HARVARD gazette

Just sleep on it: And empty the brain's 'in box'

October 26, 2000

By William J. Cromie, Gazette Staff

Robert Stickgold is doing experiments that knit together the raveled threads of sleep, memories, and dreams. (Staff photo by Jon Chase)

Robert Stickgold caused 17 different people to have the same dream.

In doing so, he added to evidence that the purpose of sleep is to process information — to take the jumble of a day's events, filter it, and send important impressions to the brain's memory centers.

One startling outcome of the research shows that amnesiacs do the same kind of processing although they cannot make the same memories.

"Busy people are familiar with the feeling that their heads fill up with a jumble of facts during the day, like an overstuffed inbox," says Stickgold, assistant professor of psychiatry at Harvard Medical School. "Such people often say, 'I need to sleep on it.' They do, and their heads feel less cluttered in the morning. Much of the excess detail is gone, and the important facts seem clearer."

"We know from recording brain waves of sleepers that the brain keeps working while we sleep," adds Allan Hobson, professor of psychiatry at the Medical School. "What's it doing? The most logical conclusion is that it's processing information received during the day."

To demonstrate this, Stickgold and his colleagues at Harvard and the Massachusetts Mental Health Center had 22 college students and five amnesiacs play the computer game Tetris. Players try to position falling blocks of different shapes so that they completely fill up lines. The blocks come down at varying speeds from the top of a space. Filling the whole space with solid lines of blocks wins the game. Gaps in the space lose the game.

When the players went to sleep on game days, Stickgold's colleagues woke them up every few minutes during the first hour after they dozed off, and asked them about dreams or images they were experiencing. That made it a tough night for 27 people, but the researchers obtained good information about dreams.

Just after falling asleep, during that time when thoughts and images course through the mind, most of the players dreamt of small objects falling and rotating. "I see little shapes falling down," was a typical response.An amnesiac forgot that she had played Tetris that day. When the woman came into her bedroom, she was surprised to see a researcher sitting by her bed. "Who are you, and what are you doing in my bedroom?" she asked.

Nevertheless, as she dozed and was awakened, she reported "thinking about little squares coming down on a screen and trying to put them in place."

To Stickgold such results mean that "the fundamental purpose of sleep is to catch up on processing information received during waking hours. Parts of the brain that do this are not available when you are awake; they are busy with other tasks.

"That's a reason to take a nap during the day," he continues. "It helps clear out the brain's 'inbox' and integrates that information into memory. During most of history, humans took siestas for this purpose. Modern men and women are perhaps the only advanced species of animal that goes 16 hours or more a day without a nap."

What dreams are for

Images seen as we fall asleep are different from dreams we experience later at night during deeper phases of sleep. These sleep-onset images occur only during the first two minutes or so.

"At this time, they are very intrusive, very demanding of your thoughts," Stickgold notes. "After that, the images are gone. You can't get them back, but the information is in brain storage."

Several Tetris experts recovered such memories when they sat down to play again. They had learned the game on color monitors with music in the background. The experiments were done with black-and-white graphics and no sound. When these people dropped off to sleep, they dreamed in color. The black-and-white game called-up old memories of games gone by.

These experiments showed how less relevant information gets culled from memories. None of the sleep-onset dreams included anything about the room, chair, desk, or keyboard. Only visions of falling, spinning blocks and filling lines played out in the little theater of the mind.

"That's as it should be," Stickgold points out. "Your memory isn't large enough to store all the minor things you experience every day."

Dreams in deeper stages of sleep, which are weirder in content, also connect to our memory. "I think that these dreams involve a search for new and creative ways to put memories and ideas together," Stickgold says. "They can make associations that we wouldn't make when we're awake. Sometimes such associations are valuable, but more frequently they're useless. I think that's why we dream, the brain searches for associations that are less obvious than those we make when we're awake."

Hobson notes the case of Otto Loewi, an Austrian Nobel Prize winner, who solved the mystery of how nerve cells transmit and receive messages. Loewi dreamed of chemicals being released from the end of a nerve. The dream was incomplete, so Loewi determined to finish it the following night. He was able to do this and to solve the problem of how the vagus nerve slows down the beating of the heart by sending it a chemical message.

Memories are made of this

Stickgold first thought about his experiment while climbing Camel's Hump, a low, worn-down mountain in Vermont. It's really more of a steep walk than a climb, with only one stretch that requires clinging to the rocks and moving carefully.

"I finished the climb about 2 p.m., then didn't think about it until I went to bed," Stickgold recalls. "As I dozed off, I instantly felt the sensation of my hands on the rocks. I roused myself a couple of times, but when I went back to sleep, the feeling of rocks on my fingers always returned. It actually felt like I was on the mountain. I thought, 'this is cool.' Then I went into a deeper sleep, and the feeling was gone."

For the next five years, Stickgold couldn't get that dream out of his mind. He wanted to do an experiment in which a group of people climb the same mountain, then test their sleep-onset dreams. But he couldn't obtain support because funding agencies would not expose human subjects to what they considered a dangerous situation

Finally, someone suggested doing the experiment with Tetris. Stickgold's group tried it and obtained good results. Now, they are running other experiments with Alpine Skier, a computer game in which the player puts his feet on artificial skis and races downhill.

When they fall asleep, the computer skiers dream of difficult turns, crashes, and other scary parts of their virtual trip. "The only part of my Camel's Hump climb that I remembered was the one difficult stretch," Stickgold comments. "And the parts that the skiers recall are the falls and scares. Thus, sleep-onset dreams put only the most crucial parts of our experiences into memory."

But what about the amnesiacs? Supposedly, they can't remember anything because of damage to the hippocampus, a small, S-shaped structure deep in the brain where memories first form.

"I included amnesiacs in the study because I thought they wouldn't have memories of Tetris playing and so strengthen my idea of the dream-to-memory connection," Stickgold says. "I thought they would provide a clear comparison between people who have memories and those who don't."

However, when three of the amnesiacs saw Tretis images, "It absolutely blew me away," Stickgold admits. He concludes that sleep-onset images don't come through the hippocampus; they proceed directly to higher levels of the brain, the cortex, where associations form.

Such recollections are called perceptual memories, as opposed to episodic memories. When you learn facts about the assassination of President John F. Kennedy, they register first in the hippocampus, but if you actually saw the assassination, that vivid experience would be recorded as a perceptual memory in the cortex. Although amnesiacs don't possess a hippocampus to call a memory back, perceptual memories in their cortexes drift into their dreams like disconnected fragments of the past.

That's what happens to all of us during our dreams. Communications between the hippocampus and cortex are cut off. Bits of memory float around our cortex, and the brain attempts to paste them together to form some sort of coherent "story." Sometimes that story provides a valuable insight or association; most of the time, however, dreams are just bizarre.

POPULAR


Probe of Alzheimer's follows paths of infection
May 11, 2017


2017 Election Results: Harvard Overseers and HAA Elected Directors
May 19, 2017

JFK speaks from his Harvard past
May 9, 2017


To age better, eat better
May 3, 2017

Moving the needle
May 15, 2017

Making rhyme and reason speak for him
May 16, 2017