Cortical Thickness is Related to Episodic Memory in Early Childhood

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Introduction

- Episodic memory relies on a network of brain regions. Extant neuroimaging research in adults and adolescents has identified multiple regions for which cortical thickness is associated with episodic memory performance.
- E.g. Cortical thickness of orbitofrontal regions has been linked to delayed recall performance in 8 to 19 year-olds (Østby et. al., 2012).
- Additionally, both memory (Riggins, 2014) and cortical thickness (Ducharme, et al., 2016) shows nonlinear development in young children.
- Little research has examined relations between memory and cortical thickness and in young children.
- The current study aims to examine this link in 4- to 8-year old children.

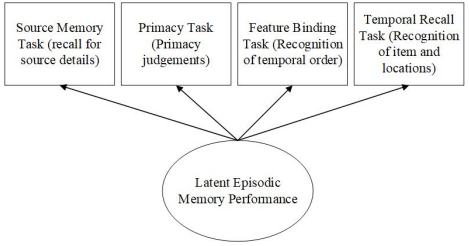
Methods

Participants

- 200 children, 4-8 years (M_{age} = 6.21 years, SD=0.107) participated as part of a larger longitudinal study examining the development of episodic memory.
- 176 children provided useable behavioral and neuroimaging data
- "Young" and "Old" age groups were formed using a median split.

Latent Memory Composite

A composite memory measure (Canada et al., 2018) was estimated from four separate memory tasks, fitted through a second-order latent growth models (Hancock et al., 2001).

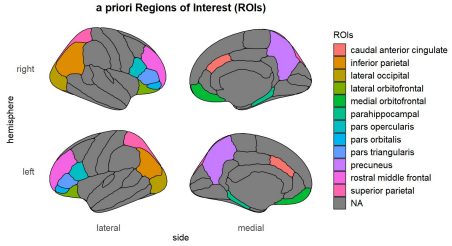


Structural MRI Data

- A T1-weighted structural MRI scan (.9 mm^3) was obtained using a Siemens 3T scanner with a 32-channel coil. Cortical thickness were extracted via Freesurfer v5.1 (Fischl, 2012). Manual edits were performed when necessary.

Results: ROI Analysis

- ROI analysis included 12 bilateral pre-selected regions that have been previously associated with memory development (e.g., Ghetti & Bunge, 2012; Schommartz et al., 2023).



- After controlling for sex and age, cortical thickness of **right caudal anterior cingulate** (β=-.07, p<0.05) was negatively associated with participants' episodic memory performance, and **right pars orbitalis** (β=.09, p<0.01) was positively associated with participants' episodic memory performance.

Results: Whole Brain Analysis

Whole brain voxel-by-voxel analysis was conducted in Qdec (Fischl, 2012) with a threshold of p<0.05, corrected for multiple comparison via Monte-Carlo simulation.

- In older children, the memory composite score was *positively* related to cortical thickness of the middle temporal area and postcentral gyrus in left hemisphere, and pars orbitalis in right hemisphere, when controlling for both age and sex.

Older Children (6-8 years)

Younger Children (4-6 years)

- In younger children, the memory composite score was not significantly associated with any region controlling for both age and sex.

Discussion

- This study is one of the first to examine relations between episodic memory and cortical thickness in early childhood (4-8 years).

ROI analysis:

- Different directions in the effects of anterior cingulate v.s. pars orbitalis are consistent with previous findings documenting different and often nonlinear developmental trajectories during brain maturation among cortical regions (Ducharme, et al., 2016).
- To assess these potential nonlinear trajectories, data collected at two subsequent time points will be analyzed to characterize longitudinal changes.

Whole brain vertex-by-vertex analysis:

- Higher cortical thickness in memory-related cortical areas (middle temporal area, postcentral gyrus, pars orbitalis) predicts better memory in older children, but not in younger children.
- This is consistent with previous findings that show brain–behavior relations vary across development (e.g. Riggins et al., 2015; Geng, Botdorf & Riggins , 2020).
- The result adds to the emerging literature that experiences shape the brain during development (Geng, Botdorf & Riggins , 2020), as cortical processes get more involved in memory in older children.

Take-Home Message

Cortical thickness is positively related to memory in older children, but not in younger children.

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For questions or comments, please contact: ylei1@umd.edu.