Relations between hippocampal functional connectivity during rest and memory performance in 5- to 8-year-old children

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Introduction

- The ability to remember details of life events relies on a network of brain regions including the hippocampus, prefrontal, temporal and parietal cortices in both school-age children and adults.
  - The majority of evidence for this memory network comes from task-based fMRI studies in individuals 8 years of age and older (see Ghetti & Bunge, 2012 for review).
- Investigations examining memory networks earlier in life have been limited due to the demands of the testing environment.
  - This is unfortunate, as behavioral studies suggest important changes in memory development prior to 8 years of age (e.g., Drummey & Newcombe, 2002; Riggins, 2014).
- To overcome these challenges, we utilized a method in which the hippocampal memory network was examined in the absence of a task via "resting-state functional connectivity" MRI (or rs-fcMRI) and related these connectivity metrics to behavioral performance on an episodic memory task performed outside the scanner.
  - In adults, this approach has been shown to reveal the full distribution of the hippocampal memory network (Vincent et al., 2006) and connectivity within this network during rest is predictive of memory performance (Wang et al., 2010a, b).

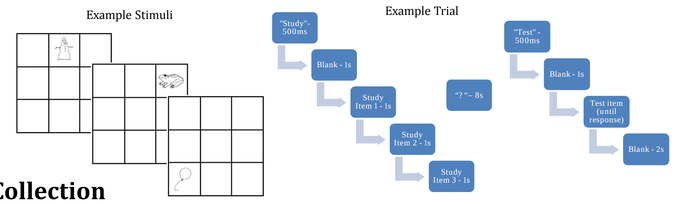
Methods

Participants

- A total of 64 children completed the imaging session and memory task.
  - Participants were excluded due to failure to complete the resting-state scan (n=5), motion exceeding 3mm (1 voxel) in any direction or rotation (n=14), or completing the scan with incorrect scan parameters (n=2).
- Data from 43 participants (23 female) aged 5-8 years (M= 7.43 ± 0.8 years) were included in the present analyses.
  - Participants were part of a larger study examining effects of maternal depression. Of the 45 children included in these analyses 16 were from the comparison group with no history of maternal lifetime depressive disorder (MDD) and 27 were from the group with a history of MDD.

Memory Assessment

- Episodic memory was assessed using a computerized, laboratory-based measure that required children to recall individual features (item or location, 16 trials each) and the combination of those features (items and locations, 32 trials) with a *yes* or *no* recognition task (Lorsbach & Reimer, 2005).



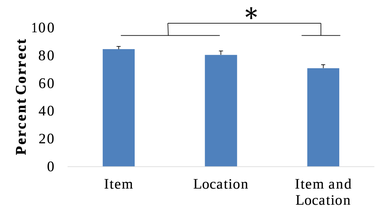
MRI Data Collection

- Functional and anatomical data were collected at the Maryland Neuroimaging Center using a 12-channel coil in a Siemen's 3T scanner. Participants watched a video of abstract patterns/shapes (like a screen saver) during a 6-minute acquisition of resting-state functional data.

MRI Data Processing & Analysis

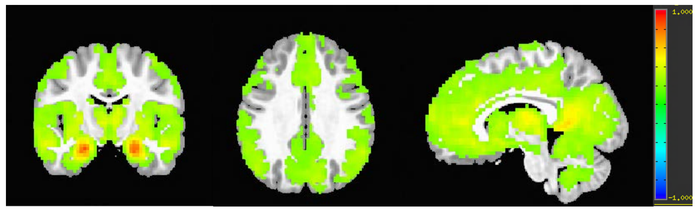
- All functional analyses were conducted using AFNI (Cox, 1996).
- BOLD signal from white matter and CSF masks and continuous motion regressors from 6 directions (roll, pitch, yaw, x, y, z) and their temporal derivatives were included as noise covariates.
- Data were band-pass filtered at .009<f<.08.
- Framewise displacements >1mm were censored.
- Correlation coefficients were computed between bilateral hippocampal regions of interest and the whole brain using z-scored memory performance (on item, location, item and location conditions) as covariates.

Results – Memory Performance



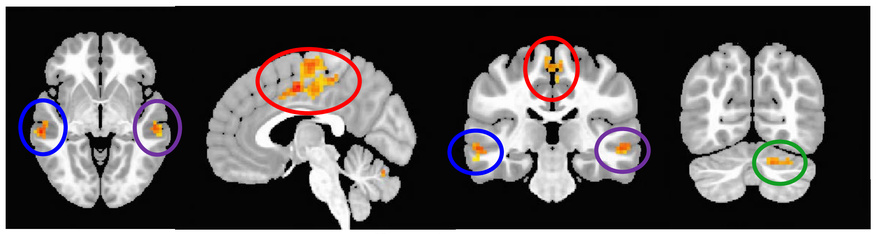
Results – Hippocampal Functional Connectivity

Hippocampal Connectivity at Rest



FWE p<.05 [8,12,32]

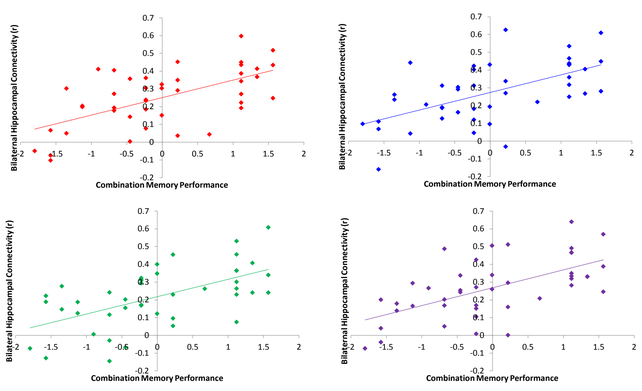
Relations between Hippocampal Connectivity and Memory for the Item and Location Condition



p <.05 corrected

Table 1. Regions showing significant associations between hippocampal connectivity and memory performance, *p*s <.05, corrected, RAI.

Region	k	x	y	z
Medial Frontal Gyrus/Supplementary Motor Area (SMA)	250	1	-5	46
Right Middle Temporal Gurys	61	-62	-29	-5
Cerebellum	55	22	-74	-26
Left Middle Temporal Gyrus	51	55	-23	-11



Discussion

- A similar hippocampal 'resting map' was found compared with previous studies in adults (e.g., Vincent et al., 2005)
- Connectivity between the hippocampus and 4 regions was positively correlated with performance on the memory task. No negative correlations were observed.
  - These relations were specific to the Item and Location condition (i.e., no relations were observed for either the Item or Location condition individually).
- These findings are consistent with previous data from task-based fMRI studies indicating task-based connectivity between the hippocampus and both frontal and temporal cortices are related to memory performance in school-age children (Ghetti & Bunge, 2012).
  - However, these results extend this work to a slightly younger age range.
- Future directions include examining relations between memory and hippocampal connectivity in younger children using this method.

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