Associations between sleep spindles and hippocampal volume in preschool-age children

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Introduction

- Sleep is critical for daily functioning (Rasch & Born, 2013).
- Early childhood is a period of interesting change in sleep as children transition from biphasic to monophasic sleep patterns.
  - Physiological recordings during naps suggest sleep spindles play a critical role in learning and memory (Kudziel et al., 2013).
- Memory-related brain structures, such as the hippocampus, also develop during early childhood and relate to memory (e.g., Riggins et al., 2018).
  - Relations between memory and hippocampal volume are moderated by age, as volume increases and then decreases with development.
- It has been suggested that relations between sleep spindles and memory result from development of memory-related brain structures, such as the hippocampus. However, this has not been tested.
- The purpose of the study is to examine the relation of sleep spindle and hippocampal volume in preschool-age children.

Method

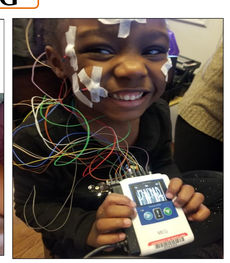
Participants:

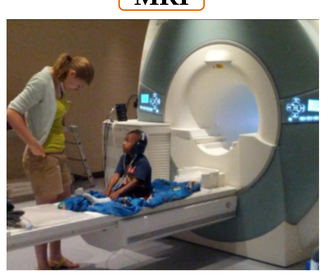
- 26 children ages 3 to 5 years (*M* = 3.92 years, *SD* = .49, 12 females) were recruited via University of Maryland (UMD) Infant and Child Studies.
  - Ages ranged from Participants were typically developing, English-speaking children who took regular naps (at least 5 days per week).

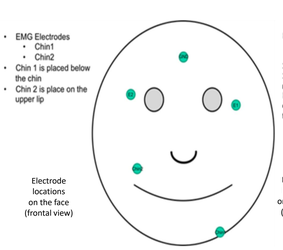
Procedure:

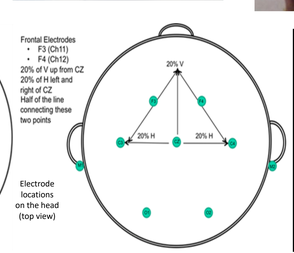
- Three visits were conducted over the course of 3 weeks (2 in-home, 1 at Maryland Neuroimaging Center). Order of home visits was counterbalanced. At each home visit, children completed a visuospatial memory game.
- At one home visit, children napped as normal while polysomnography (PSG) was recorded.
- At the other home visit, the child was kept awake and given non-stimulating toys to play with quietly.
- On the third visit to UMD, children completed a structural MRI scan.
- Hippocampal subregion volumes were obtained using FreeSurfer and Automated Segmentation Adapter Tool and manual identification of anatomical landmarks to obtain bilateral head, body, and tail volumes.

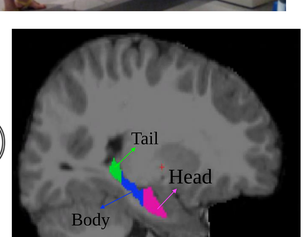
PSG **MRI**







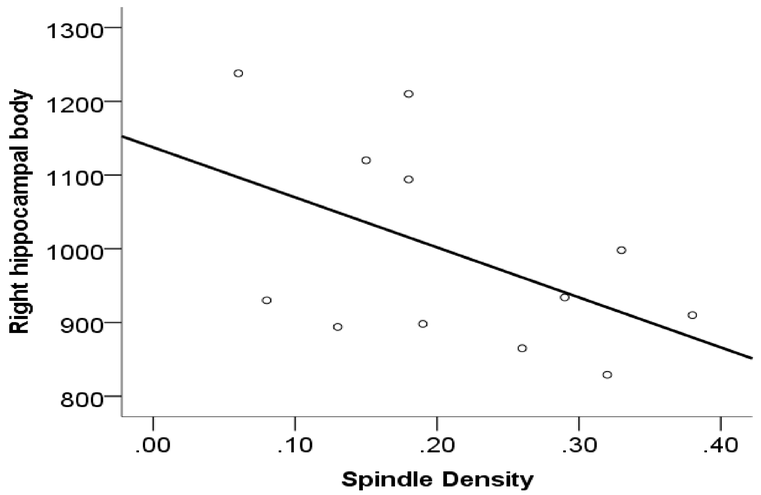




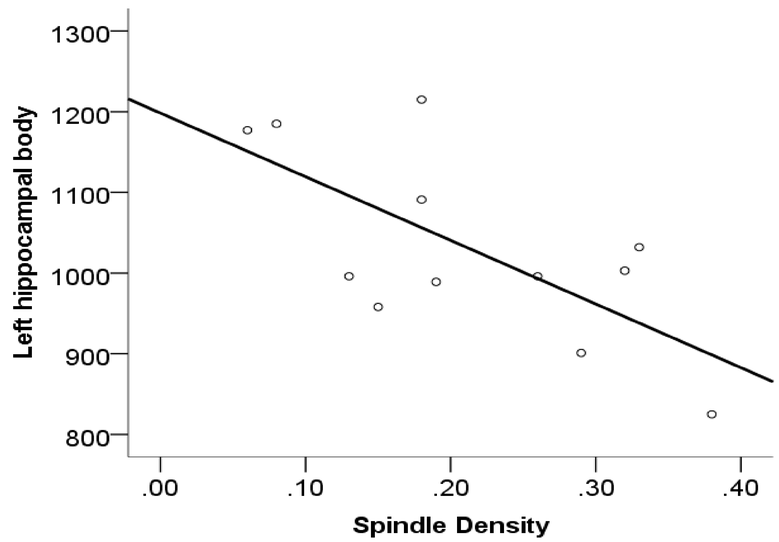
Results

- **Sleep spindles were related to hippocampal body volume in both right and left hemispheres.**

Right Hippocampal Body **r(12)= -.50, p =.095**



Left Hippocampal Body **r(12)= -.69, p =.013**



Discussion

Main Finding:

- Right and left hippocampal body volumes were negatively correlated with sleep spindle density.
  - More spindles were related to smaller volumes.
  - No significant associations were observed with performance on the memory task, counter to previous research.
- These findings are the first to show relations between nap physiology and brain structure in young children.

Future Directions:

- The study is ongoing and future analyses will probe the specific question of whether brain development mediates the relation between sleep spindles and memory in early childhood.

Take Home Message

Conclusion:

- Sleep spindles are related to hippocampal volume in preschool children.
- Associations between sleep, memory and brain development are important for our understanding of healthy development.

References

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