# Sleep and Hippocampal Development during Early Childhood

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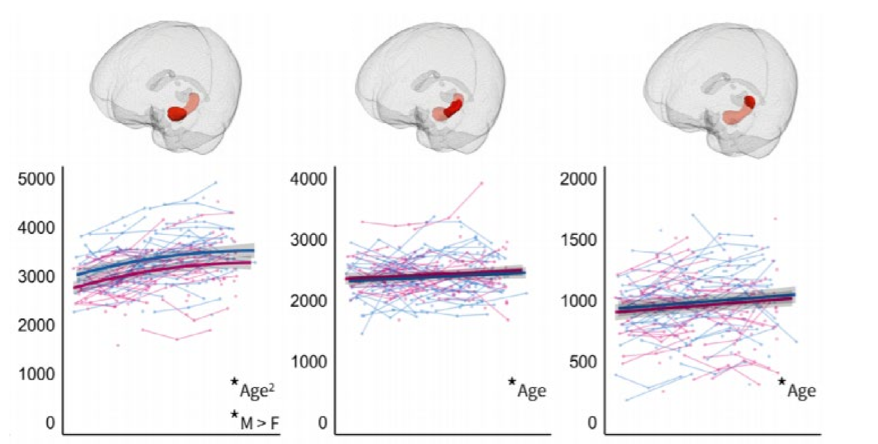
## Introduction

- In early childhood, memory performance is enhanced by an afternoon nap (Kurdziel, Duclos, & Spencer, 2013).
  - This process is thought to reflect consolidation of memories from hippocampus to the cortex supported sleep spindles (Rasch & Born, 2013).
  - Additionally, in early childhood, the nap benefit has been associated with spindle density (Kurdziel, Duclos, & Spencer, 2013; Schabus et al., 2004).
- It is critical to study these processes during early childhood because memory improves and the hippocampus shows age-related changes (Riggins et al 2015; Riggins et al., 2018;).
- **Purpose:** Investigate relations between the nap benefit on memory, spindle density, and hippocampal volume.



Canada, Botdorf, & Riggins, in press

## Methods

### Participants

- Participants are part of an ongoing longitudinal study.
- Preliminary analyses included 31 habitual nappers who provided usable data ($M_{age}$=3.87 years, 19 female).

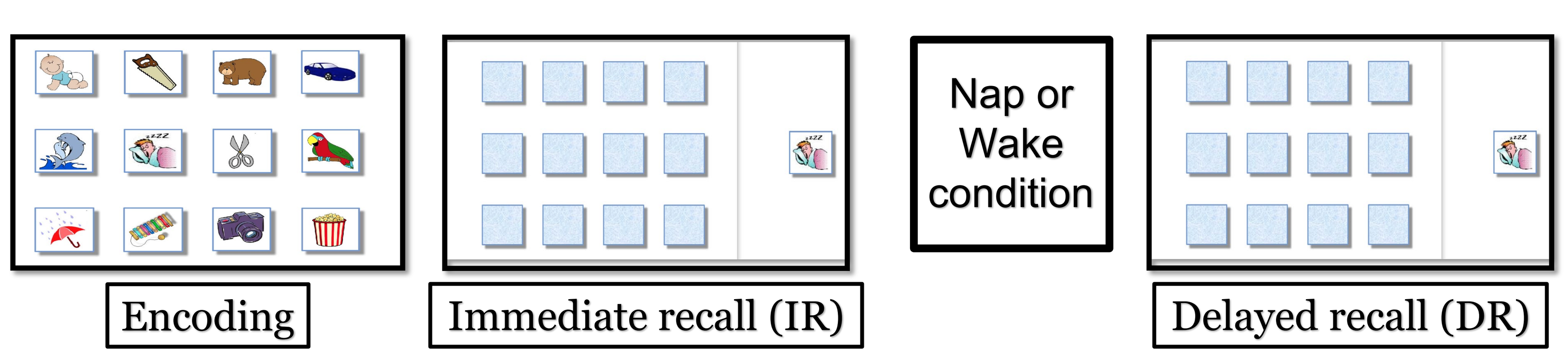
### Experimental Design

- Children participated in three visits, aprox. one week apart.


### Polysomnography (PSG)

- Spindles were identified in the 9-15 Hz range at C3 during nREM2 and spindle density was calculated manually (Kurdziel, Duclos, & Spencer, 2013).

### Behavioral Memory Task



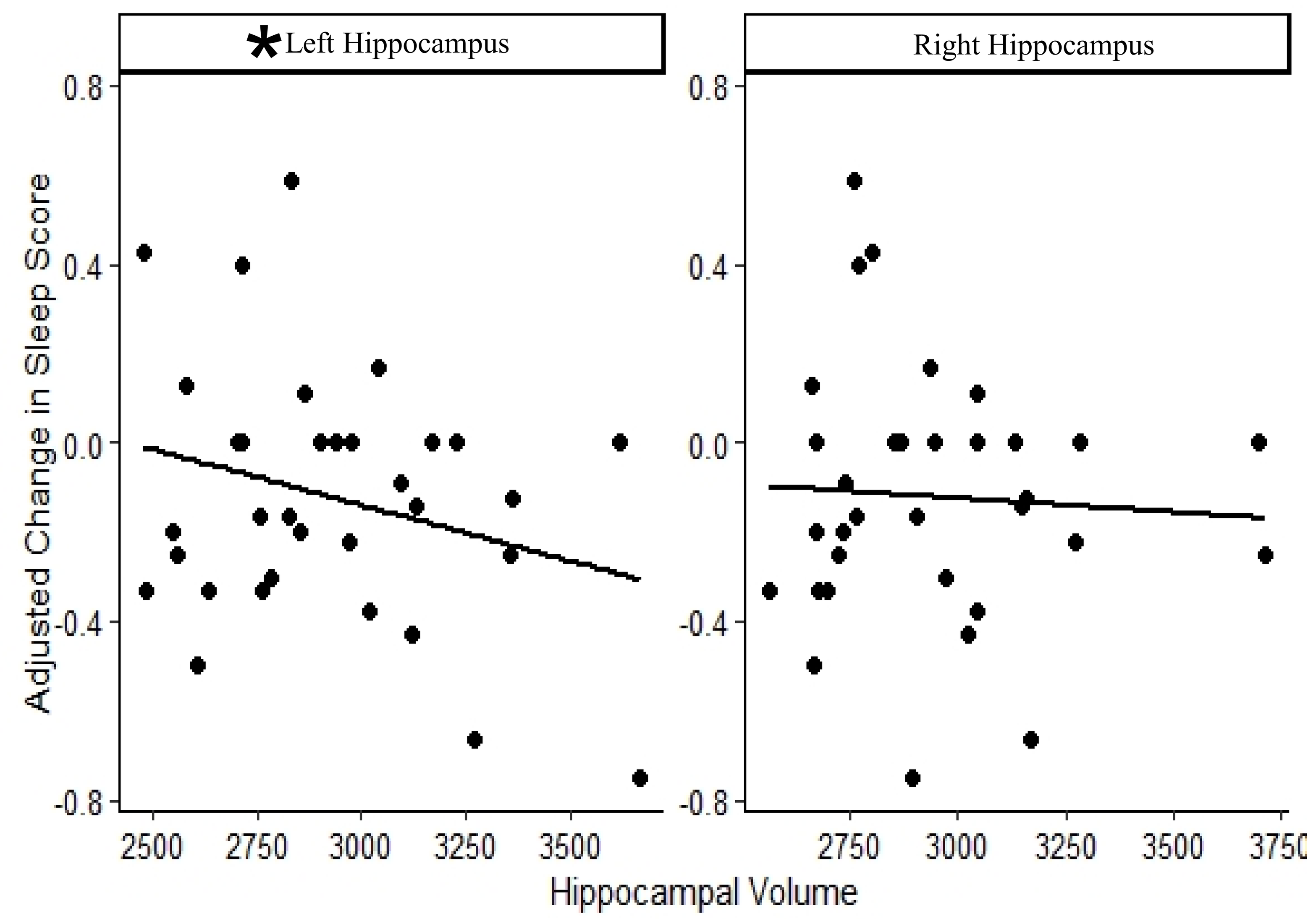

**Adjusted Sleep Change Score** = (Sleep IR – Sleep DR)/Sleep IR

### Structural MRI Data

- A T1-weighted structural MRI scan (.9 $mm^3$) was obtained using a Siemens 3T scanner with a 32-channel coil.
- Hippocampal volumes were extracted via Freesurfer v6.0 (Fischl, 2012) and refined using ASAT (Automated Segmentation Adapter tool, Wang et al., 2011).
- Hippocampal subregions (head, body, tail) were defined using standard anatomical landmarks (DeMaster et al., 2013; Riggins et al., 2015).

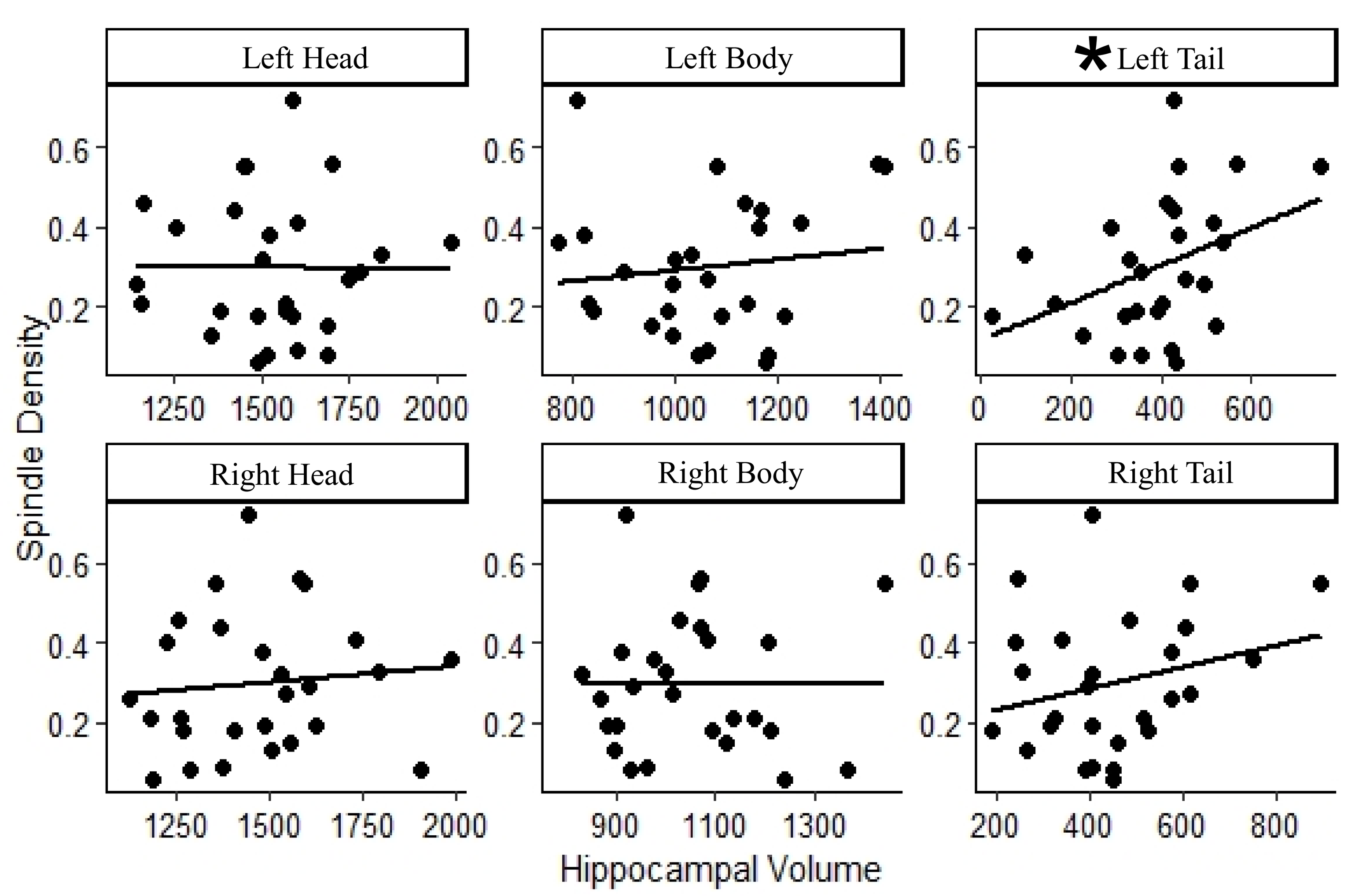
## Results: Brain– Sleep Change Score

Left, but not right, hippocampal volume was negatively associated with nap benefit on memory (i.e., adjusted sleep change score) when controlling for age, sex, and ICV.




## Results: Brain– Sleep Spindles

Left hippocampal tail volume was positively associated with spindle density when controlling for age, sex and ICV. No other significant relations were observed.




## Discussion

- Children with a larger hippocampus
  - Benefited less from the nap on a memory task
  - Demonstrated greater sleep spindle density.
- Together, these findings reveal relations between memory, nap physiology, and hippocampal volume during early childhood.
- These findings may suggest that children with larger hippocampi produce greater spindles density and are less dependent on the nap benefit for memory.
- **Future Directions:** Given these findings, we plan to investigate these relations in children who have transitioned out of their nap and those who have not using our longitudinal sample.

## Take-Home Message

**Children with a larger hippocampus demonstrated greater spindle density and benefited less from the nap. This may be an early indicator of a transition out of the afternoon nap.**

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