Relations between cortical thickness and sleep-dependent episodic memory performance in preschoolers

Isabella Schneider[1], Lindsey Mooney[2], Erin L. Ratliff[1], Rebecca M. C. Spencer[2], Tracy Riggins[1]

[1]University of Maryland, College Park, [2] University of Massachusetts Amherst

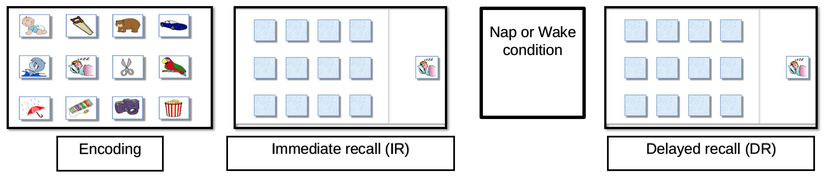
Introduction

- Early childhood is a developmental period in which one's ability to remember details (episodic memory) proliferates with age[1].
- During early childhood, the thickness of the gray matter across the cortex has been found to decrease as a function of age[2].
- Decreases in prefrontal cortical thickness have been associated with working memory in preschool-aged children[3, 4].
- Sleep, including naps, has been shown to have a positive effect on episodic memory[5, 6].
- No studies have investigated the link between regions in the cortex and sleep-dependent episodic memory in young children.
- The present study investigated whether structural measures of memory-related cortical regions are associated with sleep-dependent episodic memory accuracy in a preschool-aged sample.

Methods

Data collection.

- Participants were 33 children between the ages of 3 and 6 years (M = 3.98, SD = 0.47; 19 Female).
- T1-weighted MRI images were acquired and pre-processed using FreeSurfer 6.0.
- Participants were presented with a grid of cards face-up and trained to a criterion of 70% accuracy, then the cards were concealed, and the children were asked to recall the locations of the cards (immediate recall) and then again **following a nap or equal time spent awake** (delayed recall)
- Children were presented with a grid of 3x3 cards if younger than 48 months and a grid of 3x4 cards if older.

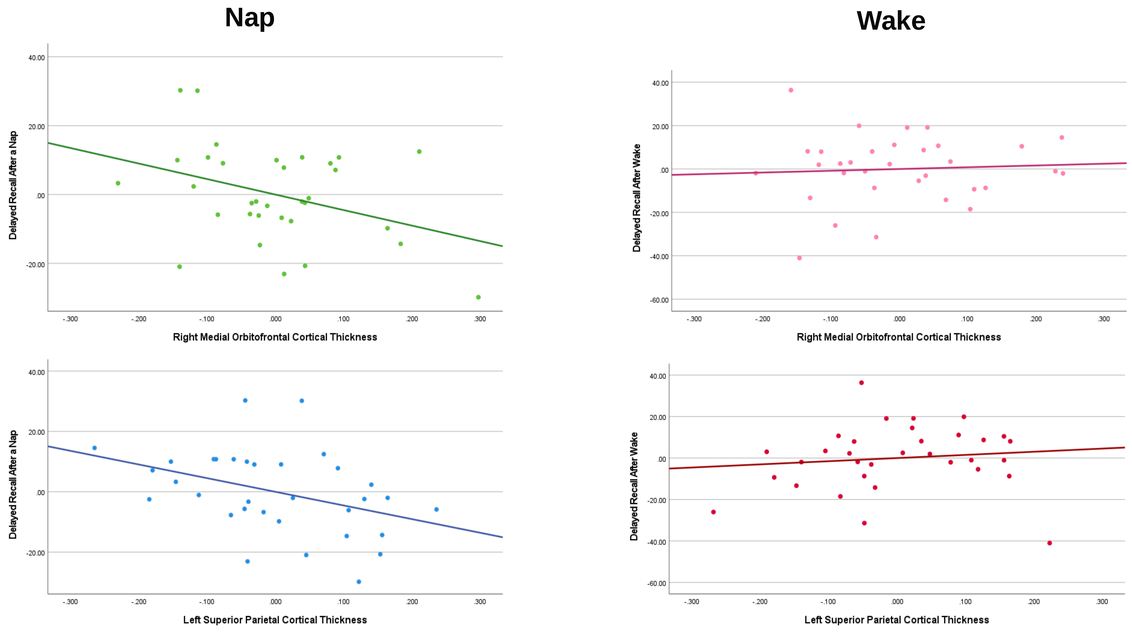


Data analysis.

- 6 cortical ROIs that have been associated with episodic memory in school-aged children were chosen: the caudal anterior cingulate, pars orbitalis, superior parietal, inferior parietal, lateral orbitofrontal, and medial orbitofrontal cortices[7,8,9].
- Linear regressions were run to identify associations between delayed recall (nap & wake) and each ROI (right/left hemisphere), controlling immediate recall accuracy, age, and sex. The Bonferroni method was used to correct for multiple comparisons.
- Additionally, a whole-brain cluster analysis was performed for cortical thickness and volume using FreeSurfer 7.4, controlling for immediate recall accuracy, age, and sex. The Bonferroni method was used to correct for multiple comparisons.
  - Controlling for immediate recall accuracy isolates the effect of the delay (nap or wake) on delayed recall accuracy.

Results

- There was a significant negative relation between delayed recall accuracy following a nap and **right medial orbitofrontal cortex thickness**, $t(28) = -2.08$, $p = 0.046$, as well as **left superior parietal cortical thickness**, $t(28) = -2.24$, $p = 0.033$.
- No significant relations were found when the children were kept awake, including the right medial orbitofrontal cortex thickness, $t(28) = 0.33$, $p = 0.74$, and left superior parietal cortical thickness, $t(28) = = 0.62$, $p = 0.54$.
- No significant clusters were found in the whole-brain analysis of cortical thickness and volume.



Discussion

- Thinner right medial orbitofrontal and left superior parietal cortices were associated with better delayed recall when children napped, but not when they were kept awake.
- Prior studies in older children have reported thinner cortices are associated with better episodic memory performance[10], but these studies did not look at the effect of sleep on episodic memory.
  - The differences in findings for the nap and awake conditions may indicate there are differences in the extent to which cortical regions are involved in consolidation during periods of sleep compared to periods of wake in young children.
  - Future studies should test this implication by comparing the functional associations between cortical regions and memory performance on recall assessments between sleep and wakefulness.

Acknowledgements

We would like to thank all our families for participating in this study and members of the Neurocognitive Development Lab for assistance with this project.

This research was supported by NIH (HD094758) and NSF (BCS 1749280) to TR and RS

References upon request.

ischnei1@umd.edu