

Relearn Faster and Retain Longer: Along With Practice, Sleep Makes Perfect

Stéphanie Mazza, Emilie Gerbier, Marie-Paule Gustin,⁴ Zümrüt Kasikci, Olivier Koenig, Thomas C. Toppino, and Michel Magnin, University of Lyon, 2016

The Participants:

Forty participants between 18-29 years of age are chosen; 20 in the 'sleep' group, 20 in the 'wake' group.

"The sleep and wake groups were not significantly different with regard to age or gender. The two groups also did not differ with regard to sleep quality, circadian typology, or sleep quality score. In addition, short- and long-term memory performance in the two groups was not statistically different."

Sleep group studied at 9pm, slept, then had a retest at 9am.

Wake group studied at 9am then had a retest at 9pm – no sleep between.

The Learning and Test:

"The initial learning session consisted of the presentation of the 16 Swahili-French word pairs. Pairs were presented successively, in random order, and participants were asked to study the French translation."

"After this presentation, each Swahili word was displayed with a response box under it, cuing the participants to type its French translation. Participants could take as long as they wished to answer or leave the response box empty."

'Number of successful recalls' was then measured out of 16.

Completed session one ("the learning session"), then sessions:

- After 12 hours
- After 1 week
- After 6 months

During session one (the initial learning session), "the sleep and wake groups did not differ significantly in the number of translations successfully recalled at the first retrieval attempt after study."

"There was also no significant difference between the groups in the number of subsequent pair trials needed to answer each of the 16 pairs correctly. Subjective sleepiness at the time of the learning session was similar in both groups. Data are consistent with the assumption that the two groups completed the learning session with similar performance and effort and that performance was not significantly influenced by the time of day (evening or morning)."

In contrast, after 12 hours, "the number of initially remembered translations was higher for participants who had slept (10.3 out of 16 on average), than for those who had spent the day awake (7.45 out of 16 on average.)"

"Participants in the sleep group needed approximately half as many list trials to get all 16 translations correct."

Sleep group: 3 attempts on average, Wake group: 6 attempts on average.

“Thus, at the end of the relearning session, the wake group reached the same performance level as the sleep group (i.e., they reached the relearning criterion) but expended much more time and effort to do so.”

One week later...

“The sleep group scored 15.2 out of 16 on average. (60% of the participants performed perfectly at this delayed recall task.)”

“The wake group’s retention suffered much more after the 1-week delay (11.25 out of 16 on average.) No participant was able to recall all 16 translations, and no score was higher than 14.”

Six months later...

“The sleep group scored 8.67 out of 16 on average.

“The wake group scored 3.35 out of 16 on average.

“In the sleep group, 56% of items recalled at 1 week were still recalled after 6 months, whereas in the wake group, only 30% of such items were recalled.”

Conclusions

“Our results indicate that when the interval between successive study sessions is filled with sleep rather than with wakeful activity, the process is much more efficient because it both facilitates relearning and enhances long term retention. Compared with the sleep group, the wake group started off the relearning session with a lower level of memory and therefore had to engage in greater retrieval efforts to reach the expected level of mastery. Those efforts, however, did not translate efficiently into long term retention, as indicated by the fact that their performance did not reach the level attained by the sleep group 1 week later.”

“This result seems to be an exception to the desirable difficulty principle (E. L. Bjork & Bjork, 2011; Schmidt & Bjork, 1992), according to which long-term retention is facilitated by conditions that make learning harder. Surprisingly, in the present study, the benefit of sleep was immune to any diminishing effects induced by relearning: Our results suggest even an amplification of the effect of post-learning sleep through relearning.”

“Sleep has been shown both to passively protect memories against decay and interference and to actively consolidate new memories (Diekelmann & Born, 2010). It is possible that the cognitive processes engaged by the wake group during relearning were inefficient because they operated on memories degraded by interference from diurnal activities (Wixted, 2004). In contrast, the lesser efforts expended by the sleep group may have been more rewarding in the long term because they operated on sleep-consolidated memories.”

“Finally, the striking difference in long-term retention between the wake and sleep groups might also seem surprising given that the wake group slept shortly after relearning. However, in this group, sleep operated on memories that had suffered from more diurnal interference, the effects of which may not have been eliminated entirely by their extensive relearning. Moreover, participants in the wake group did not have the opportunity to relearn sleep-consolidated memories the next morning. These results suggest that an uninterrupted sequence of learning, sleep-dependent consolidation, and relearning (that is, repeatedly alternating study and sleep) is particularly efficient for long-term retention.”