Sleep and Rest Facilitate Implicit Memory in a Visual Search Task

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INTRODUCTION

Sleep is shown to facilitate learning on a variety of tasks that require non-declarative, procedural memory.

- non-declarative: non-medial temporal lobe dependent, knowing "how", learning actions, habits, perceptual and motor skills, and implicit learning
- declarative: medial temporal lobe dependent, knowing "what", in terms of events, places, and general knowledge

Based on rodent models, it has been suggested that replay of waking events during sleep may underlie hippocampal learning by humans.

However, behavioral data for the role of sleep in human hippocampal-related memory have been inconsistent.

Since the mechanisms underlying consolidation of declarative and non-declarative memories are still unknown, further clarification of the relationship between medial temporal lobe memory processing and sleep would be useful.

We investigate the effect of sleep on learning in an implicit visual learning task that has been shown to rely on the hippocampus and surrounding medial temporal lobe area.

METHODS

Subjects:

Nappers (N=28): 90-minute naps with Polysomnography (PSG) recording.

Quiet Rest (N=28): Sat in a comfortable lazy boy for 90-min, listening to relaxing non-verbal music, with eyes-closed, and PSG recording.

Active Wake (N=28): Went about their business between test sessions.

All subject refrained from sleeping outside designated times, and drinking caffeine and alcohol the night before or day of the study. Subjects also maintained regular sleep schedules monitored with sleep diaries.

Outline of Experimental Protocol:

Nap, Quiet Rest, and Active Wake

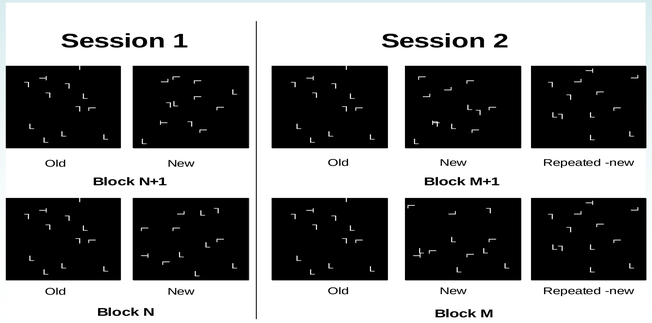
9 - 10 AM	1 - 3 PM	5 - 5:15 PM
Session One: Contextual Cueing: Old and New configurations	**Nap** or **Quiet Rest** or **Active Wake**	**Session Two:** Contextual Cueing: Old, New, and repeated-New configurations

Contextual Cueing:

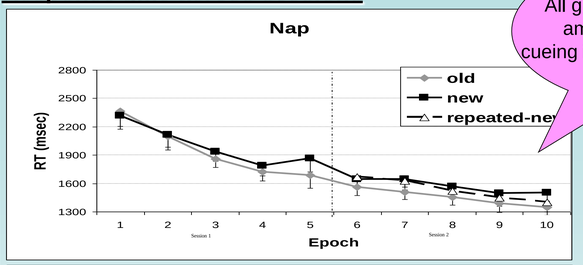
Session One: Subject perform a visual search task. Unbeknownst to subjects some search displays were repeated in the experiment. Contextual cueing was revealed by faster search speed on repeated trials (*Old*) than unrepeated ones (*New*), even though subjects were unaware of the trial repetition.

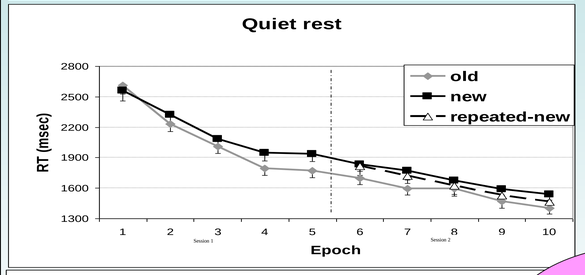
Session Two: Subjects shown *Old, New*, and *repeated-New* (novel set of 12 new configurations repeated throughout session two that examined new learning).

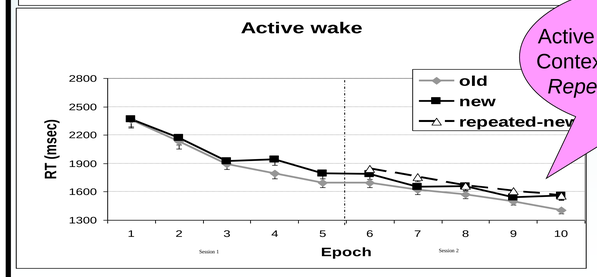
Explicit Recognition test: *Old, New* and *repeated-New* configurations.



Response time across sessions







All groups show the same amount of contextual cueing in *Old-New* comparison.

Active Wake failed to show Contextual cueing effect in *Repeated-New* condition

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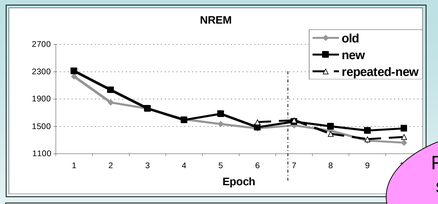
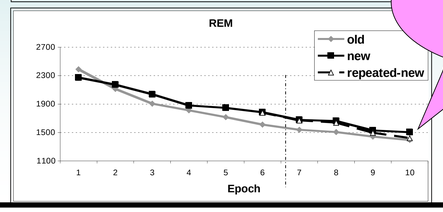
Response time of NREM vs REM naps





REM group failed to show improvement of Repeated-new condition.

Summary and Conclusions

The current results demonstrate that learning in this paradigm is dependent on training and does not require an offline process for improvement.

The amount of new learning in contextual cueing, however, does appear to depend on a period of "quiet time" for stabilization and consolidation, as learning of a new group of associations between configurations and target locations in session two were blocked in an active wake group. Furthermore, when looking at the individual sleep architecture within the napping condition and comparing those having REM (Rapid Eye Movement) versus those with only nREM (NonREM) there appears to be improvement of new learning with the decreased brain activity of nREM that is not seen with REM.

The Interference model of medial temporal lobe memory consolidation suggests that an offline process is required to stabilize memories, but this process does not require sleep, per se (Wixted 2004). Instead, sleep or quiet wake affords the brain a period of quietude without Long Term Potentiation that allows mechanisms of consolidation to occur without interference from new memory processing.

These data demonstrate a limit to the amount of medial temporal lobe learning available during active wake. We find that quiet rest or sleep is necessary for increasing the amount of associations between configurations and target locations that can be learned within a day.

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