



# Trying to

# FORGET

The ability to let go of thoughts and remembrances supports a sound state of mind, a sharp intellect—and even superior memory *By Ingrid Wickelgren*

**S**olomon Shereshevsky could recite entire speeches, word for word, after hearing them once. In minutes, he memorized complex math formulas, passages in foreign languages and tables consisting of 50 numbers or nonsense syllables. The traces of these sequences were so durably etched in his brain that he could reproduce them years later, according to Russian psychologist Alexander R. Luria, who wrote about the man he called, simply, “S” in *The Mind of a Mnemonist*.

But the weight of all the memories, piled up and overlapping in his brain, created crippling confusion. S could not fathom the meaning of a story, because the words got in the way. “No,” [S] would say. “*This is too much. Each word calls up images; they collide with one another, and the result is chaos. I can’t make anything out of this.*” When S was asked to make decisions, as chair of a union group, he could not parse the situation as a whole, tripped up as he was on irrelevant details. He made a living performing feats of recollection.

Yet he desperately wanted to forget. In one futile attempt, he wrote down items he wanted purged from his mind and burned the paper. Although S’s efforts to rein in his memory were unusually vigilant, we all need—and often struggle—to forget. “Human memory is pretty good,” says cognitive neuroscientist Benjamin J. Levy of Stanford University. “The problem with our memories is not that nothing comes to mind—but that irrelevant stuff comes to mind.”

The act of forgetting crafts and hones data in the brain as if carving a statue from a block of marble. It enables us to make sense of the world by clearing a path to the thoughts that are truly valuable. It also aids emotional recovery. “You want to forget embarrassing things,” says cognitive neuroscientist Zara Bergström of the University of Cambridge. “Or if you argue with your partner, you want to move on.” [For more on emotional memory, see “A Feeling for the Past,” by Ingfei Chen, on page 24.] In recent years researchers have amassed evidence for our ability to willfully forget. They have sketched out a neural circuit underlying this skill analogous to the one that inhibits impulsive actions.

The emerging data provide the first scientific support for Sigmund Freud’s controversial theory of repression, by which unwanted memories are shoved into the subconscious. The new evidence suggests that the ability to repress is quite useful. Those who cannot do this well tend to let thoughts stick in their mind. They ruminate, which can pave a path to

Certain neurons in your brain inhibit reflexive behaviors, such as the tendency to run after a ball that you've sent flying into the street. A similar set of neurons may stop unwanted recollections from entering consciousness.



depression. Weak restraints on memory may similarly impede the emotional recovery of trauma victims. Lacking brakes on mental intrusions, individuals with attention-deficit hyperactivity disorder (ADHD) are also more likely to be among the forgetful (to coin a term). In short, memory—and forgetting—can shape your personality.

The ability to forget, however, is not immutable. If you practice applying your mental brakes, unwanted memories tend to fade. Thus, contrary to conventional wisdom, suppression therapy might someday aid in the treatment of mood and cognitive disorders. Because intentional forgetting depends on controlling which thoughts and memories seep into our awareness, the science of rejected recollections might also help scientists understand consciousness.

## Cleaning the House of Memory

For most people, the concept of forgetting conjures up lost car keys, missed appointments and poor scores on exams. Worse, it augurs dementia. Psychologists traditionally shared this view, and most of them studied memory with an eye toward closing the cracks through which knowledge can slip. Even shutting out disturbing emotional memories was long considered bad form. In the early 1900s Freud proposed that people tend to block out negative recollections as a defense mechanism. According to his theory, individuals need to revisit these memories to promote psychological recovery.

An early challenge to that downbeat view of forgetting emerged in 1970, when psychologist Robert A. Bjork, now at the University of California at Los Angeles, reported that instructions to forget some learned items could enhance memory for others. Forgetting is therefore not a sign of an inferior intellect—but quite the opposite. The purpose of forgetting, he wrote, is to prevent thoughts no longer needed from interfering with the handling of current information—akin to ridding your home of extraneous objects so that you can find what you need. “When people voice complaints about their memory, they invariably assume that the problem is one of insufficient retention of information,” Bjork wrote. “In a very real sense, however, the problem may be at least partly a matter of insufficient or inefficient forgetting.”

Few scientists subscribed to Bjork’s ideas at first, still considering forgetting to be antithetical to learning and memory. Then, in the 1990s, Bjork, along with his wife Elizabeth L. Bjork and his graduate student Michael C. Anderson, all then at U.C.L.A., identified another purpose to letting knowledge go—a phenomenon they called retrieval-induced for-

### FAST FACTS

#### The Art of Forgetting

- 1» We can will ourselves to forget; a neural circuit like the one that inhibits actions governs the ability to reject memories we neither want nor need.
- 2» Emerging data provide support for Sigmund Freud’s controversial theory of repression, by which unwanted memories are shoved into the subconscious.
- 3» The inability to forget can impede emotional recovery in trauma victims; it is also associated with attention-deficit hyperactivity disorder.
- 4» If you practice rebuffering recollections, you are likely to get better at it.

getting. They found that deliberately revisiting certain stored information impedes later recall of material very similar to it. The process is adaptive because it eliminates or tones down memories that are most likely to obstruct more important thoughts. It enables the route you drive to a friend's new house, for example, to overshadow the way you went to her previous abode. "If you forget things, there is less interference with the stuff you do want to keep," says psychologist John Jonides of the University of Michigan at Ann Arbor. "That is a big boost to memory."

This boost is thought to rely on the brain's prefrontal cortex, which sits roughly behind the fore-

the word that went with it or to suppress (not think about) the associated word.

Suppression seemed to work. The students even recalled fewer of the suppressed word associations than the "baseline" words—ones they learned but neither practiced nor inhibited. And the more times the students tried to block the memory of a word pair, the worse that memory was; that is, the more they *tried* to forget the more they *did* forget. In contrast, their recollection for a word pair improved as they recited it repeatedly. When the researchers gave the students new cues for the same words, the students again had the most trouble coming up

## Psychologists have now found scientific support for Sigmund Freud's controversial theory of repression.

head. The prefrontal cortex is home to the brain's so-called executive functions, which include planning, calculating and reasoning, as well as control over our impulses. Many areas of the prefrontal cortex are thought to be inhibitory; they calm the responses of neurons in other parts of the brain. When we feel like lashing out at a spouse for coming home late or leaving the house a mess, for example, cells in these regions (if they are working that day) keep us from raising our voice. More prosaically, they can stop us from reflexively running after a ball that has been knocked into a busy street.

Researchers surmised that some of these same inhibitory neurons could work on memory. In the case of retrieval-induced forgetting, the inhibition occurs unintentionally, beneath our awareness. But about 10 years ago Anderson, then a cognitive psychologist at the University of Oregon, wondered if people could exert conscious control over their memories. Can we will ourselves to forget? After all, we often want to forget things, whether for emotional or intellectual reasons.

### Repression Revisited

To test his idea, Anderson constructed a memory version of a task called go/no-go that is used to assess a person's ability to inhibit actions. In a study published in 2001 Anderson and his student Collin Green, now at the NASA Ames Research Center, gave 32 college students what they called a think/no-think task. The students learned 40 word pairs such as ordeal-roach, with the first word serving as a cue for the second. Next they presented the cues and asked participants either to think about and say

with the suppressed words, showing that they had forgotten those words. These findings suggest that the brain can tamp down unwanted memories, as Freud suggested. Although Freud thought repressed memories came back to haunt us, the new data indicate that people can make such recollections fade into the background (although for how long is still unclear). Doing so may therefore be an important way of regulating our emotions and thoughts. Letting miscellaneous notions wander into our mind in response to reminders is a cognitive version of a motor reflex, says Anderson, who is now at the Medical Research Council's Cognition and Brain Sciences Unit in Cambridge, England. "We don't always want to act reflexively," he says. "That's what makes us human."

### Machinery of Restraint

Within a few years Anderson and others had sketched out the brain regions undergirding this memory control. In 2004 he, along with psychologist John Gabrieli, then at Stanford, and their colleagues, used functional MRI to scan the brains of participants as they performed the think/no-think task. By looking at the contrast between scans generated when a person was supposed to remember the words with those from when they tried to forget, the researchers associated memory suppression with greater activity in two regions of the prefrontal cor-

### (The Author)

INGRID WICKELGREN is an editor at *Scientific American Mind* and author of the blog *Streams of Consciousness* on [ScientificAmerican.com](http://ScientificAmerican.com).

tex—the aforementioned region devoted to planning and oversight—and diminished activity in the hippocampus, an area responsible for both binding components of a memory together and reactivating it [see “Making Connections,” by Anthony J. Greene; *SCIENTIFIC AMERICAN MIND*, July/August 2010].

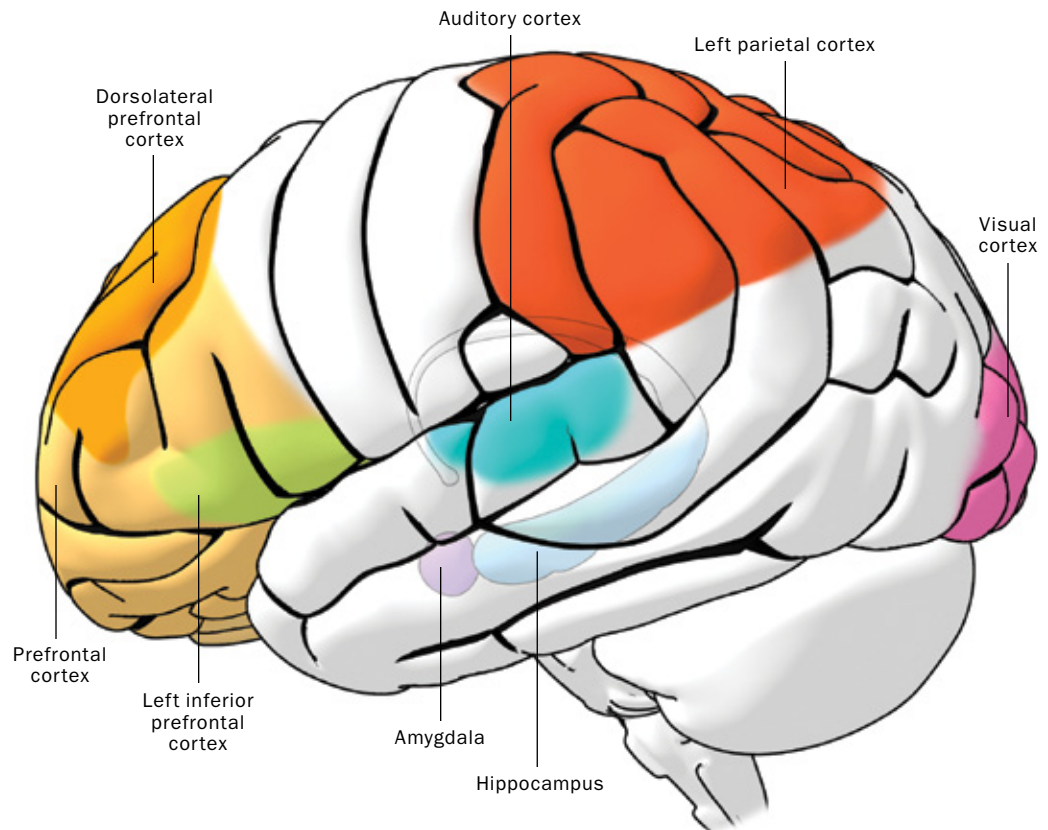
Items that were later remembered produced more activity in the hippocampus than did items that would be forgotten, a pattern that thus forecast which pairs were successfully suppressed. Meanwhile the engagement of the prefrontal cortex foretold the likelihood of forgetting in an individual: more activation meant more inhibitory power.

Cognitive neuroscientist Brendan Depue of the University of Colorado at Boulder and his colleagues decided to examine how emotion might affect those results. In a 2006 study Depue’s team tested subjects on their ability to learn, remember and suppress as-

sociations between faces with neutral expressions and several other stimuli—words that are negative (such as “deformed”) or neutral (“lantern,” for example) or pictures that were either unpleasant or unemotional. They found not only that suppression worked for this task but that it is even stronger if the stimuli are negative, hinting that people may have more power over emotional memories than neutral ones. Moreover, when individuals are exerting this control, Depue and his colleagues reported in 2007, sensory parts of the brain, including the visual cortex, first go silent, as if the brain is trying to rid itself of recollected imagery. As people continue to practice holding back a thought, both the hippocampus and the amygdala, a key player in processing emotions, quiet down. Once the visions of the experience fade, Depue theorizes, the brain tries to minimize the emotions still clinging to it and strives to degrade

## Forgetting to Remember

A patchwork of brain areas play roles in forgetting—and remembering. In the prefrontal cortex, the dorsolateral region governs memory suppression, whereas the left inferior part aids in the construction of stronger emotional memories. The hippocampus is the hub of memory formation. It is accompanied by its sidekick, the amygdala, when feelings are involved. Visual and auditory regions go silent when the mind is shutting down recollections. An analogous quieting occurs over the parietal cortex, as evidenced by a shrinking of the brain-wave signal detected there.



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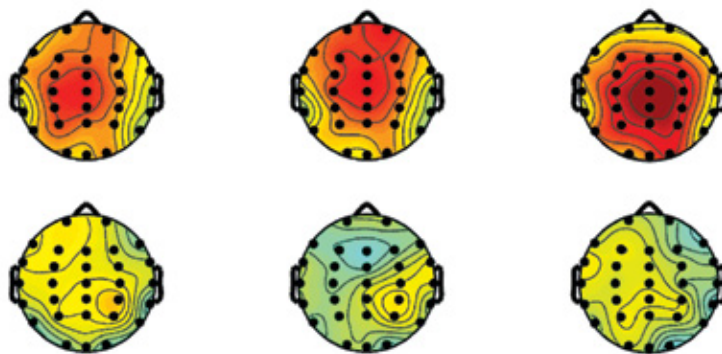
the memory as a whole. The region running the show was, as usual, the prefrontal cortex.

Bergström and her colleagues have now identified a brain signal that marks the moment of forgetting. Using electroencephalography, her team taps into the electrical fields generated by neurons through electrodes affixed to the scalp. Changes in these fields instantaneously reflect new cognitive events. One wave of activity detected near the crown of the head is related to the amount of recollected information, according to Bergström's latest data. The larger the signal, the more detailed the memory. In a study published in 2007 Bergström and her colleagues saw this signal shrink within half a second of an attempt to suppress a memory that had been elicited by a cue. In 2009 the same group reported that only concerted efforts to suppress a memory, without thinking about anything else, provoked this electrical sign of forgetting. "The signal related to the recollection was reduced to the point where it looked like they were not remembering much at all," Bergström says.

When people instead used thought substitution—a technique that involves replacing the idea you want to stop with another—the memory signal did not shrink. Although the participants doing such switches did forget some of the word associations they had learned, their forgetting was less complete, suggesting it occurred by a different mechanism, Bergström says [see illustration on this page].

### Too Much Memory

Forgetting does not come easily to everyone. The best performers in Anderson's experiments forgot up to 60 percent of the material they tried to block—an impressive feat for just a little more than one minute of practice. Mild versions of Shereshevsky, in



Maps of the brain show voltage differences over the crown of the head (parietal cortex) about half a second after people try to suppress memories (top row) but not following attempts to substitute one thought for another (bottom). The colors represent the difference in voltage between trials in which a word was later forgotten and those in which it was remembered. A positive difference (red) shows that forgetting follows a brain potential that was reduced relative to remembering. Yellow and greenish hues indicate little or no discrepancy between the two.

In one experiment, published in 2003, psychologist Paula T. Hertel of Trinity University in San Antonio and Melissa Gerstle, now at the Texas Children's Hospital and Baylor College of Medicine, found that depressed students recalled many more words they had practiced suppressing than other students did. The students who had the most trouble forgetting scored the highest on measures of rumination—which is the tendency to dwell on a concern—and the frequency of unwanted thoughts.

Poor memory control can also accompany other cognitive problems—inattention, in particular. In 2010 Depue's group reported that people with ADHD had more trouble forgetting face-picture pairs in a think/no-think task than individuals did without the disorder. The more severe a person's ADHD, the more difficulty he or she had on this task. A distinct pattern of brain activation seemed

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contrast, strained to erase the traces of the word pairs, in some cases recalling them *better* after many suppression attempts. “There’s a huge range in how effective people are at forgetting,” Levy says.

This skill, or lack of it, has ripple effects on personality. If you cannot shake negative memories, for example, you might be easily sucked into a bad mood. Although the inability to forget does not cause depression, research shows that depressed patients have difficulty putting aside dark thoughts.

to underlie these deficits: the prefrontal cortex was less active during the suppression tasks in the patients than in the others. Even after 10 to 12 attempts to block an association, the hippocampus and amygdala, which together record emotional memories, showed no signs of shutdown in those with ADHD. Thus, ADHD seems to involve diminished control over memory as well as actions. This shortfall opens the door to distracting thoughts that can disrupt efforts to concentrate.

Perhaps not surprisingly, those with good executive function excel at memory suppression. One measure of executive function is so-called working memory, a mental workspace that enables you to hold and manipulate information in your mind to, say, read or perform mental calculations. In two recent experiments, not yet published, Anderson and Ted Bell, a psychologist at the University of Oregon, tested people's working memory by asking them to hold an ever lengthening list of words in their mind while performing mental calculations. The individuals who could remember the most words were also the best forgetters in a think/no-think task. "Keeping things in mind is related to keeping things out of mind," Anderson quips.

For the average person, the ability to forget goes up and down over the years just as executive function does. In 2009 Anderson, neuroscientist Pedro M. Paz-Alonso of the University of California, Berkeley, and their colleagues reported that memory suppression improves between age eight and 12, when it approaches the level seen in young adults. At the end of life, forgetting again becomes more difficult. In a study published in 2011 Anderson and his colleagues discovered that elderly adults had more trouble than those aged 18 to 25 keeping an experience out of con-

ories is on the horizon [see "Totaling Recall," by Adam Piore, on page 40]. Nevertheless, people might be coached to forget.

In psychology experiments, 10 to 20 attempts to block a memory reliably lead to forgetting in many people, Bäuml says. Thus, in theory, you could bury a recollection by shutting it out every day for a month. Bäuml has also found a way to enhance the effect. In 2010 he and his colleagues gave college students performing the think/no-think task one second of advance notice about having to suppress (or recall) a word they had associated with a face. The warning improved performance: the students who could prepare to apply their mental brakes forgot more of those words than did those who received the cue at the same time as the instruction to suppress. So when you have to enter a situation that is likely to trigger difficult memories, think about the need to put these out of mind ahead of time, and you may find yourself better able to do so.

Practicing suppression over years might also make you better at it. Anderson, along with his graduate student Justin Hulbert and neuroscientist Brice Kuhl of Yale University, showed that college students who had experienced serious trauma—say, from the death of a loved one, a rape or a natural disaster—

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sciousness when reminded of it. "Kids and older adults have a hard time getting rid of this stuff," says psychologist Karl-Heinz Bäuml of Regensburg University in Germany. As a result, Bäuml surmises, both age groups may have particular problems recovering from unpleasantness in life.

### Eternal Sunshine

In the 2004 movie *Eternal Sunshine of the Spotless Mind*, Clementine (Kate Winslet) has a falling-out with her boyfriend, Joel (Jim Carrey), so she has him erased from her mind. As the doctor, Howard (Tom Wilkinson), explains to Joel, "She was not happy; she wanted to move on. We provide that possibility." Howard's services are summed up neatly by his adoring assistant: "Adults are this mess of sadness, phobias ... Howard just makes it all go away," she says.

If only. Researchers are investigating pharmaceutical ways of finessing forgetting, but no fool-proof medical means for erasing troublesome mem-

were consistently better at blocking words when reminded of them than were undergraduates who had suffered little. Therefore, a long-term effort to keep a bad memory out of mind may hone your inhibitory skills. Of course, trauma victims who make it to college may have good executive control to begin with.

Indeed, because of such individual differences, suppression alone might not work well for everyone. In a 2009 study Hertel, Jutta Joormann of the University of Miami and their colleagues had adults who were depressed memorize unrelated pairs of nouns, each consisting of an emotionally neutral word plus either a positive or negative term—mushroom-hostage, for example, or curtain-humor. They then practiced the positive pairs and suppressed the negative ones, although some of the subjects used a thought-substitution strategy in which they replaced the target word with a different one. When they were tested on the material, the depressed people who used suppression did not forget any more of the negative words than they did the words they did not try to



Intentional memory suppression may not work for everyone. But someday it might form the basis of a new psychotherapy for post-traumatic stress and other mood disorders.

suppress. In contrast, the patients who used thought substitution saw about a 25 percent drop in recall after just two opportunities to practice the technique. The results suggest that those who are depressed cannot just push away unwanted memories; they may need to actively replace them.

Some psychologists advocate neither method. Another way to forget, says cognitive psychologist Tracy Tomlinson of the University of Maryland, is simply to do something distracting at the moment of recall. In a study published in 2009 Tomlinson and her colleagues found that individuals who pressed the enter key whenever the cue for a word appeared forgot just as many words as those who tried to mentally block the words from coming to mind. “People don’t have to actively search for a memory and then stomp it out,” Tomlinson says. “Action interferes with recollection.”

None of these methods of personal mind control has been refined for clinical use. Clearly, people can forget upsetting words or terrified faces, but their ability to shut out deeply personal emotional memories, such as those of sexual abuse, remains uncertain, Tomlinson says. Nevertheless, researchers hope to parlay some kind of forgetting into treatments for mood disorders, including depression and post-traumatic stress, and perhaps obsessive-compulsive disorder.

Some situations should not simply be put out of mind, of course, because they could recur or may need to be assessed for other reasons. Even here, forgetting may play a role. In helping patients reinterpret an experience, therapists may inadvertently induce memory loss by emphasizing the event’s uplift-

ing aspects. In so doing, they may change the relative accessibility of positive and negative memories, such that the uplifting ones spring to mind more readily. In this way, forgetting in its many guises may be the secret agent behind much of mental health.

It also may help crack the code of consciousness. The ingredients of conscious awareness come not only from our senses, which monitor the external world, but also from our thoughts and memories, of which we can also be aware—or unaware. Knowing how people willfully exclude such internal abstractions from their minds could teach us about how consciousness works in general, Anderson says. “What is there for us other than our moment-to-moment conscious experience?” he asks. “If we can understand that, we will touch what is fundamental to people.” **M**

### (Further Reading)

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- ◆ **Inhibitory Control of Memory Retrieval and Motor Processing Associated with the Right Lateral Prefrontal Cortex: Evidence from Deficits in Individuals with ADHD.** B. E. Depue, G. C. Burgess, E. G. Willcutt, L. Ruzic and M. T. Banich in *Neuropsychologia*, Vol. 48, No. 13, pages 3909–3917; November 2010.
- ◆ **Interference Resolution in Major Depression.** Jutta Joormann, Derek Evan Nee, Marc G. Berman, John Jonides and Ian H. Gotlib in *Cognitive, Affective and Behavioral Neuroscience*, Vol. 10, No. 1, pages 21–33; March 2010.
- ◆ **Intentional Suppression of Unwanted Memories Grows More Difficult as We Age.** M. C. Anderson, J. Reinholz, B. A. Kuhl and U. Mayr in *Psychology and Aging*, Vol. 26, No. 2, pages 397–405; June 2011.