Relations between source memory and hippocampal volume in early childhood

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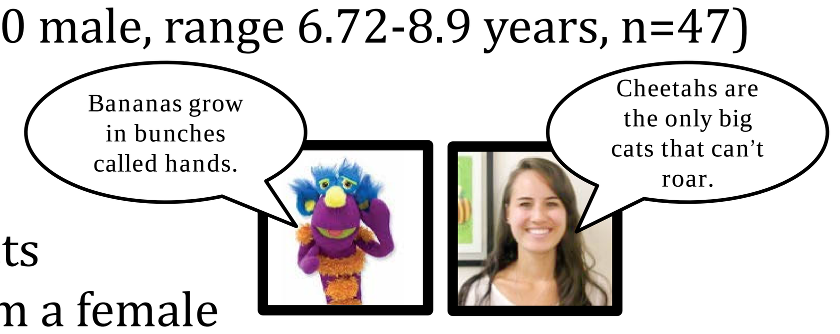
Introduction

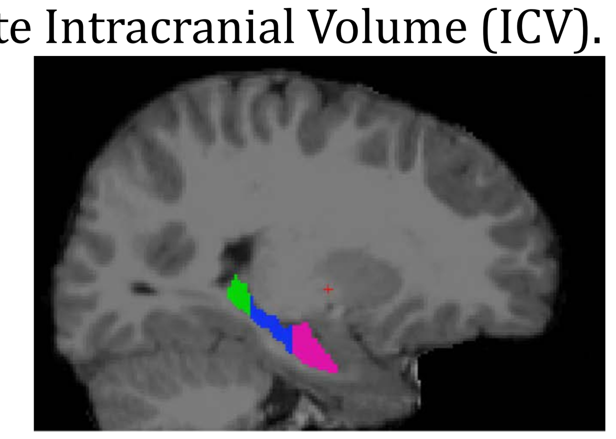
- Episodic memory improves rapidly during early childhood.
  - Children's ability to recall contextual details surrounding an event (such as the source from whom they learned novel information) shows rapid improvement between 5-7 years of age (Riggins, 2014).
- It has been hypothesized that developmental changes in the hippocampus, a region critical for memory, may underlie these dramatic improvements.
  - Research in animals suggests that the hippocampus undergoes protracted development until at least 5 years of age postnatally (e.g., Serres, 2001; Lavenex & Lavenex, 2013).
  - Research in humans suggests developmental differences in brain-behavior relations between episodic memory performance and volume of hippocampal subregions (e.g., DeMaster & Ghetti, 2012; Riggins et al., 2015).
    - Specifically, previous work in our lab suggested there is a significant positive association between volume of the hippocampal head and source memory in 6-year-old children, but no such association in 4-year-old children.
- The goal of the present study was to extend previous work to a large sample 4- to 8-year-old children and a different source memory task.

Methods

- **Participants**
  - 144 children between 4-8 years of age were divided into 3 equal groups
    - Young = 4.4 years (24 female, 24 male, range 4.1-5.23 years, n=48)
    - Middle = 6.0 years (17 female, 32 male, range 5.24-6.72 years, n=49)
    - Old = 7.8 years (27 female, 20 male, range 6.72-8.9 years, n=47)
- **Source Memory**
  - Novel Fact Paradigm (adapted from Drummey & Newcombe, 2002; Riggins, 2014)
    - Children learned 12 novel facts
      - Half from a puppet, half from a female
    - After a 1-week delay (M= 7 days, SD = 2), children were asked to recall the fact and from whom the fact was learned

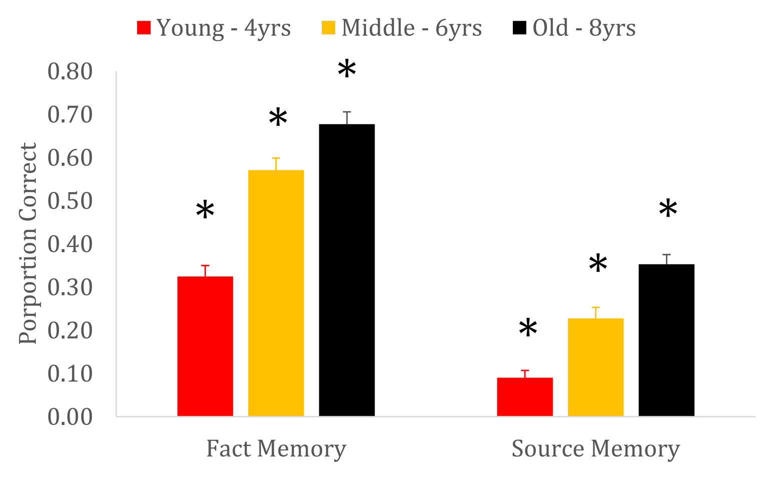


- **Hippocampal Volume**
  - A standard resolution (1mm^3) T1-weighted whole-brain structural scan was acquired from a Siemens 3T scanner with a 32-channel coil.
  - Freesurfer v5.1 (surfer.nmr.mgh.harvard.edu; Fischl, 2012)and Automatic Segmentation Adapter Tool (ASAT, nitrc.org/projects/segadapter; Wang et al., 2011) were used to derive hippocampal volumes.
  - Demarcation of head, body, and tail subregions was completed manually using standard anatomical landmarks (Weiss et al., 2005; DeMaster et al., 2012; Riggins et al., 2015). Inter-rater reliability was good to excellent (ICCs = .68-.98)
  - Hippocampal volumes were adjusted for total brain size (Raz et al., 2005). FSL was used to compute Intracranial Volume (ICV).

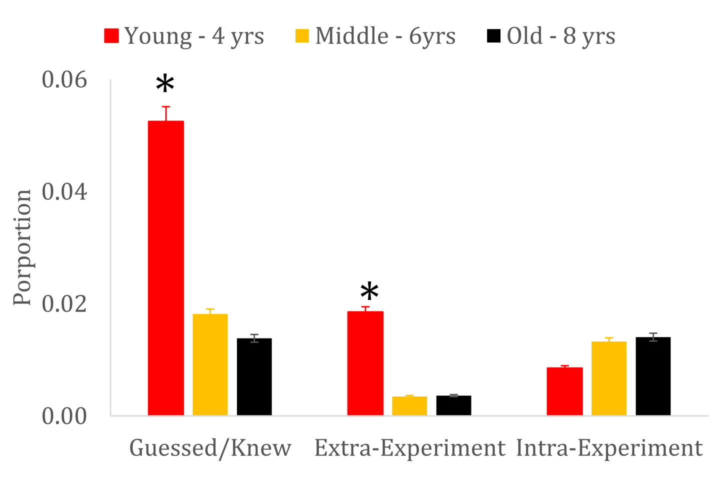


Results – Memory Performance

Fact and source memory increased as a function of age group, ps<.001.



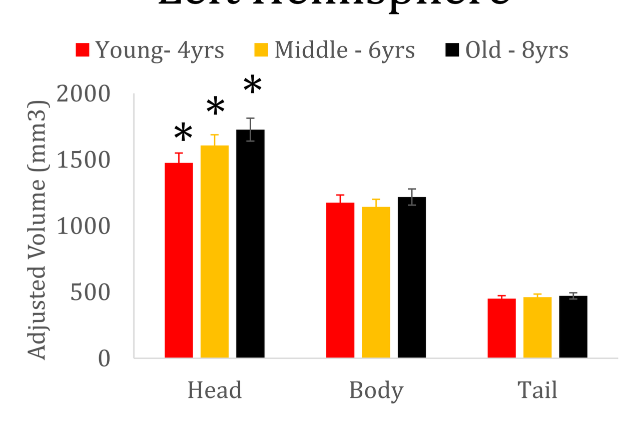
Few source errors were made. However, the younger age group gave more "Guessed/Knew" responses and made more Extra-Experimental errors, ps<.05.



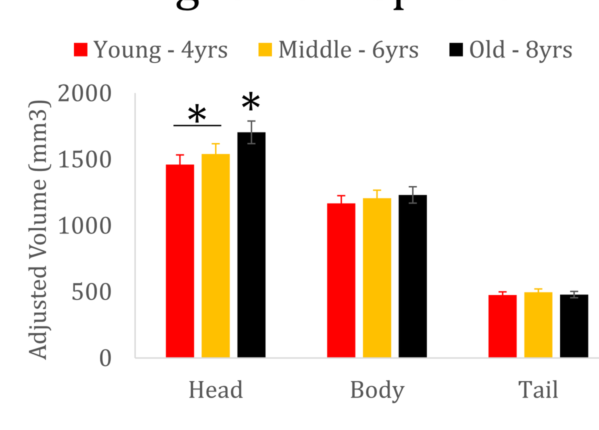
Results – Hippocampal Volume

Adjusted volume of the head increased as a function of age group, ps<.05. Body and tail did not differ between the age groups.

Left Hemisphere

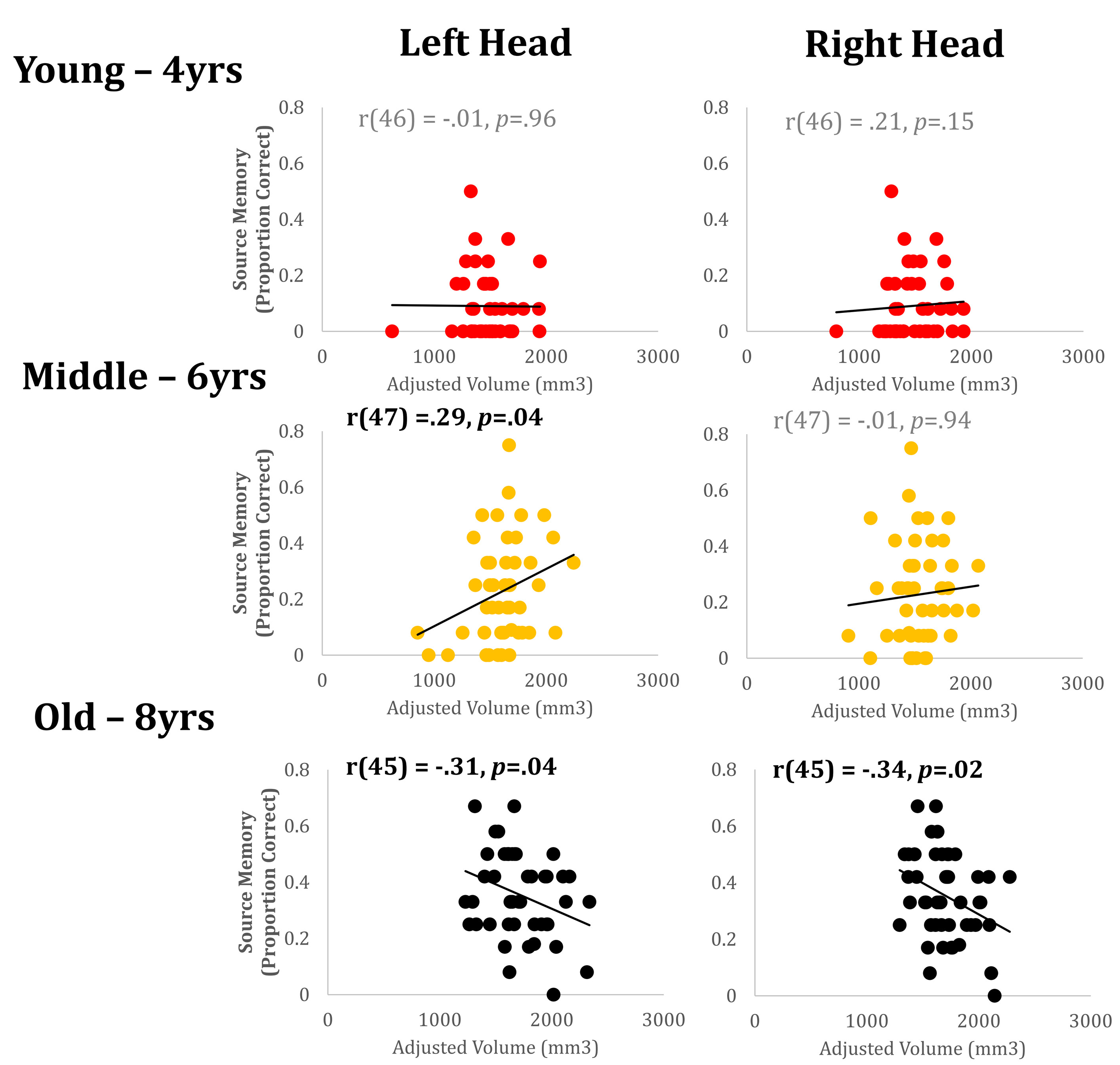


Right Hemisphere



Results – Brain-Behavior Relations

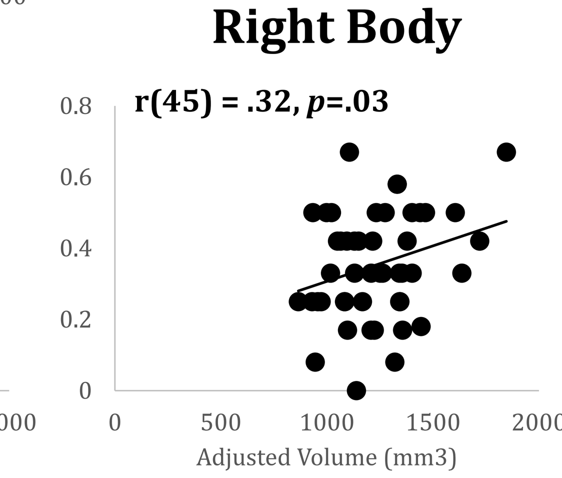
The relation between source memory and hippocampal volume varied as a function of age group.



Age was correlated with head volume in the young group, even after ICV correction.

Fact memory was only correlated with left body in the oldest age group.

Right Body



Discussion

- Consistent with previous research (e.g., Riggins, 2014; Riggins et al., 2015)
  - Fact and source memory increased with age
  - Relations between source memory and volume of the hippocampal head varied as a function of age.
    - No relations @ 4yrs, Positive correlations @ 6yrs
- Novel findings from the present study include:
  - Hippocampal head volume increased between 4-8 years of age.
    - May be due to increased precision in measurement of the hippocampus resulting from the use of ASAT.
  - Negative correlation between source memory and bilateral hippocampal head volume & positive correlation with right body @ 8 yrs.
    - This pattern is similar to that observed in adults in DeMaster & Ghetti, 2012.
    - This pattern may reflect the transition from an immature to a mature hippocampal-memory network (see Riggins et al., 2016)
- Associations between source memory and hippocampal volume are relatively specific as fact memory was only related to volume of the left hippocampal body in the old age group.
- Interestingly, after controlling for ICV, volume of the hippocampal head was still correlated with age in the young (4yr) age group.
  - This may reflect growth processes that are specific to the hippocampus (e.g.,, postnatal neurogenesis)
- Future research will attempt to reconcile these findings with volume of hippocampal subfields (CA1, dentate gyrus, and subiculum) that are differentially distributed along the longitudinal axis.

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