Learning in Dreams: Gaining Knowledge and Skills

By Robert Hoss, MS

A growing volume of research is beginning to suggest that dream sleep might promote learning of several types. Is this influence of dreaming simply our ability to gain insight by applying our waking imagination to a dream we remember, or does a natural, purposeful process of learning take place within dream sleep itself – whether we recall the dream or not?

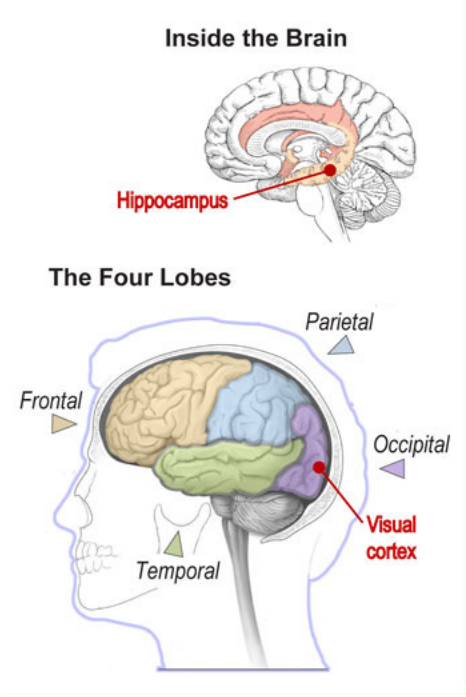
This two-part article presents a number of evolving theories based on recent research. As is usually the case with recent research, further studies and replication are required to solidify any one theory, but enough evidence from seasoned researchers is accumulating to lead in exciting new directions.

Here we'll look at how both factual knowledge and skills might benefit from dream sleep. In part 2 of this article, we'll see how dream sleep seems to help with self-restoration, adaptation to life, and personality development.

Through Mazes, Awake and Asleep

Animal studies over the past 40 years, mostly in rats and mice, suggest that sleep states stages are important for placing recently learned material into stable, long-term memory. And many studies find that humans, too, perform better after sleep as a result of learning or task acquisition during sleep.

These studies tested for learning pre- and post-sleep, but recent technological advances have enabled researchers to study the brain more directly.

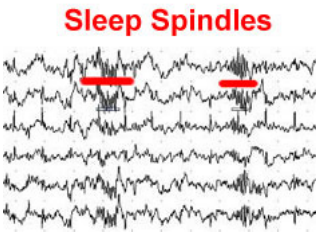


In a 2001 study, Matthew Wilson at MIT used microprobes to monitor individual neurons in the brains of rats. Among these were “place cells” in the hippocampus, which fire, or pulse electrically, as a rat navigates its environment. Wilson observed the unique firing patterns of individual neural place cells as the rats traversed each part of a maze to find a food reward. When the rats slept, these same patterns appeared again, as if the brain was replaying the maze pattern and relearning it. Likewise, the firing patterns in the visual cortex of the rats were replayed, suggestive of visual dream activity during the process. The results suggest that the rats were rehearsing and consolidating some degree of learning about the maze in their sleep.

The same has been found in humans. In 2008 Hagar Gelbard-Sagiv and her colleagues at the Weizmann Institute worked with a patient who had had similar probes inserted as part of a brain surgery procedure. As the patient viewed a sequence of images presented in story form, Gelbard-Sagiv noted the sequence in which neurons fired. As the patient slept later on, the same neurons fired in the same sequence.

In 2004, Philippe Peigneux and his team at the University of Liège used functional magnetic resonance imaging (fMRI) to look at the brain activity of humans as they worked through a virtual maze. The fMRI showed that the hippocampal areas activated during the maze experience were likewise activated later, during slow-wave (stage 3) sleep. And the amount of the hippocampal activity positively correlated with the improvement of performance the next day.

The Learning Process



Two basic learning processes appear to take place in sleep, for two types of memory: declarative (memory of facts) and procedural (learning how to do something). Researcher Carlyle Smith at Trent University (2010) indicates that some of the sporadic, spiky brainwaves in stage 2, known as sleep spindles, are due to innate learning ability, and declarative learning appears to involve stage 3 non rapid eye movement (NREM) sleep – whereas learning procedural tasks, whether motor or cognitive, involves either REM sleep or stage 2 NREM. Tasks that are completely new or novel and require a new cognitive strategy appear to involve REM sleep – where remembered dream content is often related to the material being learned. Often, no dream is remembered in this process, although that does not mean there was no accompanying mental activity (also called mentation).

Matt Wilson observed in his rat experiments that the learning process in various stages of sleep may be progressive, whereby the maze is replayed in NREM sleep and then, in REM sleep, the image fragments are combined with prior maze configurations from past tests. This suggests that in REM sleep, a more general procedure for solving mazes was developed from recent and past waking experiences. In some ways this isn't surprising; "sleeping on it" is relatively common. When a problem seems unsolvable and we go to bed without a solution, sometimes the next morning the answer seems to just "magically" be there.

But is the dream simply a reflection of a sleep mentation process, or might the dream itself play a role in the learning process?

In 1977 Harry Fiss discovered that when students dreamed of a short story, they remembered it better the following morning. In 2000, M. J. Fosse found that dreams interleave fragments of recent waking episodes with past experiences and other content.

In 2010 Erin Wamsley and her colleagues at Furman University asked study volunteers to do a virtual-reality maze task and then sleep, after which the team tested these individuals again. Those who dreamed about the maze task improved their memory ten times more than those who did not dream about it! Wamsley observed content from the maze in all stages of sleep – onset, NREM, and REM – with no statistical differences between REM and NREM.

Part 2 of this article, about dream learning and psychological growth, will be posted tomorrow.

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