Sleep, Memory Consolidation, and Semantic Relationships in a Verbal Declarative Memory Task

Jessica D. Payne (jdpayne@bidmc.harvard.edu)
Matthew P. Walker (mwalker@hms.harvard.edu)
Jeffrey M. Ellenbogen (jeffrey_ellenbogen@hms.harvard.edu)
Eva Stroynowski (estroyno@bidmc.harvard.edu)
Robert Stickgold (rstickgo@bidmc.harvard.edu)
Harvard Medical School, Center for Sleep and Cognition,
330 Brookline Avenue/FD-861, Boston, Massachusetts 02215, USA.

Keywords: Memory; memory consolidation; sleep

Introduction

It remains unclear, but critically important, to determine whether sleep influences the consolidation of declarative memories. Although several recent studies suggest a beneficial role of sleep in the consolidation of verbal declarative memories, these studies have typically used a "split-night" procedure, where memory for word pairs was tested after 3 hours of early sleep, or after 3 hours of late sleep (e.g. Plihal and Born, 1997, although see Ellenbogen et al., in press). In this study, we used English translations of Gais and Born's (2004) word-pairs, and compared performance on these original, semantically related word-pairs to performance on a matched list of unrelated word-pairs after a 12-hour period containing either sleep or wake.

Method

Participants were randomly assigned into the sleep or wake group, and studied either semantically related or unrelated word-pairs. They then recalled these words after a 12-hour delay (wake: 9AM-9PM, or sleep: 9PM-9AM).

Results

Across groups, we found that (*i*) subjects showed nearly identical performance at the end of training, but (*ii*) 12 hours later at retest, the overnight sleep group showed improved performance compared to the daytime wake group (81.3 vs. 73.1% correct, respectively, p < .05). Although subjects showed similar improvements in the recall of related words across 12 hr of Sleep and Wake (7.0% vs. 7.1%, p=.9), the Sleep group showed significant improvement in the recall of *unrelated* words, (6.2%, p<.005), while the Wake group showed significant deterioration (-4.5%, p<.05).
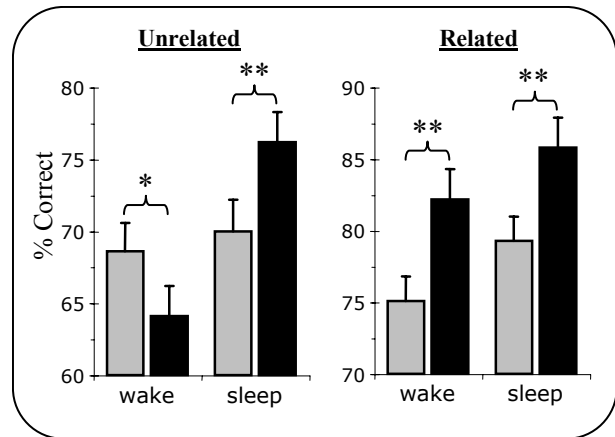

Figure 1: Mean % Recall Performance. Comparison of training (gray bars) and retest (black bars). *p < 0.05; **p < 0.005

Conclusion

We have demonstrated that verbal declarative memories benefit from a full night of sleep. In contrast to the findings of Plihal & Born (1997), it was the semantically *unrelated* words that showed the greatest enhancement post-sleep. Our results suggest that sleep benefits the consolidation of newly formed semantic relationships, perhaps via their integration into pre-existing neocortical memory stores.

Acknowledgments

References

Plihal, W. and J. Born (1997). Effects of early and late nocturnal sleep on declarative and procedural memory. *Journal of Cognitive Neuroscience*, *9*, 534-547.

Ellenbogen, J. M., Hulberg, J.C., Dinges, D.F., and Thompson-Schill, S.L. (*in press*). Interfering with

Theories of sleep and memory: Sleep, declarative memory and associative interference.