### Introduction

Pattern separation (PS) refers to the ability to keep similar memories separate (e.g., where you parked your car today versus yesterday; Halberk et al., 2008). Recent behavioral research examining PS showed significantly worse PS ability in 4-year-olds compared to 6-year-olds and adults (Ngo et al., 2017). MRI research in adults suggests subfields of the hippocampus, dentate gyrus (DG) and CA3, work together to facilitate PS (Baker et al., 2008; Yassa & Stark, 2011; Reagh & Yassa, 2014). Neuroanatomical studies in non-human primates examining the development of the hippocampus suggest that DG and CA3 exhibit a slower and prolonged developmental time course, with maturity emerging between ages 5 and 7 (Serres, 2001; Lavenex & Banta Lavenex, 2013).

Structural MRI research in 6- to 14-year-olds (Keresztes et al., 2017) shows an association between increased hippocampal maturity and PS (as opposed to pattern completion; see also Schlichting et al., 2017). Both behavioral and neuroanatomical studies suggest early childhood (5-7 years) is a stage of interest, both in terms of PS ability and hippocampal development.

The current study examined differences between performance on a modified Mnemonic Similarity Task, which reflects PS ability, and hippocampal subfield volumes in 4- to 8-year-old children.

### Methods

#### Participants

A total of 67 4- to 8-year-old children (N_{male} = 37, M_{age} = 6.63 years, SD_{age} = 1.30 years) provided both a behavioral and neuroimaging data.

#### Modified Mnemonic Similarity Task (Ngo et al., 2017)

- **Encoding**: Viewed 66 objects sequentially and decided whether the object belonged to “indoor” or “outdoor” using a 2-button box.
- **Training**: ~10 minute training delay. Required to pass one of two sets of 6 training trials with 100% accuracy.
- **Test**: Viewed 66 objects (22 targets, 22 lures, and 22 foils) and decided if each object was “old”, “new”, or “similar” using a 3-button box.

**ENCODING**

![Encoding](image1)

**TRAINING**

![Training](image2)

**TEST**

![Test](image3)

- Bilateral volumes were collapsed across hemisphere and adjusted for intracranial volume (ICV) (see Keresztes et al., 2017) for all reported analyses.

#### MRI Data Acquisition and Analyses

- **MRI Data Collection**
  - Ultra-high resolution (4 mm x 4 mm x 2 mm) structural scans of medial temporal lobe (MTL) were acquired with a T2-weighted fast spin echo sequence (TR=4120ms, TE=41ms, 24 slices, 149 degree flip angle).
- **MRI Data Processing and Analysis**
  - Bilateral subiculum, CA1, and DG/CA2-4 volumes were derived using a protocol adapted from Joie and colleagues (2010) and used in conjunction with the Automatic Segmentation of Hippocampal Subfields software (ASHS, Yushkevich et al., 2014) to yield volumes for all participants. All resulting segmentations were checked manually.

#### Pattern Separation and DG/CA2-4 Volume by Age

- **Pattern Separation (PS)** refers to the ability to keep similar memories separate (e.g., “similar” using a 2-button box. “indoors” or “outdoors”).

- **Behavioral Measure of Pattern Separation Ability**
  - Proportions of memory responses (old, similar, and new) for each item type (target, lure, and foil) were calculated for each participant.
  - Proportion of old responses to lures (“old” / “lure”) were subtracted from the proportion of old responses to targets (“old”) to create a bias-corrected measure of lure discrimination (Loiotile & Courtney, 2015; Leal, Tighe, Jones, & Yassa, 2014).
  - Positive values denote successful discrimination between targets and lures. Negative values denote a higher tendency to over-generalize between two similar items.
  - A value of zero denotes chance-level discrimination.

#### MRI Data Collection

- For questions or comments, please contact kcanada@umd.edu.

### References


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