Sleep-dependent consolidation enhances episodic memory for a real-life event

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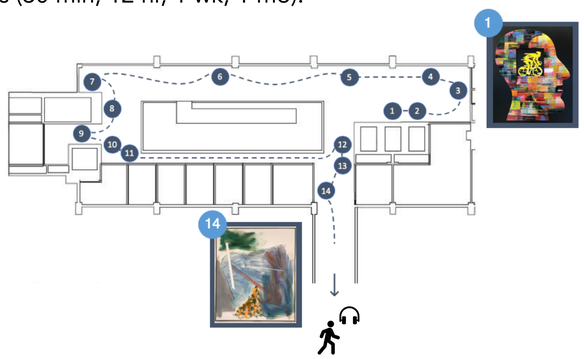
BACKGROUND

Sleep enhances memory through the process of consolidation [1]. Yet, sleep-dependent consolidation may not benefit all aspects of episodic memory. Evidence in rodents [2] and humans [3, 4] shows that spatiotemporal (sequence) information uniquely profits from sleep more so than perceptual (item) details.

Critically, most of this prior work has relied on conventional lab-based paradigms, making it unclear if these findings generalize to more naturalistic measures of memory. We resolved this by testing the memory of 82 healthy young adults (18 – 45 y/o) for a 20-min staged-event across four delays (30 min, 12 hr, 1 wk, 1 mo).



The objectives of the current study were to:

1. Determine if these previous results generalize to episodic memory for a real-life, recently experienced event (i.e., Baycrest Tour).
2. Establish whether sleep, compared to an equivalent period of wakefulness, selectively profits sequence over item episodic information.
3. Explore the relationship between sleep macrostructure (e.g., time spent in slow-wave sleep) and memory performance.

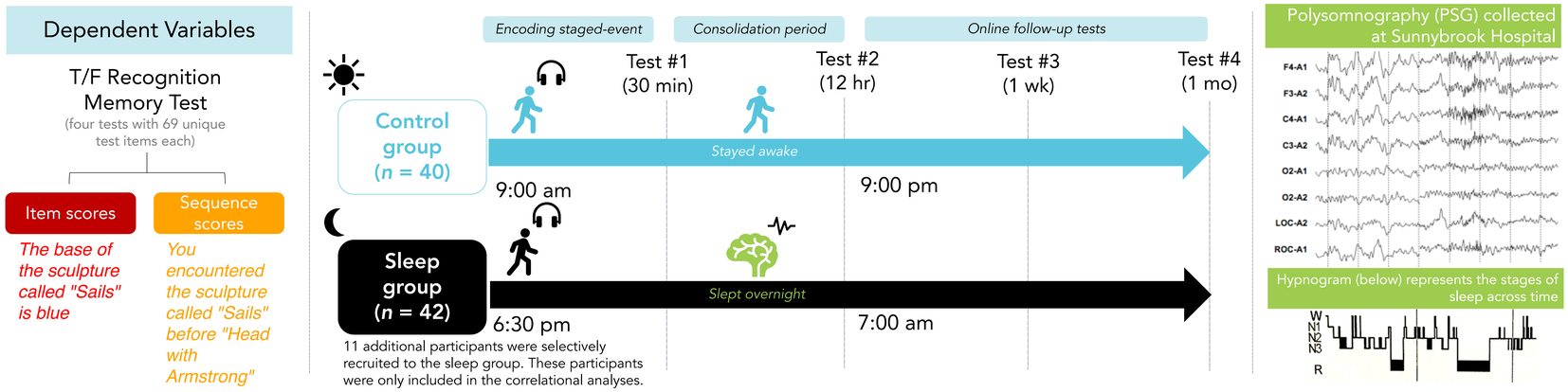
PREDICTIONS

1. We predicted that a period of sleep, not wakefulness, would facilitate better memory for the staged-event. Based on our lab's previous findings [4], we expected that sleep would be associated with enhanced sequence but not item memory.

2. This sleep-dependent memory benefit would be related to the time spent in slow-wave sleep (SWS) but not rapid eye movement (REM) sleep (assessed via polysomnography).

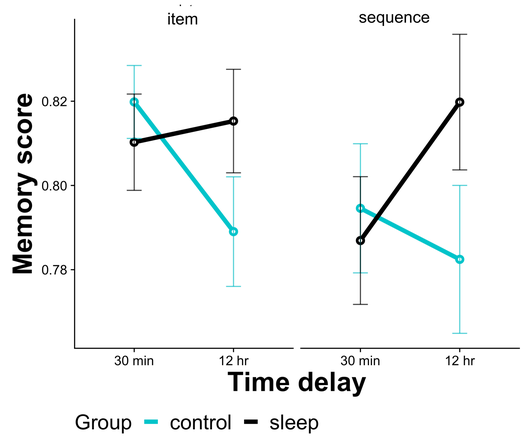
[1] Diekelmann, Wilhelm, & Born (2009). The whats and whens of sleep-dependent memory consolidation. *Sleep Med Rev, 13*(5), 309–321.
[2] Ólafsdóttir, H. F., Bush, D., & Barry, C. (2018). The role of hippocampal replay in memory and planning. *Current Biol, 28*(1), R37–R50.
[3] Helm, E. van der, Gujar, N., Nishida, M., & Walker, M. P. (2011). Sleep-dependent facilitation of episodic memory details. *PLOS ONE, 6*(11), e27421.
[4] Diamond, & Levine. (2018). *Age-related decline in the temporal organization of real-world memory recall.* Presented at the Context and Episodic Memory Symposium.

EXPERIMENTAL DESIGN



RESULTS

Fig 1. Raw memory scores for item and sequence memory at 30 min (baseline) and 12 hr delays across groups. SE bars are shown. There are no differences in baseline item or sequence scores, indicating no time of day effects.



We ran a linear mixed effects model predicting memory change scores (T2 – T1) from group, time, and detail type. The interaction between group (control, sleep) and time (30 min, 12 hr) was significant, ($F(3, 101) = 4.09$, $p < 0.01$, $\eta_p^2 = 0.08$).

Planned contrasts revealed that the change in memory is significantly greater after a period of sleep-consolidation compared to wakefulness for sequence (p = 0.03) but not item details (p = 0.05). This change is depicted by the thick lines in Fig 1.

Fig 2. Raw memory scores for item and sequence memory for sleep (n = 42) and wake (n = 40) groups across four time delays. SE bars are shown.

We ran a linear mixed effects model predicting memory score from group, time, and detail type. Irrespective of group, memory scores steadily declined across time.

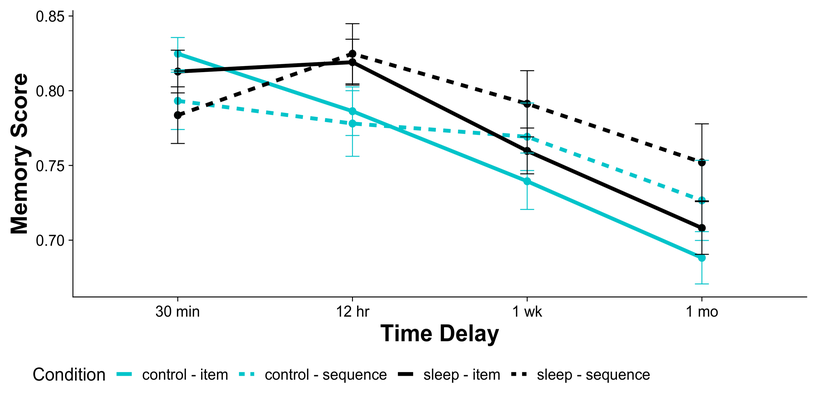
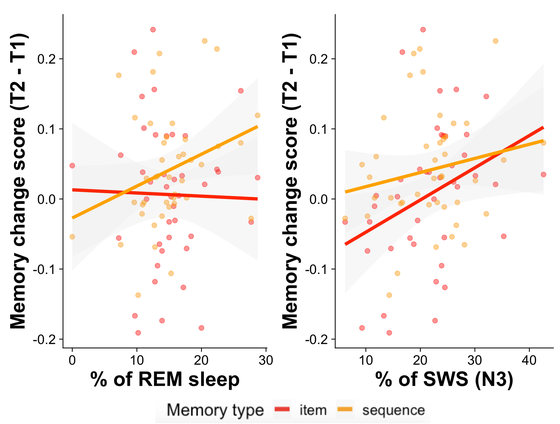


Fig 3. Relationship between the percentage of time spent in REM sleep and SWS (N3) vs. memory change scores for sleep participants ($n = 53$).



11 extra sleep participants were included in the correlational analyses here.

Neither memory scores were related to the percent of time spent in REM sleep (sequence: $r = 0.25$, $p = 0.07$; item: $r = 0.03$, $p = 0.84$).

However, item (r = 0.28, $p = 0.04$), but not sequence (r = 0.20, $p = 0.14$), memory scores were significantly related to the percent of time spent in SWS.

SUMMARY

1. Compared to wake, sleep preserves sequence *and* item memory for a recently experienced real-life event. **Notably, sleep conferred a greater benefit on the recollection of spatiotemporal (sequence) information compared to item details.**
2. **This sleep-related memory boost lasted for 12 hours**, after which both elements of episodic memory declined over time.
3. **Item change scores were significantly related to the time spent in SWS but not REM sleep.**

FUTURE DIRECTIONS

1. What is the relationship between episodic memory performance and sleep microstructure (i.e., spindles and slow-wave oscillations)?
2. Do these findings extend to other routes of retrieval (e.g., free recall)?