Matisse or Degas?

Using paintings to investigate the relevance of sleep in memory for specific details versus generalization

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Introduction

Generalization Learning

- Separate memories for multiple instances that overlap can be processed together so as to create a representation of categorical knowledge
- Memory consolidation during sleep may preferentially lead to gist memories[1] or highly specific memories, or both
- At least one prior study found sleep improved understanding of categorical structure[2]

Memory Specificity

- The ability to remember details can be preserved across sleep as compared to a wake delay[3,4]
- We tested memory for specific slices of paintings that were all very similar, such that it was difficult to accurately discriminate the studied painting
- It is unknown whether sleep, or cuing, is beneficial for maintaining category learning in this test or for recognizing stimuli used to learn the categories, or for both

Targeted Memory Reactivation (TMR)

- In order to study memory replay during sleep, cues associated with learned material can be played during sleep to reactivate specific memories[5,6]
- Reactivating memories in this way typically enhances memory performance for cued compared to uncued information[5,6]

References and Support

1. Inostroza, M., & Born, J. (2013). Sleep for preserving and transforming episodic memory. *Annual Review of Neuroscience*, *36*, 79–102.

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3. Hanert, A., Weber, F. D., Pedersen, A., Born, J., & Bartsch, T. (2017). Sleep in humans stabilizes pattern separation performance. *Journal of Neuroscience*, 1189-17.

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5. Oudiette, D., & Paller, K. A. (2013). Upgrading the sleeping brain with targeted memory reactivation. *Trends in Cognitive Sciences, 17*, 142-149.

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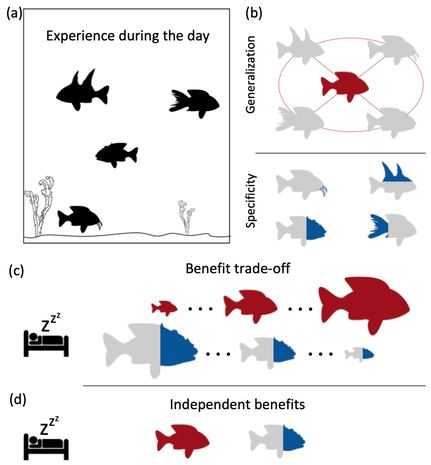
Funds were provided by the National Science Foundation Graduate Research Fellowship Program and NSF frants BCS-1461088 and BCS-1921678.

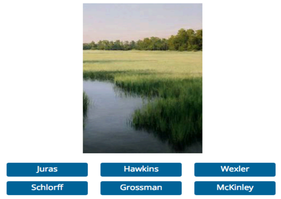
Research Question



Experimental Design

Participants

- 29 undergraduates (21 Female, 1 Non-Binary, 7 Male)
- Requested to wake up 2 hours earlier than normal and then avoid caffeine
- Experiment began between 12pm to 2pm

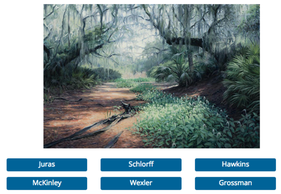


Learning Phase

Participants learned the artist of 18 painting-slices by 6 different artists. Learning occurred over 6 continuous blocks. Each artist was associated with a specific sound cue (500ms) that played during feedback.

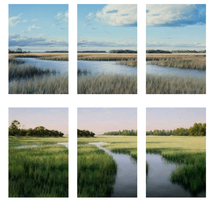
90-minute Nap

During slow-wave sleep, we played a set of 3 artist sound cues (chosen to match pretest accuracy with those not cued).



Generalization Test

Participants were tested on category membership with new, full paintings (9 paintings per artist at each test).



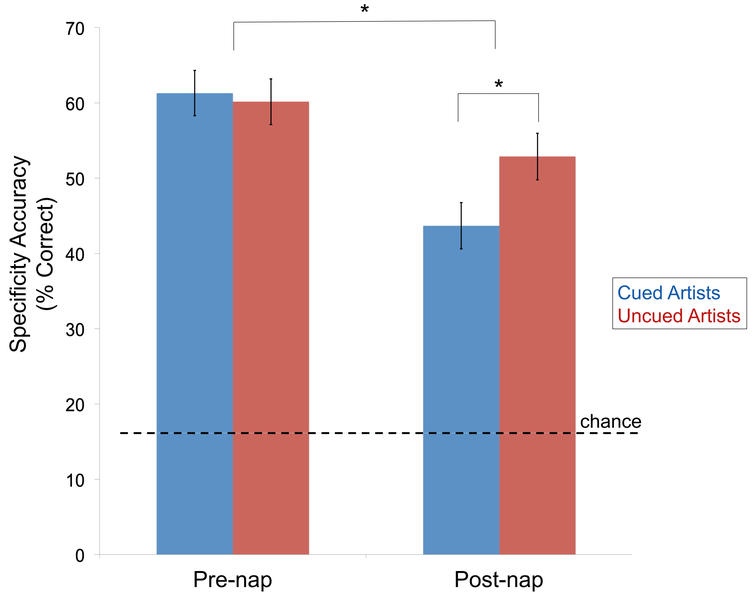
Recognition Test

Participants had to select which painting-slice they saw during the learning phase (18 paintings per artist). The lure painting-slices were by the same artist and shared perceptual features.

TMR made memory specificity worse, while generalization remained unchanged

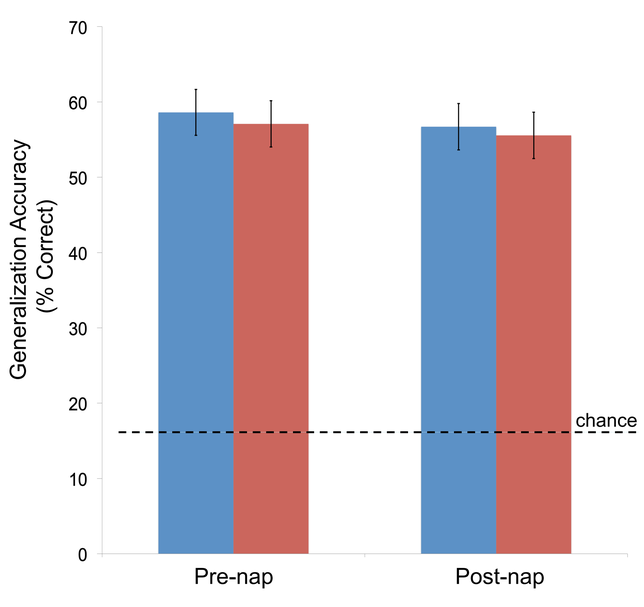
Memory Specificity

- Recognition accuracy declined over the nap [$F(1,27) = 32.55$, $p < 0.001$)]
- Cuing artists during NREM sleep led to a decrease in recognition for the exact painting-slice seen during learning [$F(1, 27) = 5.77$, $p = .02$]
- Although cuing artists impeded selecting the correct slice, cuing did not affect whether participants selected the correct painting [$F(1, 27) = 0.11$, $p = .74$]



Memory Generalization

- Generalization accuracy did not significantly decline after the nap [$F(1,27) = 0.25$, $p = 0.62$]
- There was no cuing effect on generalization [$F(1,27) = 0.01$, $p = 0.93$]
- We attempted a long-delay follow up (~105 days after the experiment), but memory had decreased to near chance levels and so results were uninformative



Conclusions

1. Participants succeeded in learning specific painting-slices as well as in generalizing those artists' styles.
2. Memory specificity dropped after sleep and was disproportionately worse for cued artists. Our interpretation is that TMR led to some degree of generalization such that participants were less accurate at selecting the correct slice (but they still tended to select the correct painting).
3. On the other hand, because generalization performance remained high after sleep, TMR appeared ineffective. This explanation is consistent with typical findings that TMR produces a relative memory benefit in the context of overall forgetting.
4. Our findings provide preliminary support for a trade-off whereby sleep reactivation can make object-memories less specific but more generalizable.