IT'S POSSIBLE TO LEARN IN OUR SLEEP. SHOULD WE?

New research suggests that people can communicate and even practice skills while dreaming.

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Illustration by Simon Bailly

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In 1932, the inventor Alois Benjamin Saliger patented the Psycho-phone, a phonograph hooked up to a timer which could play recordings while a person was asleep. The audio could be heard at his dimly lit office on Lafayette Street, in Lower Manhattan. In one recording, titled "Prosperity," Saliger intoned, "I have complete confidence in the Psycho-phone. It lulls me to sleep, but my unconscious mind hears and is deeply impressed by these affirmations. Money wants me and comes to me." In another, titled "Mating," he declared, "I radiate love. I have a fascinating and attractive personality. My conversation is interesting. My company is delightful. I have a strong sex appeal."

An advertisement in *Psychology* magazine declared that, by listening to Saliger's messages overnight, a person could get results that "would take months or years to accomplish by conscious effort." The device cost up to two hundred and thirty-five dollars—more than four thousand dollars in today's money. In 1933, a writer for this magazine visited Saliger and reviewed letters from satisfied customers. Some said that they'd lost weight or come into money. One claimed to be expecting a "Psycho-phone baby."

People have long fantasized about learning effortlessly during sleep. What if you could snooze through "War and Peace," or a Mandarin course, and wake up having absorbed it? In Aldous Huxley's dystopian novel "Brave New World," hypnopaedia—sleep education—not only teaches new languages but brainwashes people with government messaging. Many thinkers have reported that key insights came to them in their dreams. For the Russian chemist Dmitri Mendeleev, in 1869, it was the organization of the elements into the periodic table. For the novelist Mary Shelley, it was the plot of "Frankenstein."

When scientists initially studied attempts to learn while sleeping, the results seemed promising. In a 1916 study, Navy soldiers seemed to better learn Morse code when it was played overnight. In 1942, a researcher tried to get twenty boys at a summer camp to stop biting their nails. Three hundred times a night, for almost two months, he played the phrase "My fingernails taste terribly bitter" through a loudspeaker; forty per cent of them stopped biting their nails, and none in a control group did. Participants in a 1952 experiment memorized more Chinese words when they heard vocabulary while asleep. But these early studies were deeply flawed—most significantly, because they

couldn't verify that test subjects were actually unconscious. Brain scans were not widely available, and there was scant knowledge of sleep stages such as REM sleep, when more vivid dreams take place.

…n a 1954 paper, the researchers Charles W. Simon and William H. Emmons concluded that in most sleep-learning studies, subjects were actually awake—rendering their findings essentially meaningless. The nail-biting boys may have stopped biting because they heard negative messaging, not because they had learned unconsciously. Ken Paller, a sleep researcher and a cognitive neuroscientist at Northwestern University, told me that Simon and Emmons effectively condemned sleep learning to the realm of science fiction and quackery. "People didn't study it much for decades," he said. "It was thought to be a crock."

In recent years, though, scientists have been trying again. Last year, Karen Konkoly, a dream researcher who was then a post-doc student in Paller's laboratory, gave puzzles to a group of lucid dreamers—people who, during dreams, often become aware that they are dreaming. Dashiell Bark-Huss, a thirty-five-year-old software programmer who lives in Chicago, remembered being stumped by one of the puzzles: How do you plant four trees that are all exactly the same distance from each other? You obviously can't plant them in a straight line. You can't arrange them in a square, either: trees along the sides will be closer than those diagonally across from each other.

Konkoly, who is herself a lucid dreamer, told study participants to try working on the puzzle while asleep that night. Bark-Huss spent the night in Paller's lab with electrodes on her head. She told me that not all of her dreams that evening were lucid, yet a scene in one of them faintly echoed the tree puzzle. She dreamed that she and her sister were floating on balloons of some sort, and poles were rising up from each one. This seemed to mirror the solution to the puzzle: one of the trees must be lifted up and planted on a hill, so that their four locations form a pyramid. "I solved the puzzle the next day," Bark-Huss told me.

The current wave of sleep-learning research began in 2007, after a team led by Björn Rasch, a Swiss cognitive biopsychologist who researches sleep, administered a clever experiment. The team asked people to memorize locations on a graph while smelling the scent of rose. Later, when the participants were sleeping, they were exposed to the scent again. The next day, no one remembered smelling the rose overnight—yet unconscious exposure seemed to help them remember the locations

better. Paller tried a similar experiment in 2009, this time using sound. Participants learned the locations of fifty objects; each was associated with a distinct noise. When Paller played a subset of the noises to sleeping participants—monitoring their brain waves to confirm that they were asleep—no one remembered hearing the sounds. But, afterward, they could better recall where the corresponding objects were. This approach is now known as targeted memory reactivation.

What we learn in our sleep can apparently influence our behavior, too. In 2014, the neuroscientist Anat Arzi was a graduate student at the Weizmann Institute of Science. She published a study that exposed sleeping participants to pairings of scents. Smokers who smelled a mix of cigarettes and rotting fish overnight subsequently reduced their cigarette consumption by more than thirty per cent—more than people who smelled the pairing while awake.

Rasch and Arzi's most significant findings were from sleep stages in which people dream less frequently. Emma Peters, a self-described "dream engineer" at the University of Bern, has instead conducted experiments on lucid dreamers while they are in REM sleep. In these kinds of experiments, participants are told to practice physical activities—finger tapping, coin tossing, dart throwing with a nondominant hand—within their dreams. After they wake up, they turn out to show more improvement on those tasks than a control group. (That said, dreams are not the most controlled environment. One dart-throwing dreamer was distracted by a volley of darts from a doll that suddenly appeared; this participant was not any better at throwing darts the next day.)

In perhaps the most striking example of learning during sleep, Konkoly, Paller, and several collaborators witnessed what amounted to conversations with people who were in the midst of dreams. Independent lab groups in the U.S., France, Germany, and the Netherlands asked lucid dreamers to answer yes-or-no questions and solve simple math problems. Electrodes measuring body and brain activity verified that the participants were not awake. Martin Dresler, a sleep researcher at the Donders Institute, who ran the Dutch experiments, said that they were able to verbally deliver new information to the sleeping mind—and to receive responses. Some people could remember the questions they had been asked when they woke up. "This is a form of very complex learning," he told me.

Christopher Mazurek, one of the participants in the study, was nineteen at the time.

He recalled hearing a math problem—eight minus six—during a lucid dream. He doesn't remember what the dream was about—"something about my favorite video game," he told me—but he knew that the question came from beyond the dream. He was instructed to respond by moving his eyes from left to right, and sure enough, the researchers counted two rightward movements of his eyes. Other participants experienced the sounds within the context of their dreams; in one, the question seemed to emanate from a dream radio. Thomas Andrillon, a sleep neuroscientist at the Paris Brain Institute who was not involved in the research, called it "one of the most mind-breaking papers I've ever read."

Once, in Paller's lab, Bark-Huss dreamed that she crashed her car. She was convinced that she'd spent too much time as a study participant and had become sleep-deprived. She saw flashing lights that she interpreted as the police. "I was freaking out because I thought I might have killed somebody," she told me. "Then I realized, It's not the cops. I'm in the lab now, and that's the light from the lab." She was able to communicate with Konkoly using eye signals—and, through it all, she continued sleeping. She remembered finding it eerie to come across signals from the waking world. "You realize that somebody is communicating to you from what feels like another dimension," she said.

Konkoly's study of problem-solving was published earlier this year, in *Neuroscience of Consciousness*. Twenty lucid dreamers, including Bark-Huss, spent multiple nights in the lab, trying to work out puzzles in their sleep. Each puzzle was paired with a specific sound, which was supposed to prompt them to resume work on the associated puzzle. One participant dreamed of asking for help from a fellow-passenger in a car. "I actually don't know," the passenger replied. "It's kind of hard." Another dreamed of solving the puzzle when it appeared on a school exam; upon waking, the solution was apparent in real life. In the lab, participants figured out forty-two per cent of the puzzles that showed up in their dreams. They solved only seventeen per cent of the ones that didn't.

Most people aren't lucid dreamers, so the people Paller and Konkoly studied weren't representative of the general population. But, curiously, participants had the highest solve rate when the puzzles appeared in ordinary dreams, not lucid ones. Sleep stages differ in important ways, Monika Schönauer, a sleep researcher at the University of Freiburg, who wasn't involved in the study, told me. Maybe the stage in which lucid dreams occur doesn't involve as many creative leaps. She called the research "crazy," adding, "I mean this in the best possible way. It's super impressive."

So is it time to design a new Psycho-phone—one that might actually work? Certain kinds of thinking might be easier while we're asleep, Paller said. To solve the tree puzzle, he pointed out, "you have to think in another dimension—in three, instead of two, when you're planting the trees. That might be something our unconscious mind is better at." When we're asleep, we might be more ready to associate unrelated stimuli, Andrillon said. This could explain why the scent of cigarette smoke and rotting fish had an impact on people who were snoozing, but not on people who were awake.

But there could be many downsides to interfering with an activity as essential and mysterious as sleep. We depend on sleep for restoring the body and mind; it's believed not only to consolidate important memories but also to discard those that can be forgotten. "Sleep has its own universe, and we should better use that moment for what it's good for," Andrillon said. In a recent paper, Paller and others showed that targeted memory reactivation can disrupt sleep—which undermines the learning that is supposed to take place in the process.

Andrillon warned against trying to harness the sleeping mind in the service of the waking world. Dreams are not some barren landscape waiting to be populated, he said; they follow their own rules and presumably serve their own inexplicable aims. "We should care about them, promote them, and nurture them, rather than trying to replace them," Andrillon said. On this point, Konkoly, who is now a postdoctoral fellow at Cambridge University, agrees. Not long ago, at a sleep conference, she discussed the dangers of trying to "colonize" sleep with what she called "wake-centric values." In her own life, she might prefer to learn *from* sleep than learn during sleep.

In a recent lucid dream, Konkoly found herself standing in front of an old tree that had a door in its trunk. When she opened the door, she saw a coffin, and inside the coffin she saw herself as an old woman. Konkoly asked her older self, "What do you wish that you knew earlier in life, or did differently?" Her older self replied, "I wish that I listened more." Then Konkoly asked what she would accomplish in life. The answer underwhelmed her. "She said something about an administrative job at a university," Konkoly told me. "I thought, 'I want to do something cooler than that!' " ♦

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