

# Investigating Episodic Memory Consolidation Through REM- and NREM-Dominant Sleep Cycles Using Virtual Reality

Exploring hippocampal-neocortical interactions through immersive VR and sleep monitoring

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VIRTUAL  
TECHNOLOGY

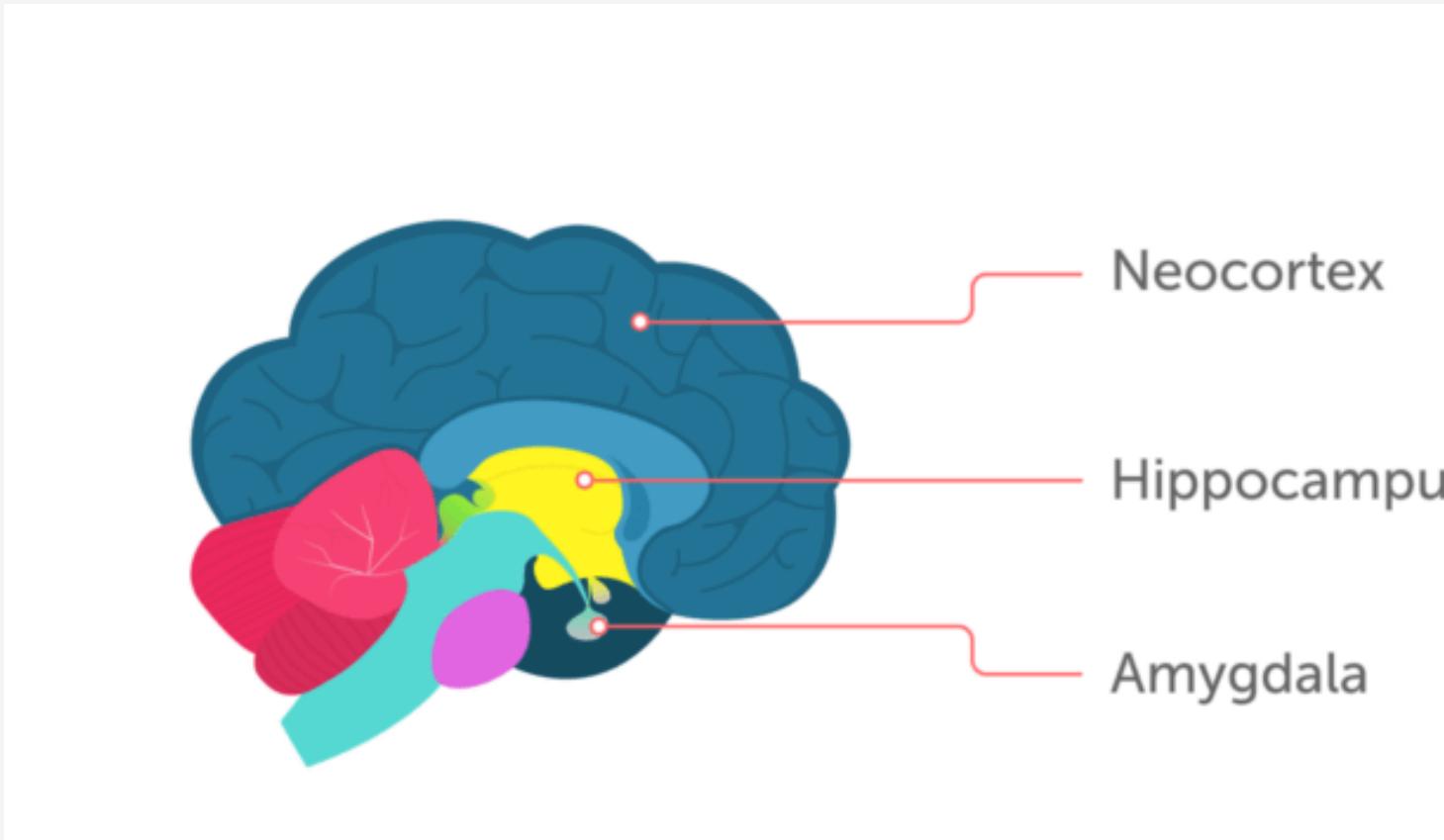
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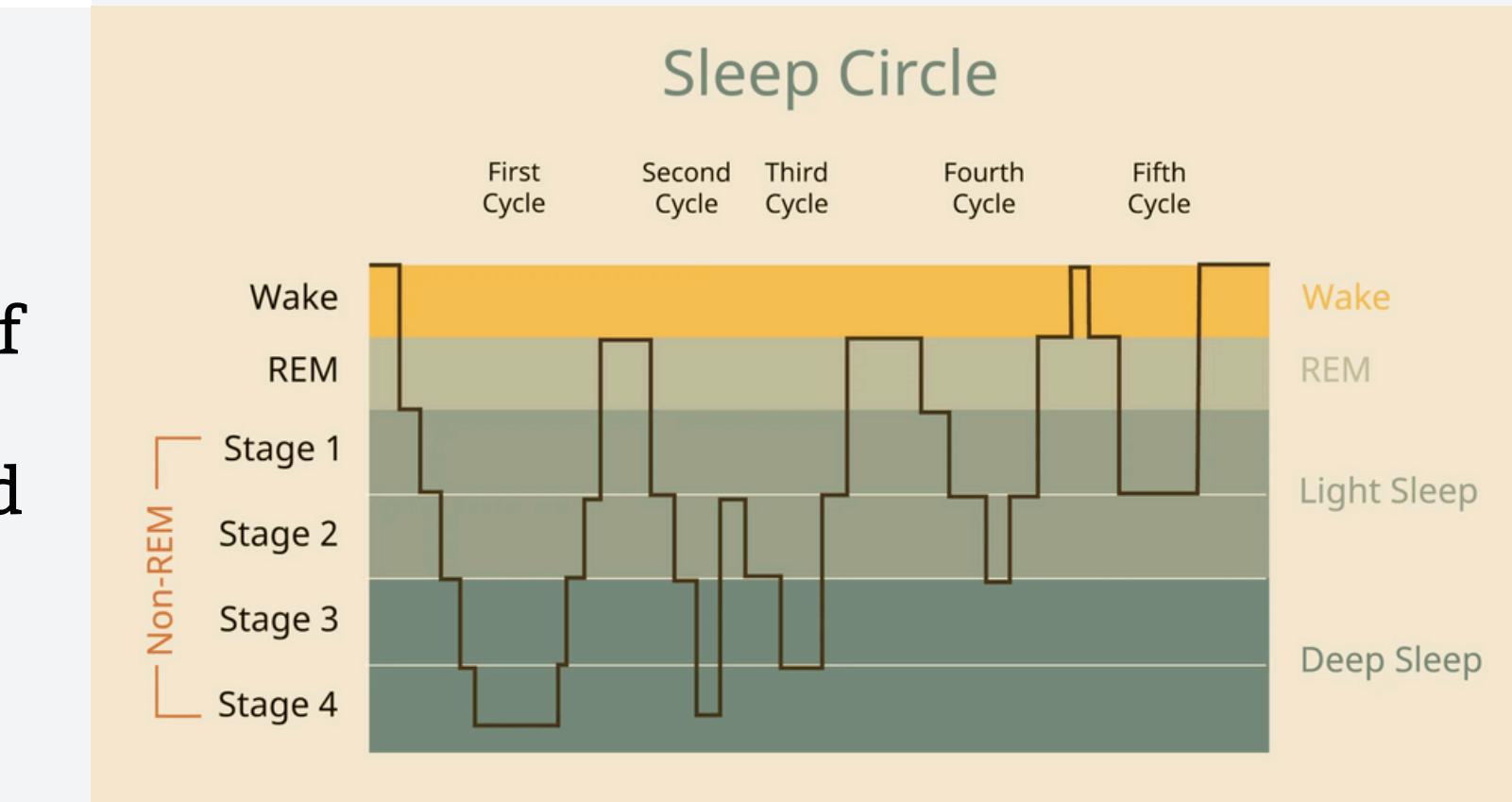
**Why was this topic interesting to  
us?**

# Introduction to Episodic Memory and Brain Structures



- **Sleep Role:**
- **NREM:** Facilitates replay and transfer of details to the neocortex.
- **REM:** Processes emotional aspects and enhances narrative coherence.

- **Episodic Memory:** Memories tied to specific events, places, and times, rich in context and emotion.
- **Hippocampus:** Key for encoding and early memory storage.
- **Neocortex:** Integrates and stores memories long-term.



# Hypothesis



Focus on hippocampal replay and transfer to the neocortex

**NREM-dominant sleep**



Enhances emotional and narrative content through hippocampal neocortical interactions.

**REM-dominant sleep**



Triggers episodic and emotional memory pathways differently across sleep stages

**VR Engagement**

# Experimental Design Overview

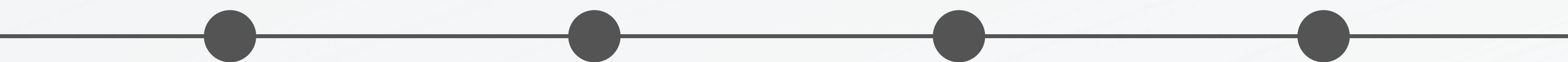
- **Objective:**
  - Investigate how episodic memories encoded through immersive VR are consolidated during REM- and NREM-dominant sleep cycles.
- **Participants:**
  - **Sample:** Young, healthy adults without sleep or neurological disorders.
  - **Sample size:** Flexible but aiming for sufficient power (e.g., 30 participants per group).
- **Experiment Variables:**
  - **Independent Variables:** Sleep type (NREM-dominant vs. REM-dominant).
  - **Dependent Variables:** Memory recall accuracy (episodic detail, emotional recall) and neuroimaging data (fMRI).

# Materials and Tools



- **VR Setup:** Meta Quest 3 or HTC Vive Pro 2.
  - Interactive tasks (navigating spaces, making decisions, engaging with objects) to simulate real-world episodic memory formation.
- **Polysomnography (PSG):**
  - **Devices:** Dreem 3 or Nox T3.
  - Used to track sleep architecture and confirm sleep cycles.
- **fMRI:** Pre- and post-sleep scans to observe memory consolidation.

# Experimental Procedure



## PRE-SLEEP PHASE

- VR tasks (social event, exploration, crisis management).
- Immediate recall to assess initial encoding.

## SPLIT SLEEP CYCLE

- Group 1: NREM sleep – detail retention.
- Group 2: REM sleep – emotional memory enhancement.

## POST-SLEEP PHASE

- After sleep, both groups recall episodic and emotional content to test memory consolidation differences.

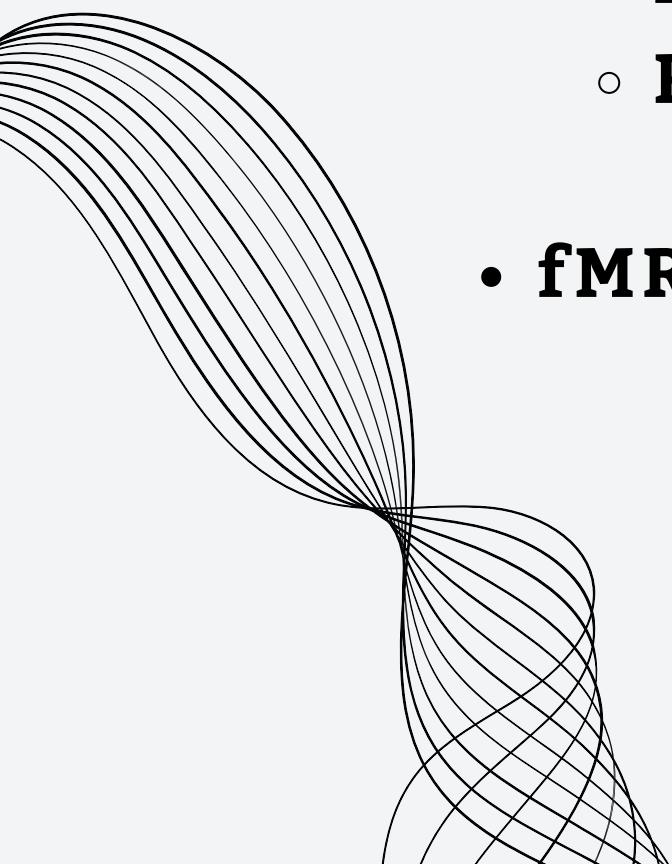
## FMRI SCANS

- Examine hippocampal-neocortical interactions post-sleep to visualize memory consolidation.

# Data Analysis



- **ANOVA:** Compare recall accuracy (episodic vs. emotional memory).
- **Sleep Stage Correlation:**
  - **NREM:** Detail retention via hippocampal replay.
  - **REM:** Emotional processing via prefrontal cortex.
- **fMRI Insights:** Visualize hippocampal-neocortical connectivity changes.



# Expected Results

## Hypothesis 1:

NREM-dominant sleep will show stronger hippocampal activity, enhancing detailed episodic memory retention.

## Hypothesis 2:

REM-dominant sleep will show increased hippocampal-prefrontal cortex connectivity, enhancing emotional narrative recall.

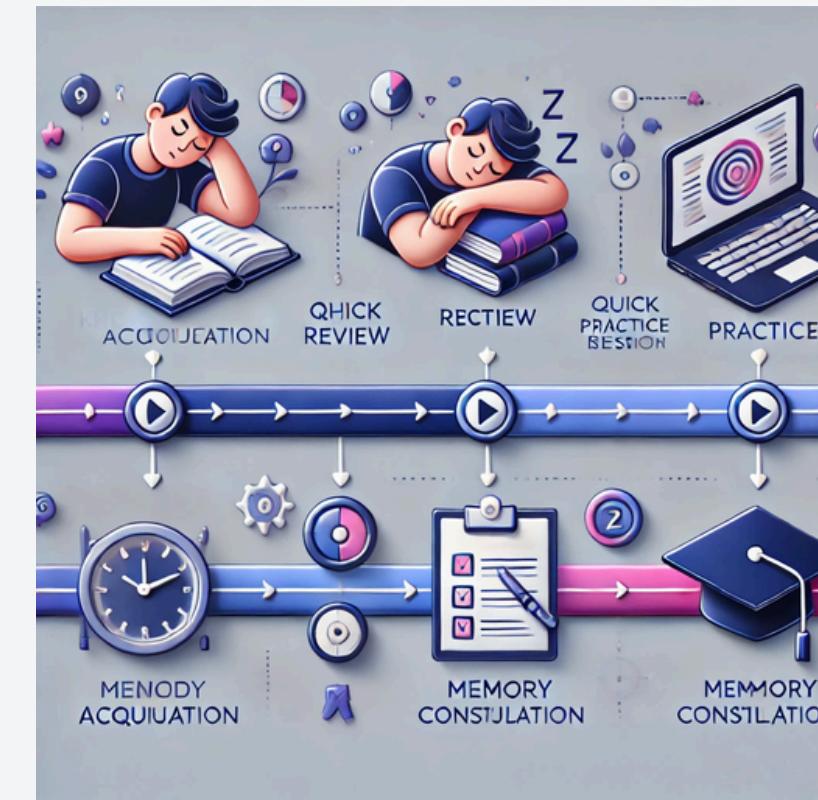
## Neocortical Integration:

Expect overall consolidation to involve the hippocampus transferring memories to the neocortex, with variations depending on sleep stage.



# Broader Implications

**Educational Applications:**  
Personalized learning schedules can be designed by aligning study sessions with sleep cycles to optimize memory consolidation.

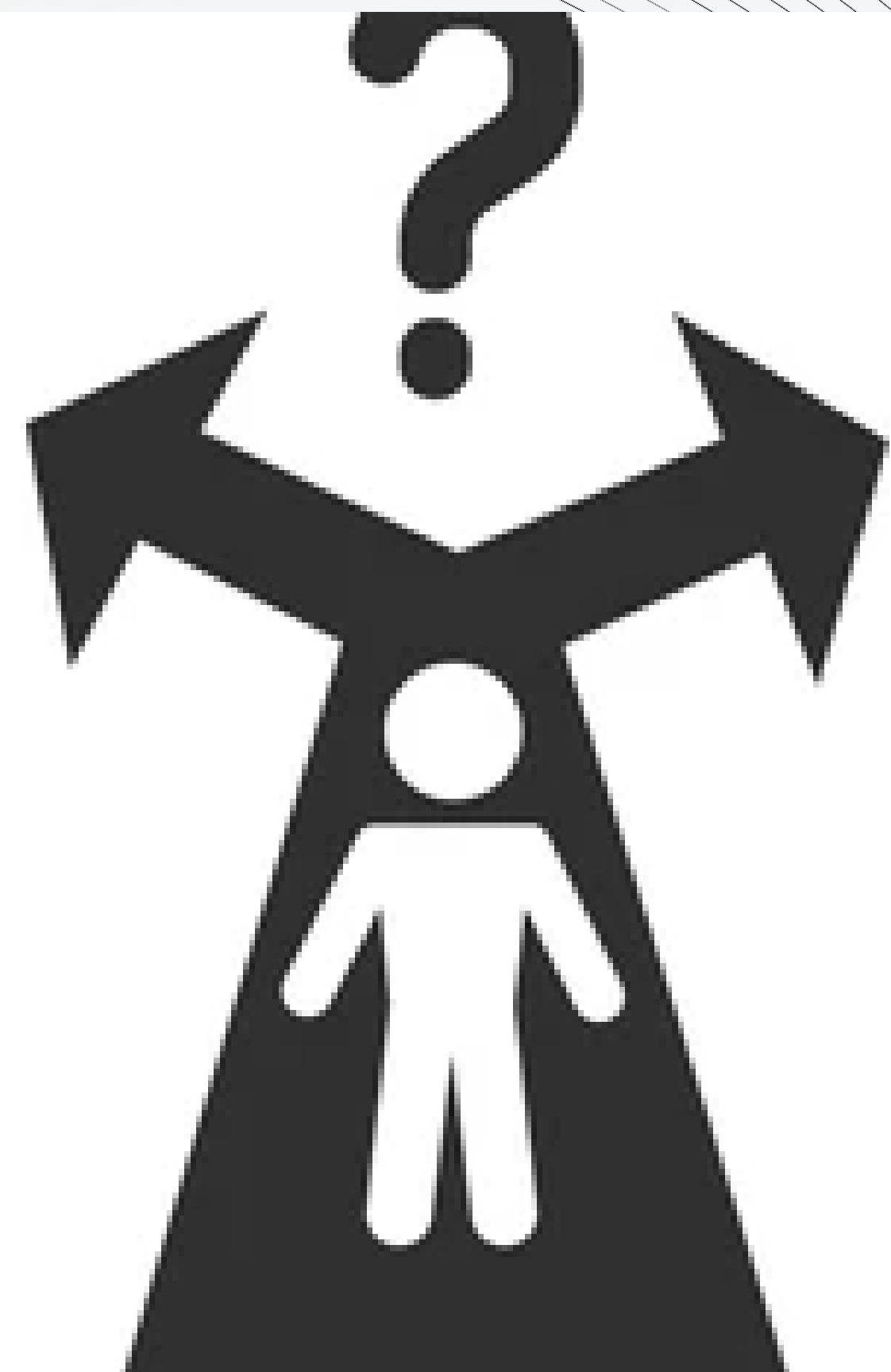


**Clinical Applications:**  
For patients with memory impairments (e.g., Alzheimer's, PTSD), sleep-based interventions can enhance memory consolidation by targeting hippocampal or neocortical processes.

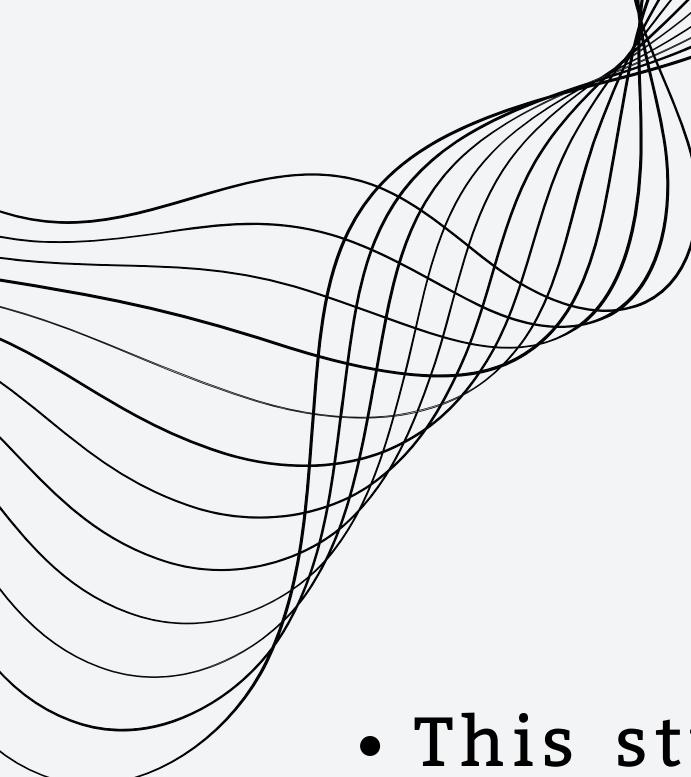


# Future Directions

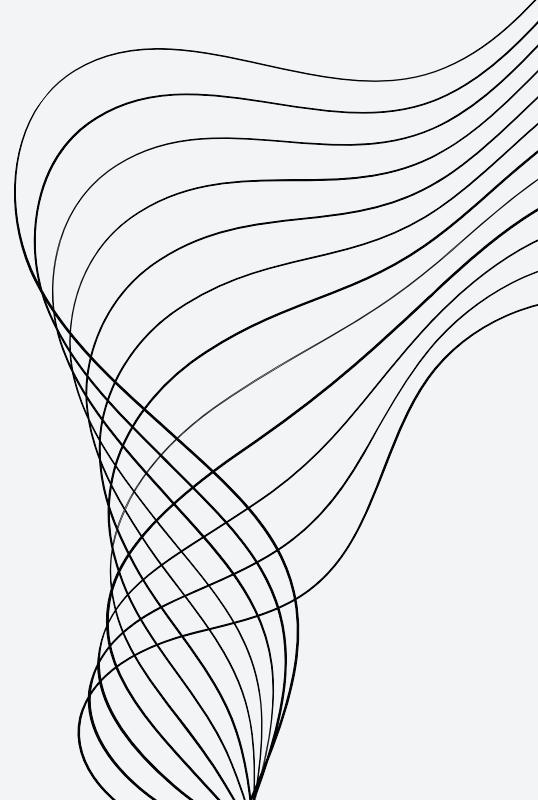
- **Age factor:** Comparison of memory consolidation between children, adults and old people
- **Longitudinal Studies:** Track long-term consolidation effects over weeks or months.
- **Clinical Trials:** Use sleep-based interventions for memory disorders.



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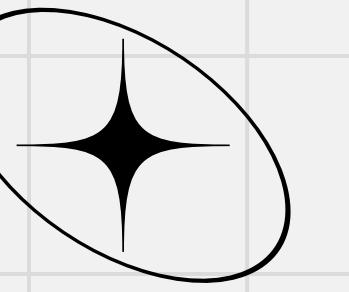


# Conclusion

- This study explores how episodic memories are processed differently across REM- and NREM-dominant sleep cycles using immersive VR.
  - **NREM:** Crucial for replaying episodic details and transferring them to the neocortex.
  - **REM:** Focuses on emotional memory processing, enhancing the narrative and emotional significance of memories.
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**THANK YOU**

