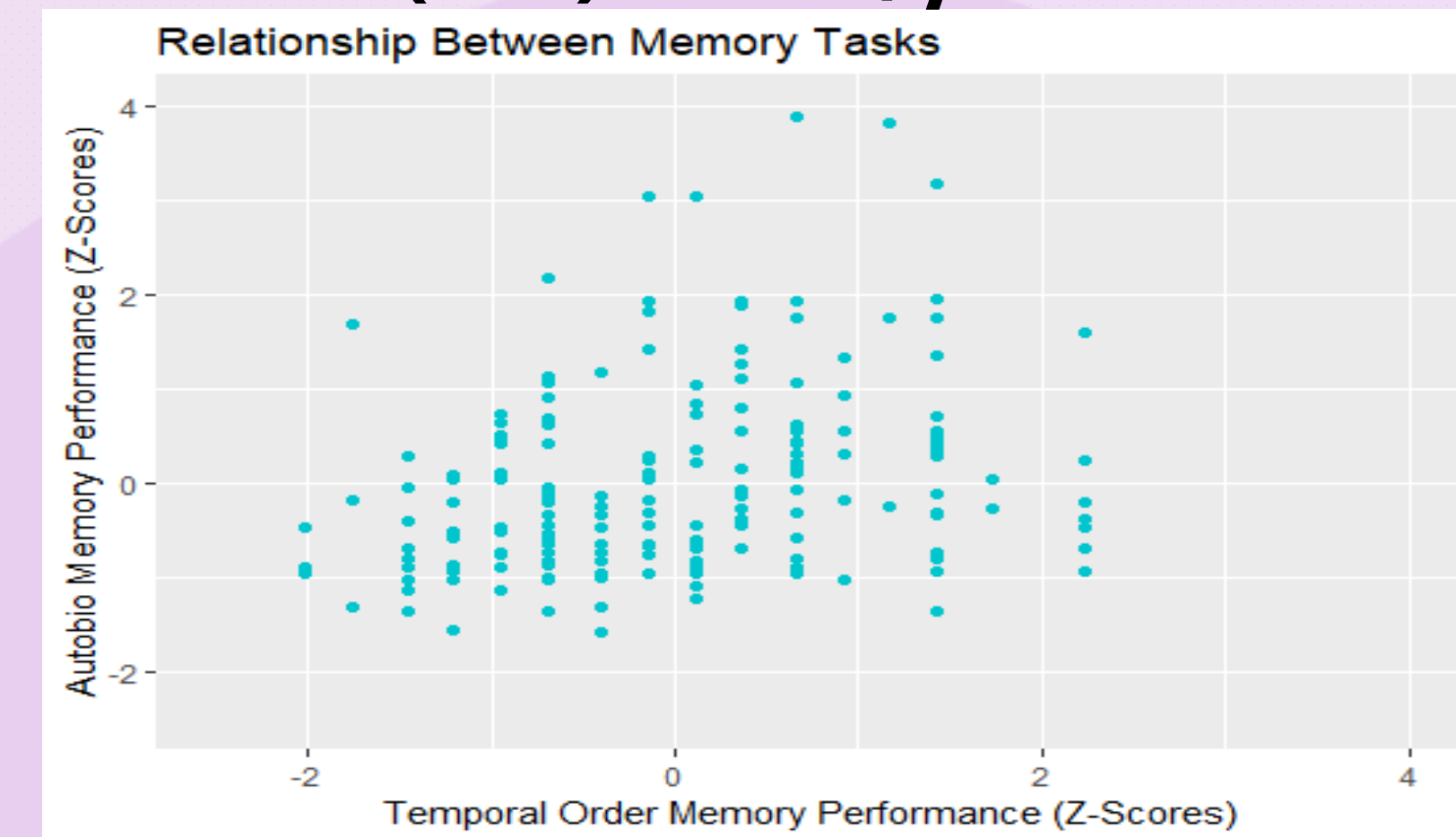
Exploratory significant linear regression accounts for 57.9% of variance, but only MLU is an independent predictor. Hippocampal Body approaches significance.

## Results

### BOTH

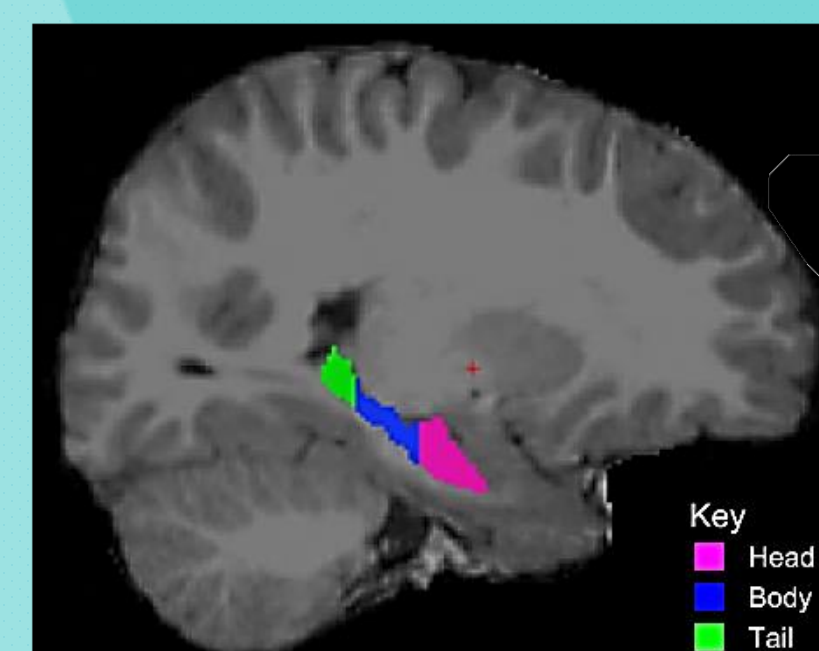
Positive relations between memory performance

$$r(190) = .270^*, p < .001$$



← Memory and Age →

← Memory and the Hippocampus →

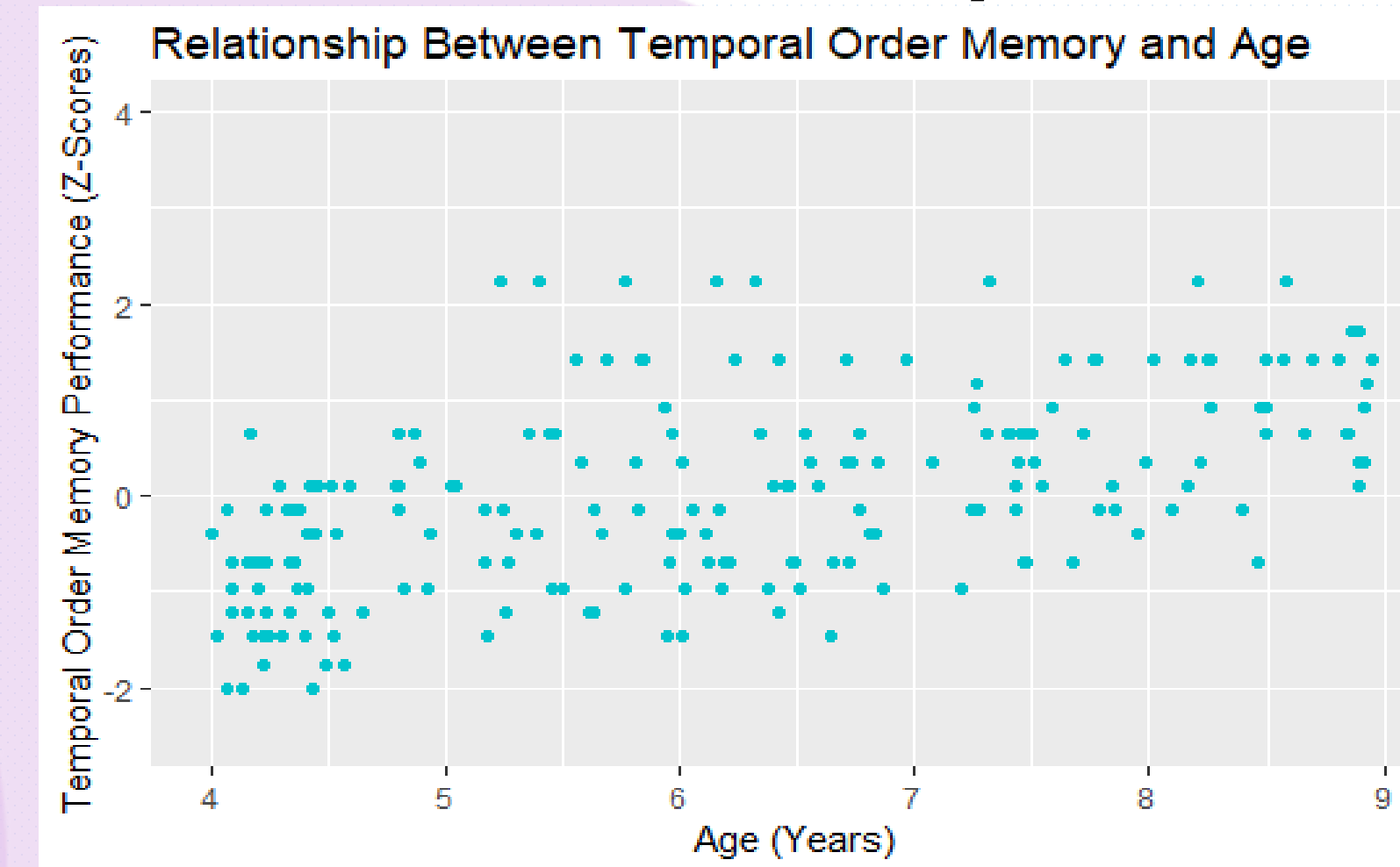


- T1-weighted structural MRI scans processed in Freesurfer v5.1 (FSL)<sub>8</sub> & Automatic Segmentation Adapter Tool (ASAT)<sub>9</sub>.
- Subregions adjusted for Intracranial Volume derived from FSL<sub>10</sub>.

## Temporal Order Memory

Better in older versus younger children

$$r(199) = .559^*, p < .001$$



Hippocampal volume did not significantly relate to temporal order memory

| Predictor Variables | <i>B</i> | <i>p</i> |
|---------------------|----------|----------|
| Age                 | .577     | .000     |
| Sex                 | -.080    | .222     |
| Hippocampal Head    | -.044    | .566     |
| Hippocampal Body    | -.056    | .425     |
| Hippocampal Tail    | -.029    | .661     |
| Adj. R <sup>2</sup> | .306     |          |
| F(5,171)            | 16.52    | <.001    |

Significant linear regression accounts for 30.6% of variance, but ONLY age is an independent predictor.

## Discussion

### Age & Behavior:

- Relations between age and autobiographical memory performance is not significant over and above verbal production.
- Older children exhibit superior performance on both tasks, but relations between autobiographical and temporal order memory are not significant beyond age effects.
  - We cannot disentangle memory from other maturing skills that affect task performance (i.e. story-telling).

### Brain:

- No significant neural correlates found in primary or post-hoc exploratory analyses.
- For autobiographical memory, right hippocampal body volume approaches significance, wherein smaller body relates to higher scores, aligning with developmental data suggesting 'bigger' does not always mean 'better'<sub>12</sub>.

## Takeaway

### Goals:

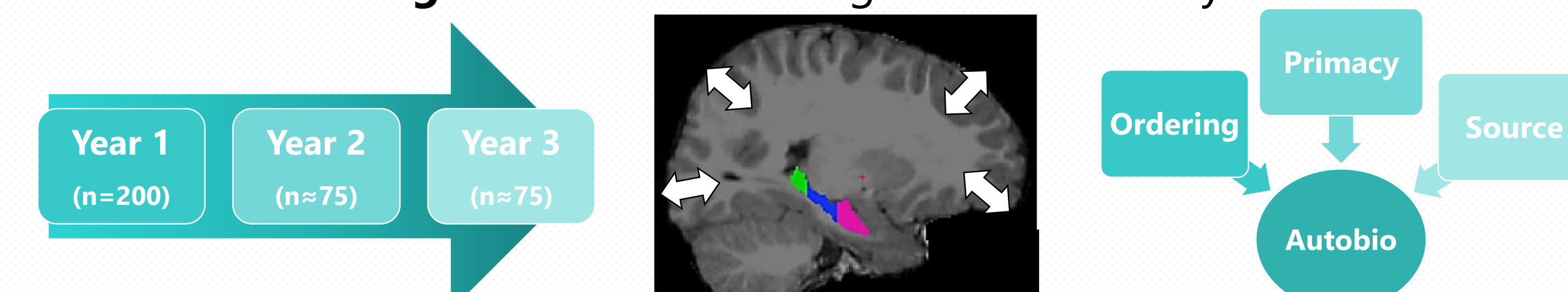
- 1) ✓: Both memory tasks show age-related differences in performance!
- 2) ✓: Children who score well on one task score well on the other task!
- 3) ? : No significant relations observed, but hippocampal body volumes *may* correlate with autobiographical memory scores.

## Future Directions

**Longitudinal Investigation:** Same-subject performance comparison (3 years)

**Neural Data:** Other anatomical variables (ex. cortical thickness)

**Behavioral Paradigms:** Relations among more laboratory-based measures



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