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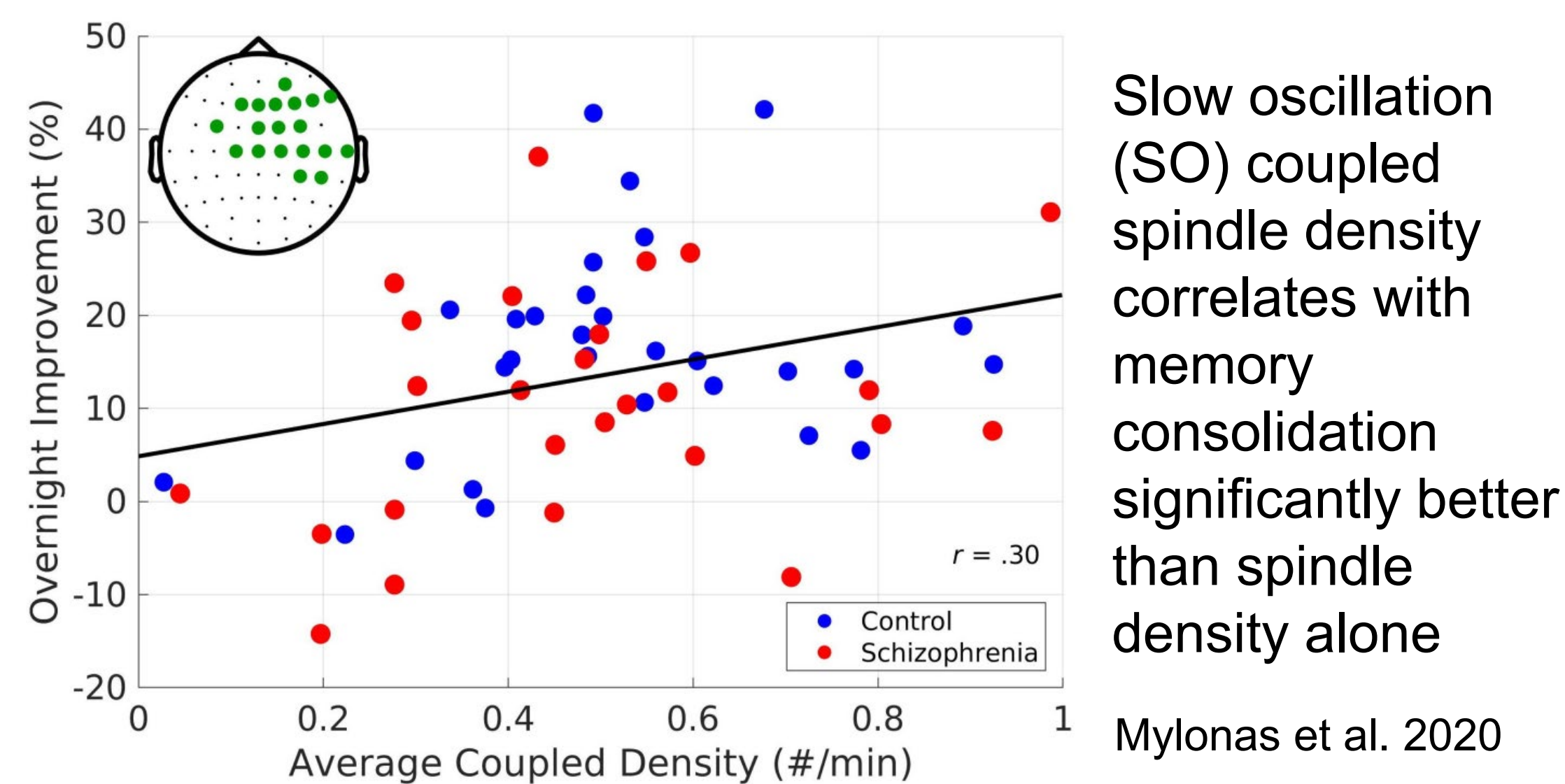
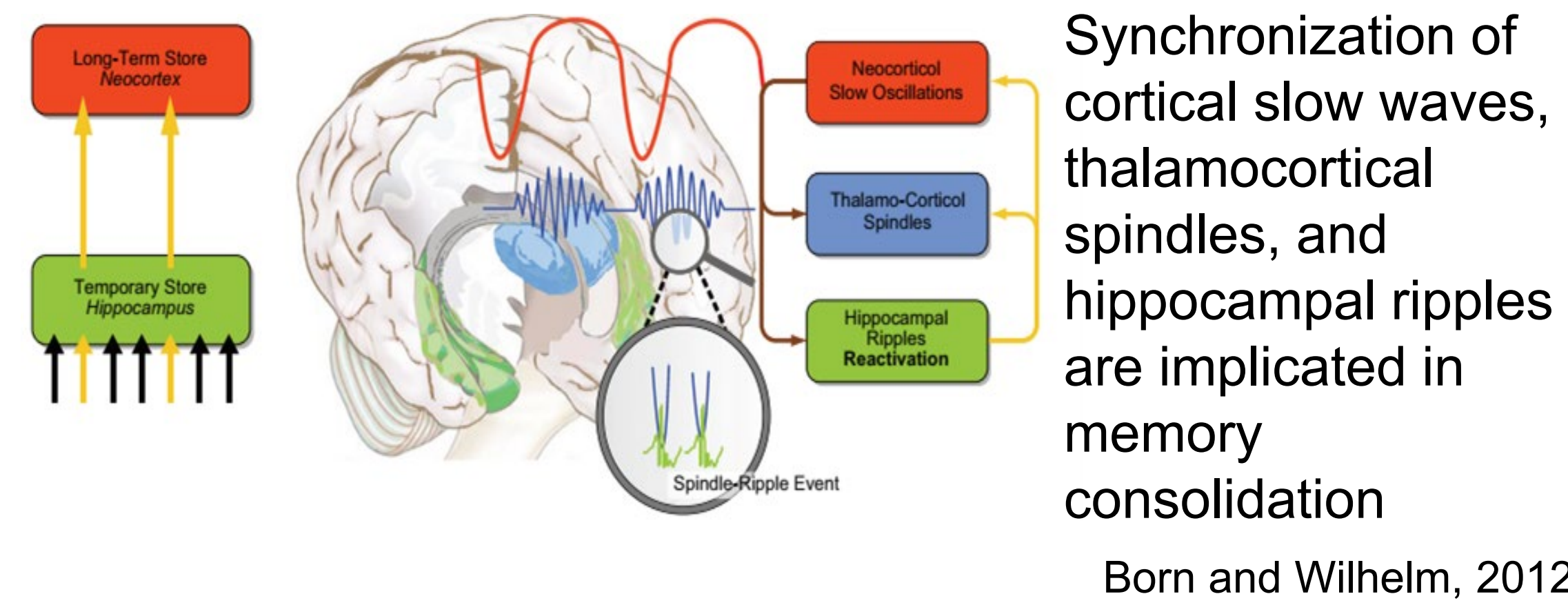
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## Motivation

- Sleep oscillations are crucial to memory and cognition
- Disrupted sleep oscillations are associated with cognitive deficits in various neurodevelopmental and neurodegenerative disorders, including schizophrenia, resulting in massive psychosocial and economic costs.
- **No effective treatments for these cognitive deficits exist.**

## Background

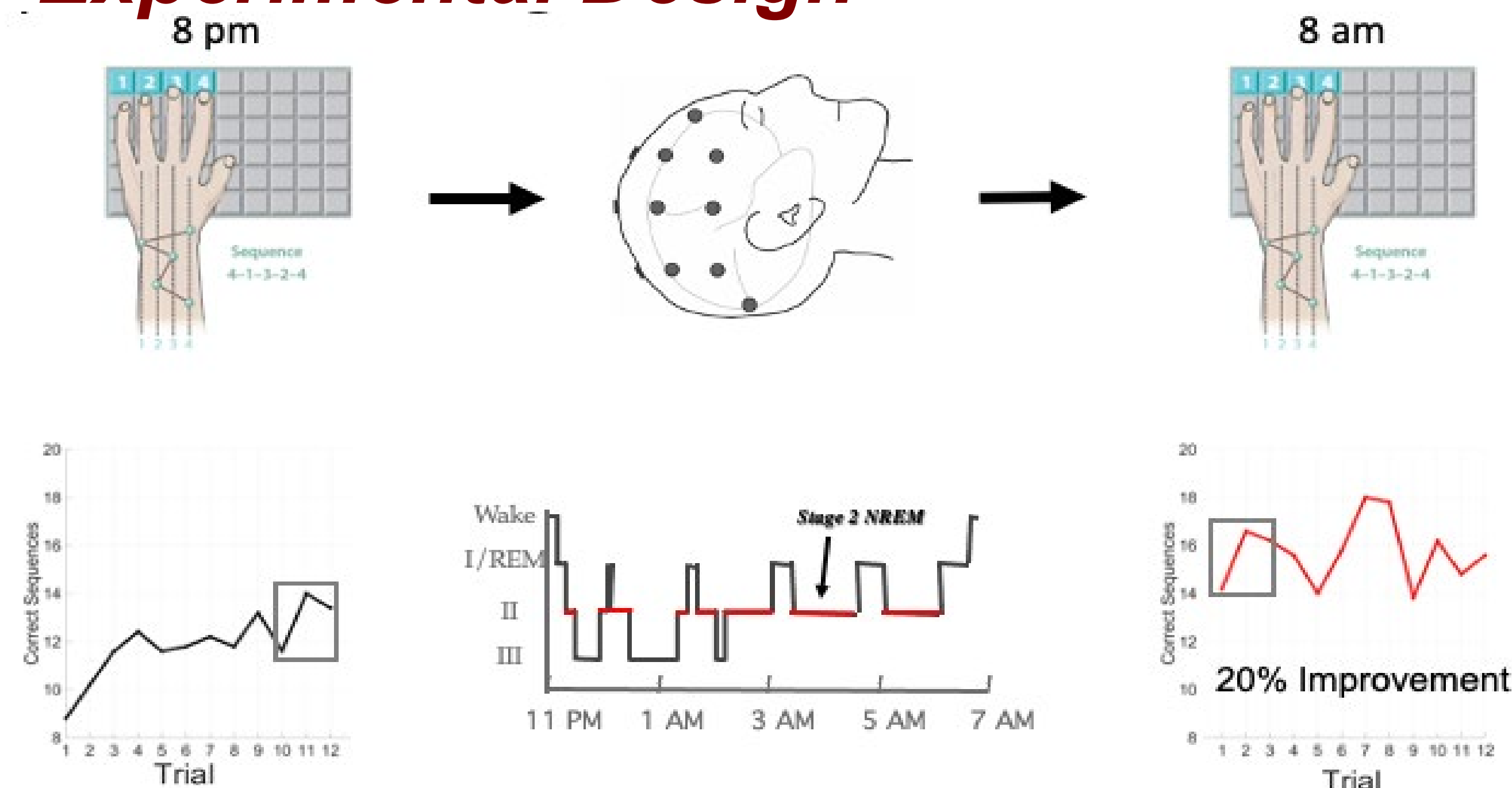
### Learning – Sleep Oscillations



The role of **hippocampal ripples** in human memory consolidation is unclear as ripples are currently not detectable noninvasively. Here we have a rare opportunity to examine intracranial hippocampal recordings in epilepsy patients to **investigate the coordination of these sleep oscillations and their effect on memory.**

## Methods

### Experimental Design



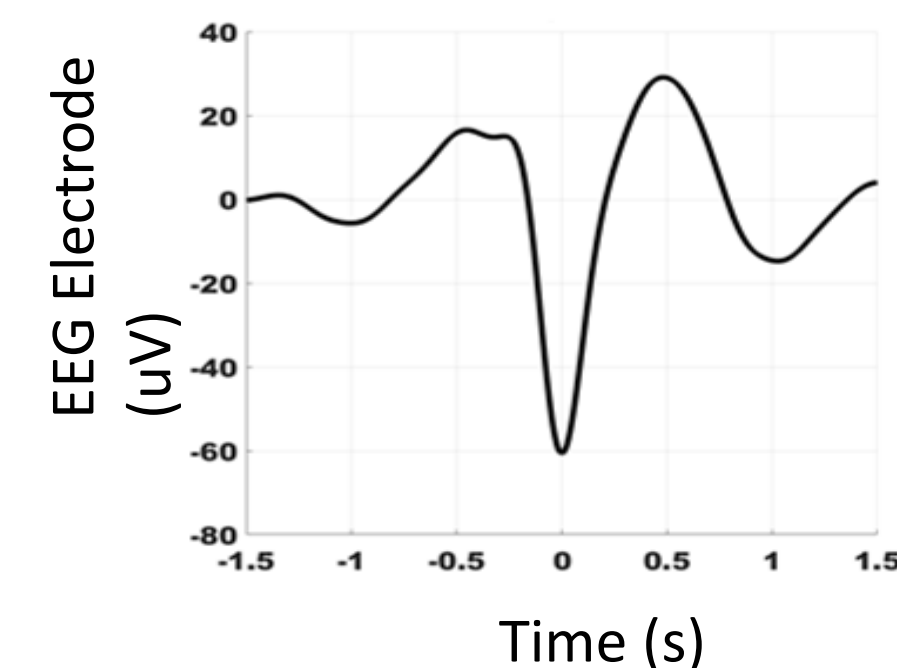
Four patients performed the **motor sequence task (MST)**, a well-validated finger-tapping procedural memory test, before (left) and after (right) a night of sleep (middle) while undergoing scalp and intracranial EEG.

### Motor Sequence Task (MST)

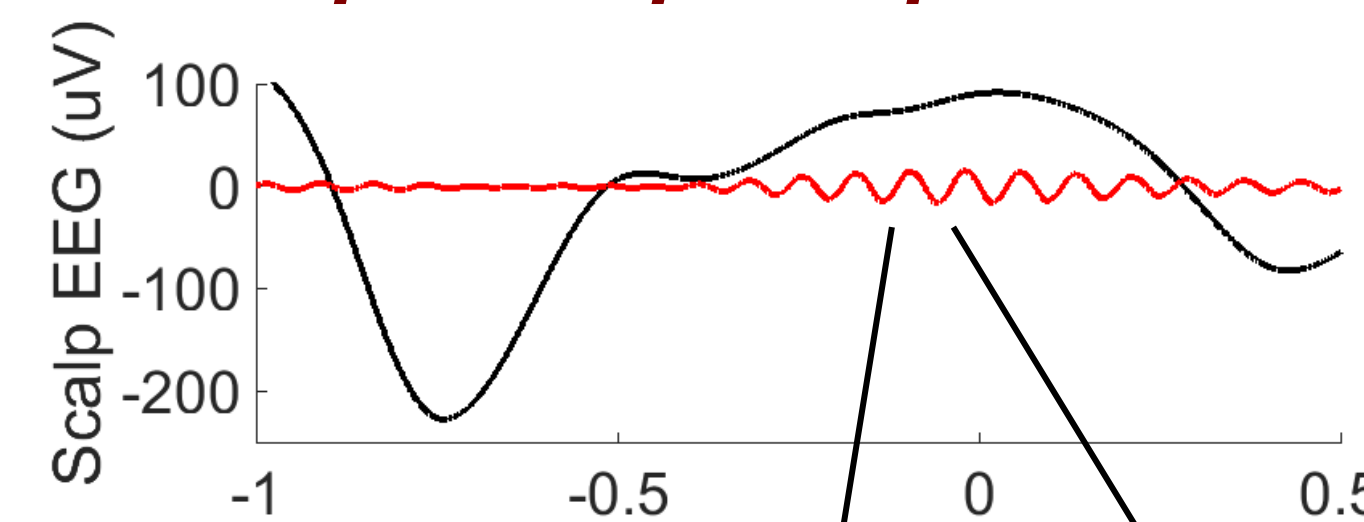
- Finger tapping task that shows sleep-dependent improvement
- 5 digit sequence (e.g., 4-1-3-2-4)
- Improvement: % change between training and testing

### Oscillation Detection

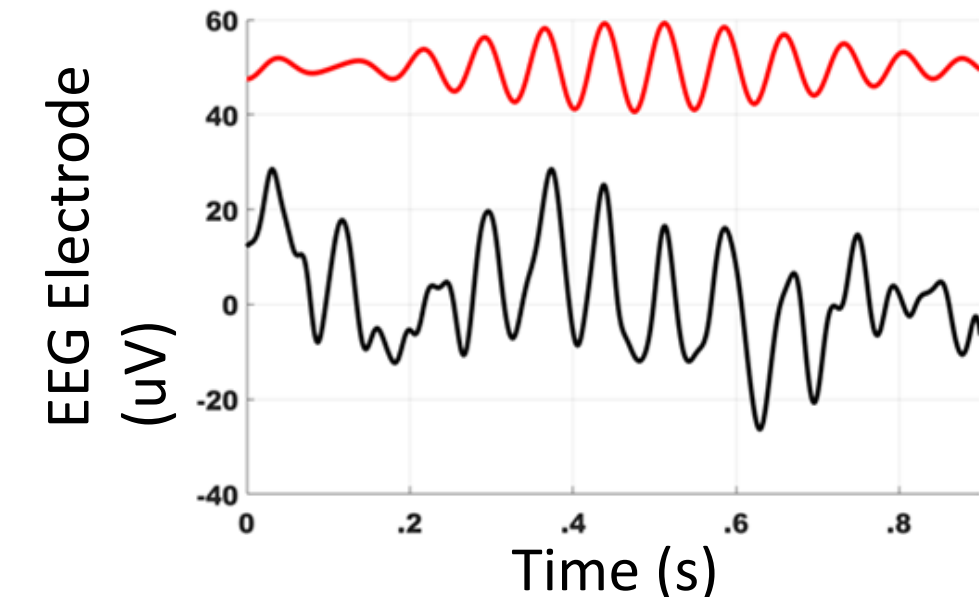
#### Cortical Slow Oscillations



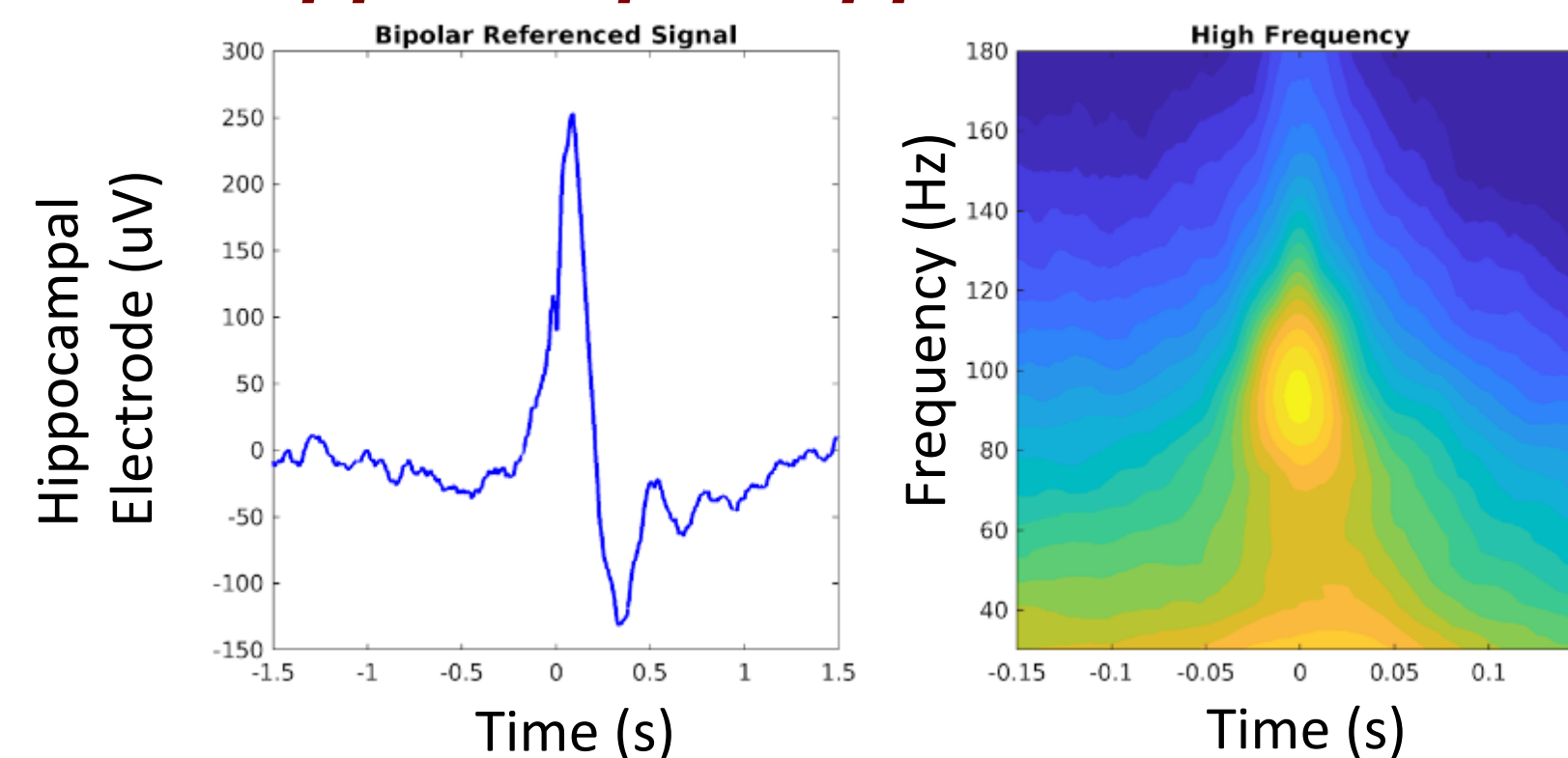
#### Triple-Coupled Spindles



#### Thalamocortical Spindles

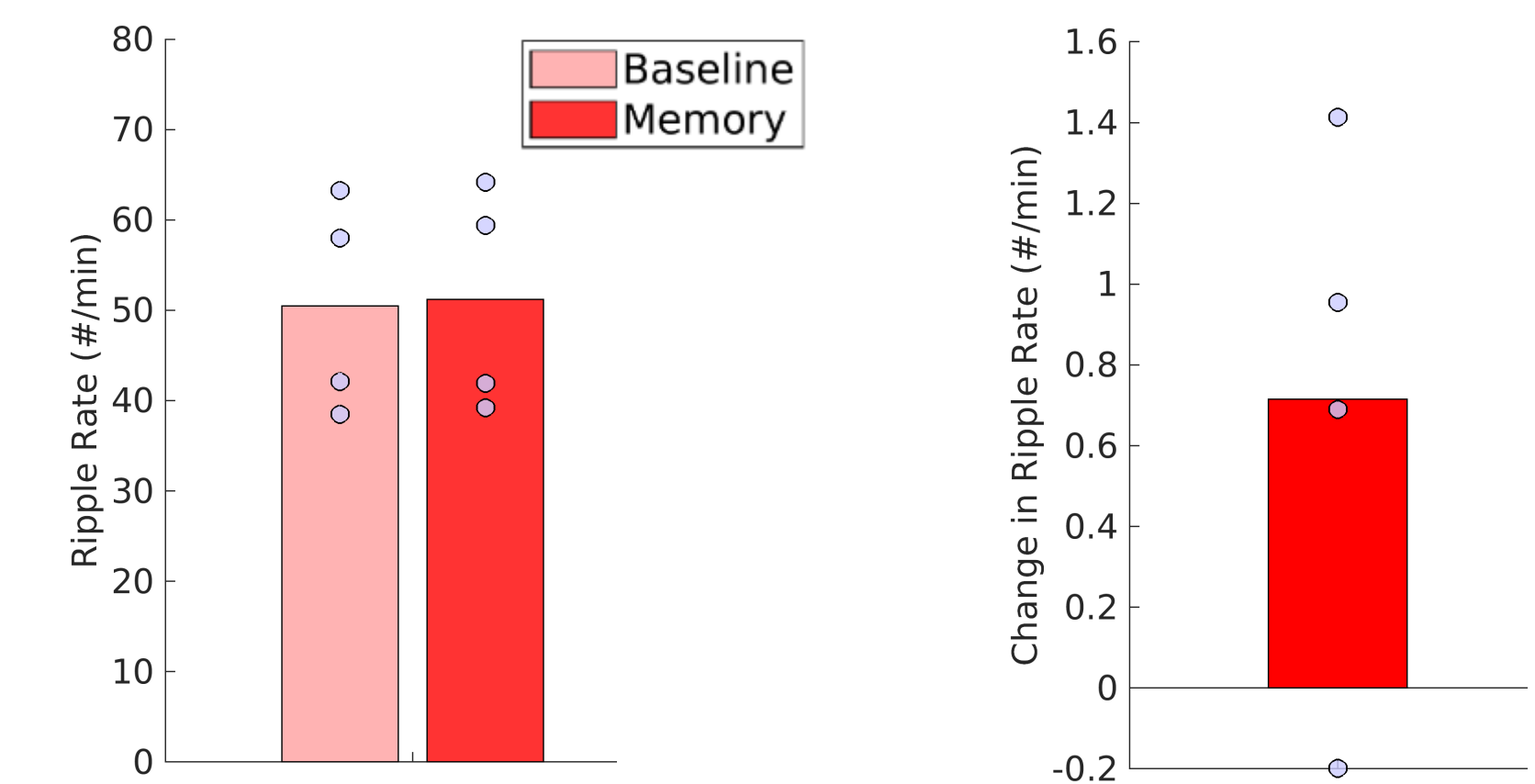


#### Hippocampal Ripples

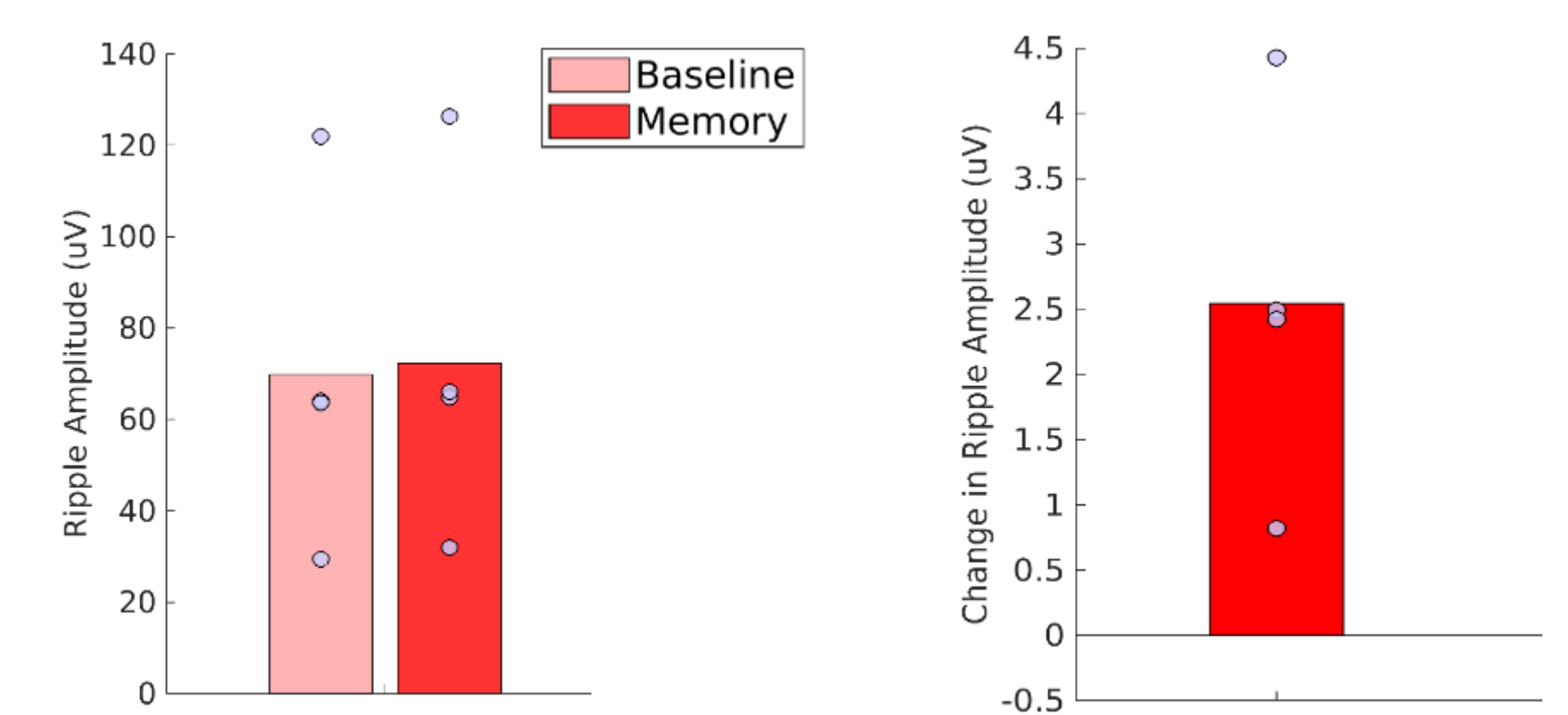


## Results

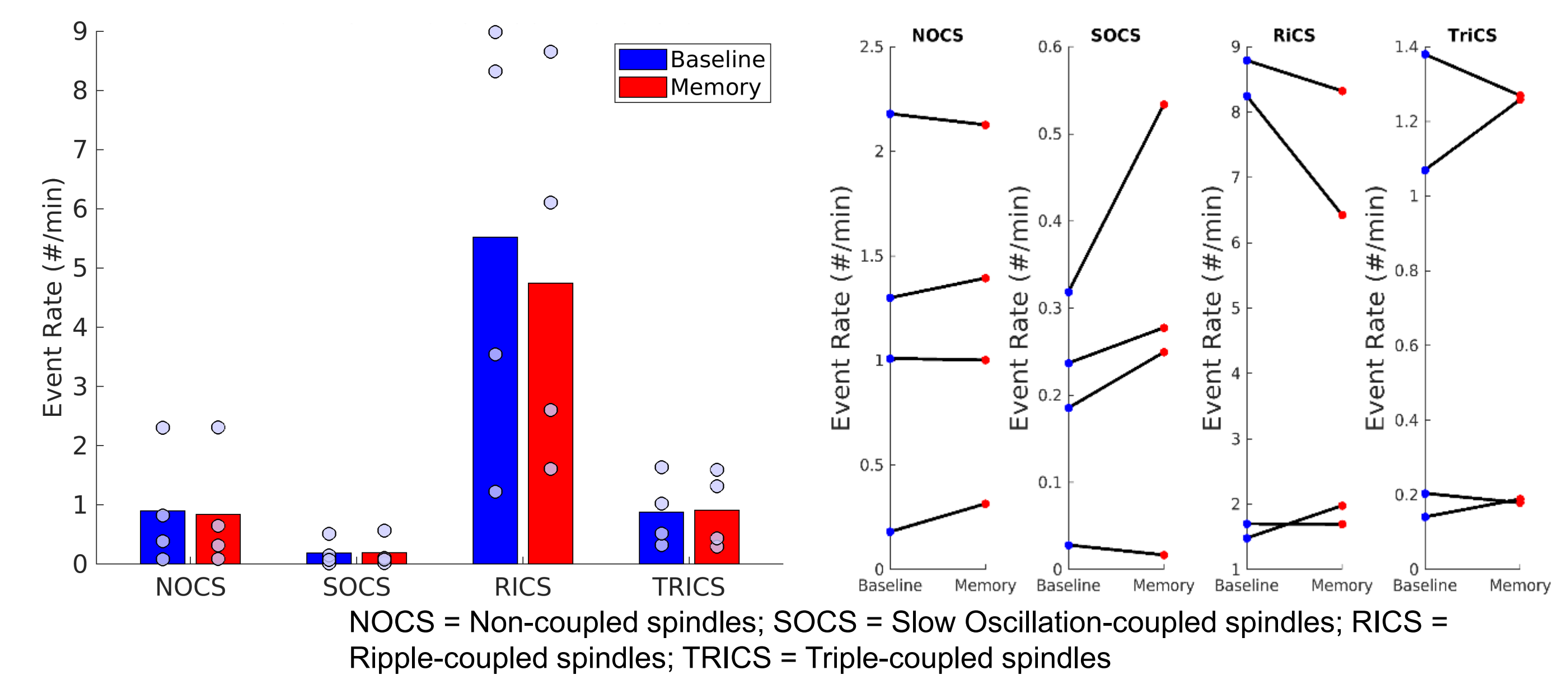
### Memory night shows increased ripple density



### Memory night shows increased ripple amplitude



### Variable changes in coupling with task performance



## Discussion

- Our preliminary analysis showed increased ripple (i) density and (ii) amplitude, in the memory night compared to baseline in the four patients with completed ripple analysis.
- This implies that **increased ripple density**, along with spindles and slow oscillations, **may play a role in sleep-dependent memory consolidation in humans**, consistent with findings in rodents .
- As we collect more data, we seek to determine how ripples are coordinated with spindles and slow oscillations and whether triple-coupled oscillations better correlate with sleep-dependent memory consolidation in humans compared to non-coupled sleep spindles.

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