Microstructural Integrity of the Hippocampus during Early Childhood: Relations with Visuospatial Memory

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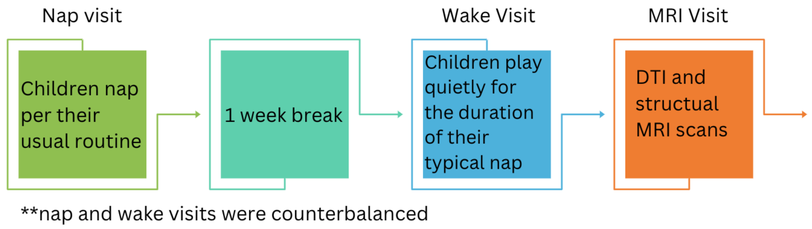
Introduction

- Diffusion imaging allows us to look at the integrity of the microstructure of the hippocampus (which reflects the presence and organization of neurons and glia) and may be a better predictor of memory performance than volume (e.g., Ibrahim & Bennett, 2023).
- Specifically, mean diffusivity (MD) provides a metric reflecting how freely water molecules move in grey matter (Callow et al., 2020).
- A previous study in 4- to 8-yr old children reported a negative association between hippocampal MD and source memory performance across a 1-week delay, even after controlling for volume (Callow et al., 2020).
- In this study, we aimed to extend this work in a younger sample, a different memory task, and over both sleep and wake conditions.

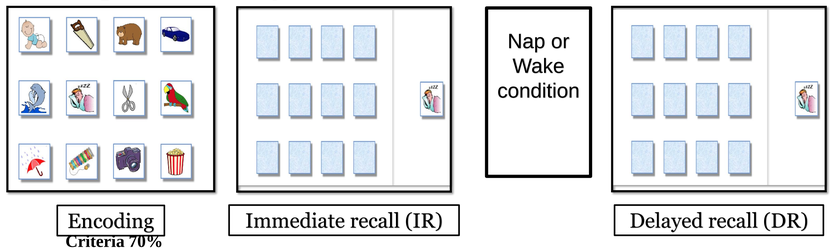
Methods

Experimental Design



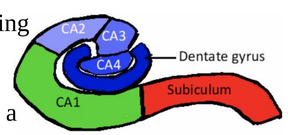
**nap and wake visits were counterbalanced

Visuospatial Memory Task



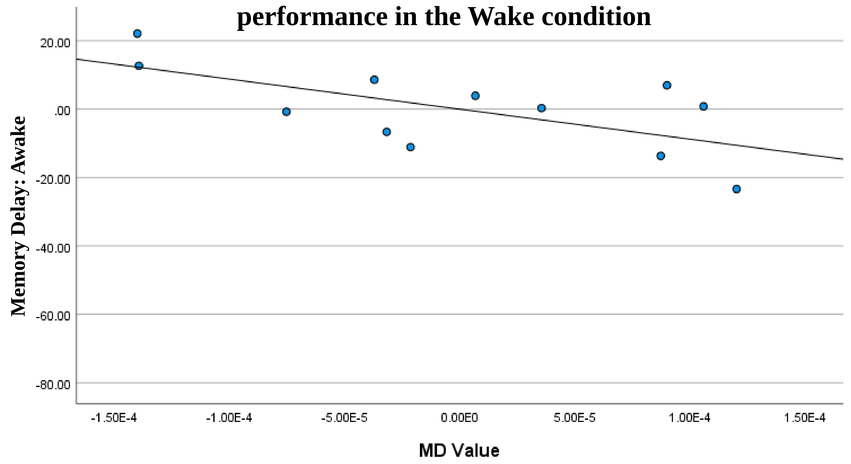
DTI Data

- Neuroimaging data were collected using a Siemens 3 Tesla Magnetom Trio MRI scanner with a 32-channel coil.
- DWI was processed using MRtrix3 pipeline
- FSL's dtifit program was used to fit the tensor model to the diffusion data providing three eigenvectors and three eigenvalues for each brain voxel, as well as the mean diffusion (MD) tensor metric.
- Each subject's MD map was registered to subject specific T1 space using a nonlinear warp calculated with the ANTS program.
- Average MD was extracted from each subject's bilateral hippocampal ROI's in T1 space.
- An anatomical bilateral hippocampal ROI was derived from each subject's T1 scan in subject specific space using Freesurfer version 7.1.1. Bilateral hippocampus was extracted from segmentation labels in Freesurfer's aseg.mgz file, which was then converted to a binary mask.

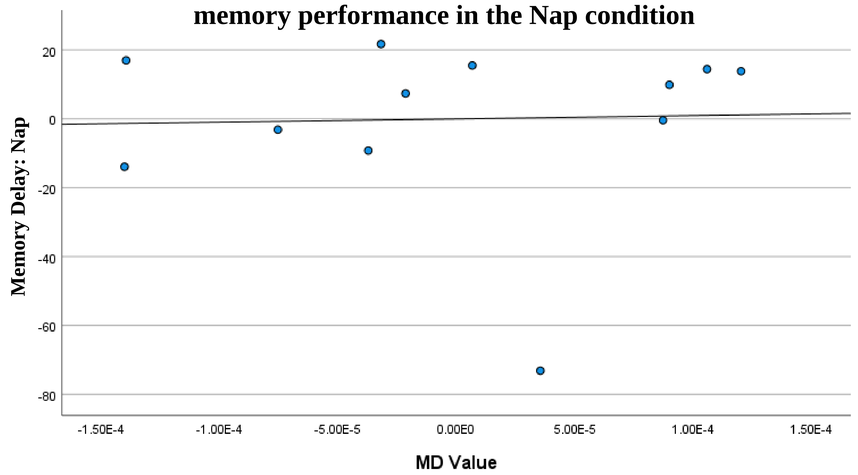


Results

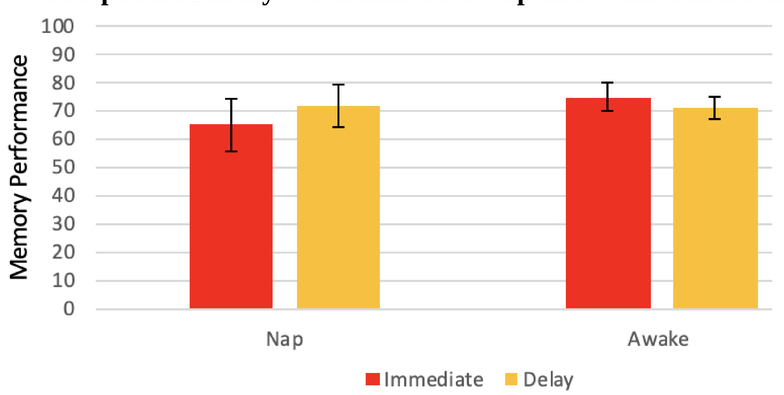
Hippocampal MD was related to delayed memory performance in the Wake condition



Hippocampal MD was NOT related to delayed memory performance in the Nap condition



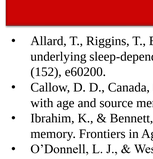
Visuospatial Memory Performance for Nap and Wake Conditions**



**no significant effects

Sample

N = 12



Mage=4.86 years, (range 3-5 years)

9 females

7 habitual nappers, (nap >5 days a week)

1 occasional napper

Analysis

- Simple linear regression analysis was conducted to evaluate the extent to which hippocampal MD could predict delayed memory performance after controlling for hippocampal volume.
- Results indicated that, in the wake condition, hippocampal MD explained 42.7% of the variance in delayed memory performance after controlling for hippocampal volume, $F(2,9) = 5.097$, $p = .033$.
- There was no significant relation between hippocampal MD and memory performance during the nap condition, $F(2,9) = 0.100$, $p = .906$, Adjusted R^2 -.196.

Discussion

- Visuospatial memory is significantly negatively associated with hippocampal MD, even after controlling for hippocampal volume, which is consistent with previous findings (Callow et al., 2020).
- This effect was observed in a younger age group (3-5yr) using visuospatial memory while the previous study had an older group (4-8yr) using a source memory task (Callow et al., 2020).
- The observed effect was specific to the wake condition
- Its been recently proposed that maturation of hippocampal-dependent memory network results in more effective memory without the need for a nap (Spencer & Riggins, 2022).

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