Relation 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 which 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 = 4-4.5 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 = 7.0 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 (1 mm³) 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 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, p<.001.

Results – Hippocampal Volume

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

Results – Brain-Behavior Relations

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

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.

References


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