Memory: Why We Remember, Why We Forget

BY JOSHUA FOER

PHOTOGRAPHS BY MAGGIE STEBER

There is a 41-year-old woman, an administrative assistant from California known in the medical literature only as "AJ," who remembers almost every day of her life since age 11. There is an 85-year-old man, a retired lab technician called "EP," who remembers only his most recent thought. She might have the best memory in the world. He could very well have the worst.

"My memory flows like a movie—nonstop and uncontrollable," says AJ. She remembers that at 12:34 p.m. on Sunday, August 3, 1986, a young man she had a crush on called her on the telephone. She remembers what happened on *Murphy Brown* on December 12, 1988. And she remembers that on March 28, 1992, she had lunch with her father at the Beverly Hills Hotel. She remembers world events and trips to the grocery store, the weather and her emotions. Virtually every day is there. She's not easily stumped.

There have been a handful of people over the years with uncommonly good memories. Kim Peek, the 56-year-old savant who inspired the movie *Rain Man*, is said to have memorized nearly 12,000 books (he reads a page in 8 to 10 seconds). "S," a Russian journalist studied for three decades by the Russian neuropsychologist Alexander Luria, could remember impossibly long strings of words, numbers, and nonsense syllables years after he'd first heard them. But AJ is unique. Her extraordinary memory is not for facts or figures, but for her own life. Indeed, her inexhaustible memory for autobiographical details is so unprecedented and so poorly understood that James McGaugh, Elizabeth Parker, and Larry Cahill, the neuroscientists at the University of California, Irvine, who have been studying her for the past seven years, had to coin a new medical term to describe her condition: hyperthymestic syndrome.

EP is six-foot-two, with perfectly parted white hair and unusually long ears. He's personable,

The 85-year-old California man researchers call "EP" dwells almost entirely in the present tense. A brain infection wiped out decades of memories, along with the capacity to create new ones.

friendly, gracious. He laughs a lot. He seems at first like your average genial grandfather. But 15 years ago, the herpes simplex virus chewed its way through his brain, coring it like an apple. By the time the virus had run its course, two walnut-size chunks of brain matter in the medial temporal lobes had disappeared, and with them most of EP's memory.

The virus struck with freakish precision. The medial temporal lobes—there's one on each side of the brain—include a curved structure called the hippocampus and several adjacent regions that together perform the magical feat of turning our perceptions into long-term memories. The memories aren't actually stored in the hippocampus—they reside elsewhere, in the brain's corrugated outer layers, the neocortex—but the hippocampal area is the part of the brain that makes them stick. EP's hippocampus was destroyed, and without it he is like a camcorder without a working tape head. He sees, but he doesn't record.

EP has two types of amnesia—anterograde, which means he can't form new memories, and retrograde, which means he can't remember old memories either, at least not since 1960. His childhood, his service in the merchant marine, World War II—all that is perfectly vivid. But as far as he knows, gas costs less than a dollar a gallon, and the moon landing never happened.

AJ and EP are extremes on the spectrum of human memory. And their cases say more than any brain scan about the extent to which our memories make us who we are. Though the rest of us are somewhere between those two poles of remembering everything and nothing, we've all experienced some small taste of the promise of AJ and dreaded the fate of EP. Those three pounds or so of wrinkled flesh balanced atop our spines can retain the most trivial details about childhood experiences for a lifetime but often can't hold on to even the most important telephone number for just two minutes. Memory is strange like that.

What is a memory? The best that neuroscientists can do for the moment is this: A memory is a stored pattern of connections between neurons in the brain. There are about a hundred billion of those neurons, each of which can make perhaps 5,000 to 10,000 synaptic connections with other neurons, which makes a total of about five hundred trillion to a thousand trillion synapses in the average adult brain. By comparison there are only about 32 trillion bytes of information in the entire Library of Congress's print collection. Every sensation we remember, every thought we think, alters the connections within that vast network. Synapses are strengthened or weakened or formed anew. Our physical substance changes. Indeed, it is always changing, every moment, even as we sleep.

I met EP at his home, a bright bungalow in suburban San Diego, on a warm spring day. I drove there with Larry Squire, a neuroscientist and memory researcher at the University of California, San Diego, and the San Diego VA Medical Center, and Jen Frascino, the research coordinator in Squire's lab who visits EP regularly to administer cognitive tests. Even though Frascino has been to EP's home some 200 times, he always greets her as a stranger.

Frascino sits down opposite EP at his dining room table and asks a series of questions that gauge his common sense. She quizzes him about what continent Brazil is on, the number of weeks in a year, the temperature water boils at. She wants to demonstrate what IQ tests have already proved: EP is no dummy. He patiently answers the questions—all correctly—with roughly the

Joshua Foer's book about the art and science of memory will be published in 2009. Maggie Steber grew up with her mother, Madje, a parasitologist, in Austin, Texas.

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same sense of bemusement I imagine I would have if a total stranger walked into my house, sat down at my table, and very earnestly asked me if I knew the boiling point of water.

"What is the thing to do if you find an envelope in the street that is sealed, addressed, and has a stamp on it?" Frascino asks.

"Well, you'd put it in the mailbox. What else?" He chuckles and shoots me a sidelong and knowing glance, as if to say, Do these people think I'm an idiot? But sensing that the situation calls for politeness, he turns back to Frascino and adds, "But that's a really interesting question you've got there. Really interesting." He has no idea he's heard it many times before.

"Why do we cook food?"

"Because it's raw?" The word raw carries his voice clear across the tonal register, his bemusement giving way to incredulity.

"Why do we study history?"

"Well, we study history to know what happened in the past."

"But why do we want to know what happened in the past?"

"Because, it's just interesting, frankly."

EP wears a metal medical alert bracelet around his left wrist. Even though it's obvious what it's for, I ask him anyway. He turns his wrist over and casually reads it.

"Hmm. It says memory loss."

EP doesn't even remember that he has a memory problem. That is something he discovers anew every moment. And since he forgets that he always forgets, every lost thought seems like just a casual slip—an annoyance and nothing more—the same way it would to you or me.

Ever since his sickness, space for EP has existed only as far as he can see it. His social universe is only as large as the people in the room. He lives under a narrow spotlight, surrounded by darkness.

On a typical morning, EP wakes up, has breakfast, and returns to bed to listen to the radio. But back in bed, it's not always clear whether he's just had breakfast or just woken up. Often he'll have breakfast again, and return to bed to listen to some more radio. Some mornings he'll have breakfast a third time. He watches TV, which can be very exciting from second to second, though shows with a clear beginning, middle, and end can pose a problem. He prefers the History Channel, or anything about World War II. He takes walks around the neighborhood, usually several times before lunch, and sometimes for as long as three-quarters of an hour. He sits in the yard. He reads the newspaper, which one can only imagine must feel like stepping out of a time machine. Bush who? Iraq what? Computers when? By the time EP gets to the end of a headline, he's usually forgotten how it began. Most of the time, after reading the weather, he just doodles on the paper, drawing mustaches on the photographs or tracing his spoon. When he sees home prices in the real estate section, he invariably announces his shock.

Without a memory, EP has fallen completely out of time. He has no stream of consciousness, just droplets that immediately evaporate. If you were to take the watch off his wrist—or, more cruelly, change the time—he'd be completely lost. Trapped in this limbo of an eternal present, between a past he can't remember and a future he can't contemplate, he lives a sedentary life, completely free from worry. "He's happy all the time. Very happy. I guess it's because he doesn't

have any stress in his life," says his daughter, Carol, who lives nearby.

"How old are you now?" Squire asks him.

"Let's see, 59 or 60. You got me. My memory is not that perfect. It's pretty good, but sometimes people ask me questions that I just don't get. I'm sure you have that sometimes."

"Sure, I do," says Squire, kindly, even though EP is almost a quarter of a century off.

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The metaphors we most often use to describe memory—the photograph, the tape recorder, the mirror, the hard drive—all suggest mechanical accuracy, as if the mind were some sort of meticulous transcriber of our experiences. And for a long time it was a commonly held view that our brains function as perfect recorders—that a lifetime of memories are socked away somewhere in the cerebral attic, and if they can't be found it isn't because they've disappeared, but only because we've lost access to them.

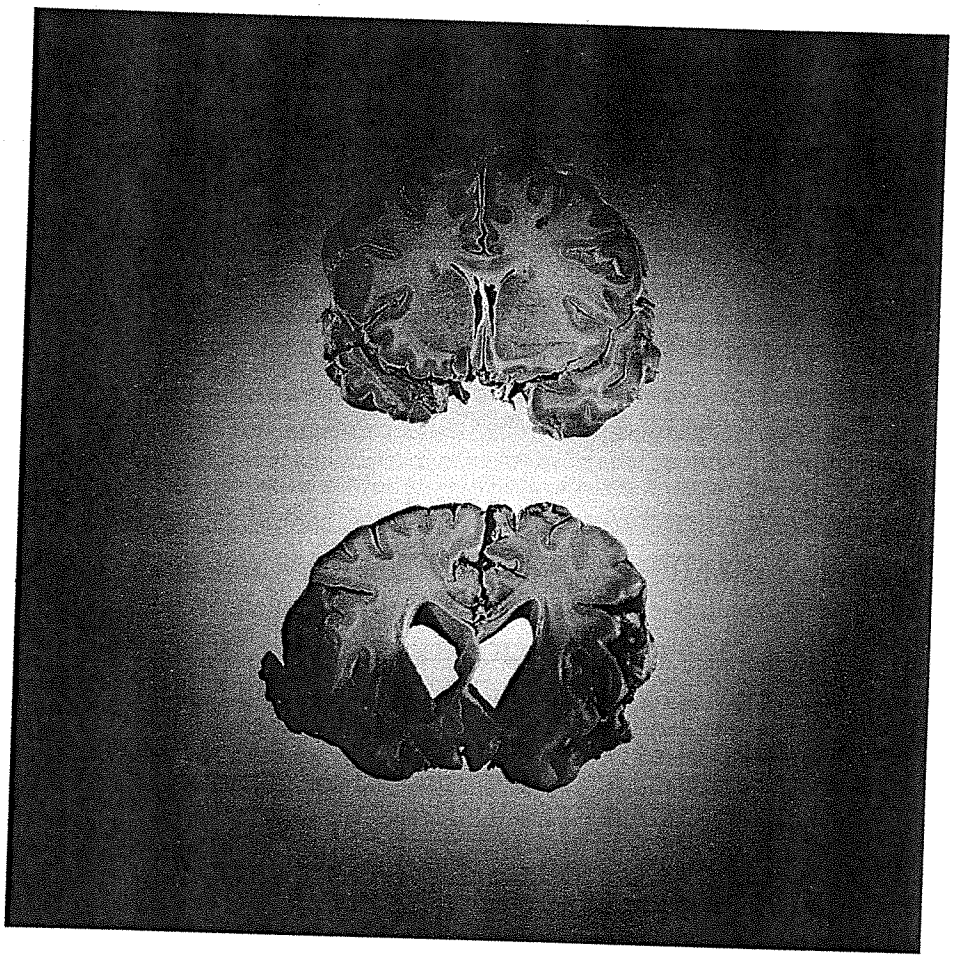
A Canadian neurosurgeon named Wilder Penfield thought he'd proved that theory by the 1940s. Penfield used electrical probes to stimulate the brains of epileptic patients while they were lying conscious on the operating table. He was trying to pinpoint the source of their epilepsy, but he found that when his probe touched certain parts of the temporal lobe, the patients started describing vivid experiences. When he touched the same spot again, he often elicited the same descriptions. Penfield came to believe that the brain records everything to which it pays any degree of conscious attention, and that this recording is permanent.

Most scientists now agree that the strange recollections triggered by Penfield were closer to fantasies or hallucinations than to memories, but the sudden reappearance of long-lost episodes from one's past is an experience surely familiar to everyone. Still, as a recorder, the brain does a notoriously wretched job. Tragedies and humiliations seem to be etched most sharply, often with the most unbearable exactitude, while those memories we think we really need—the name of the acquaintance, the time of the appointment, the location of the car keys—have a habit of evaporating.

Michael Anderson, a memory researcher at the University of Oregon in Eugene, has tried to estimate the cost of all that evaporation. According to a decade's worth of "forgetting diaries" kept by his undergraduate students (the amount of time it takes to find the car keys, for example), Anderson calculates that people squander more than a month of every year just compensating for things they've forgotten.

AJ remembers when she first realized that her memory was not the same as everyone else's. She was in the seventh grade, studying for finals. "I was not happy because I hated school," she says. Her mother was helping her with her homework, but her mind had wandered elsewhere. "I started thinking about the year before, when I was in sixth grade and how I loved sixth grade. But then I started realizing that I was remembering the exact date, exactly what I was doing a year ago that day." At first she didn't think much of it. But a few weeks later, playing with a friend, she remembered that they had also spent the day together precisely one year earlier.

"Each year has a certain feeling, and then each time of year has a certain feeling. The spring of 1981 feels completely different from the winter of 1981," she says. Dates for AJ are like the petite madeleine that sent Marcel Proust's mind hurtling back in time in *Remembrance of Things Past.* Their mere mention starts her reminiscing



A disease-free brain (top) shows intact temporal lobes along its lower flanks and, in the center, slender ventricles filled in life with cerebrospinal fluid. In a brain battered by Alzheimer's disease, the temporal lobes—a seat of memory and language—have been ravaged, and ventricles gape into voids left by cell death.

involuntarily. "You know when you smell something, it brings you back? I'm like ten levels deeper and more intense than that.

"My brother used to say, 'Oh, she's the Rain Man.' And I was like, 'No I'm not!' But I thought, what if I really. . . . Am I? Is there something wrong with me?" At one point AJ considered setting up shop on the nearby boardwalk as the Human Calendar and charging people five bucks to let them try to stump her with dates. She decided against it. "I don't want to be a sideshow."

It would seem as though having a memory like AJ's would make life qualitatively different—and better. Our culture inundates us with new information, yet so little of it is captured and cataloged in a way that it can be retrieved later. What would it mean to have all that otherwise lost knowledge at our fingertips? Would it make us more persuasive, more confident? Would it make us, in some fundamental sense, smarter? To the extent that experience is the sum of our memories and wisdom the sum of experience, having a better memory would mean knowing not only more about the world, but also more about oneself. How many worthwhile ideas have gone unthought and connections unmade because of our memory's shortcomings?

The dream that AJ embodies, the perfection of memory, has been with us since at least the

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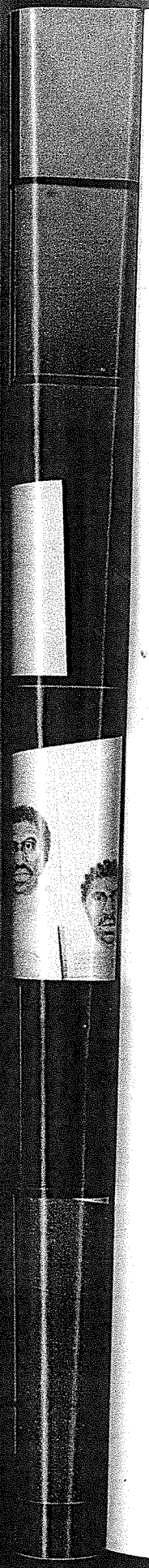


OVER THE PAST MILLENNIUM, MANY OF US HAVE UNDERGONE A PROFOUND SHIFT. We've gradually replaced our internal memory with a vast superstructure of technological crutches that we've invented so that we don't have to store information in our brains.

fifth century B.C. and the supposed invention of a technique known as the "art of memory" by the Greek poet Simonides of Ceos.

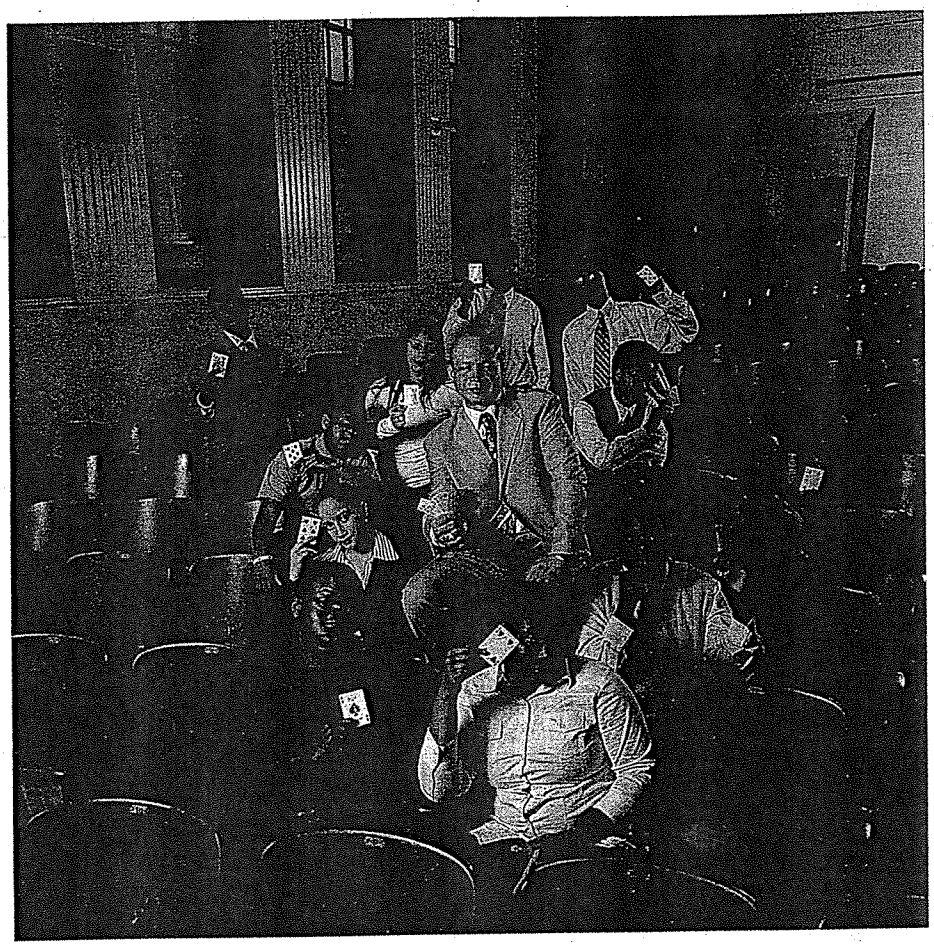
Simonides had been the sole survivor of a catastrophic roof collapse at a banquet hall in Thessaly. According to Cicero, who wrote an account of the incident four centuries later, the bodies were mangled beyond recognition. But Simonides was able to close his eyes to the chaos and see in his mind each of the guests at his seat around the table. He'd discovered the loci method. If you can convert whatever it is you're trying to remember into vivid mental images and then arrange them in some sort of imagined architectural space, known as a memory palace, memories can be made virtually indelible.

Peter of Ravenna, a noted Italian jurist and author of a renowned memory textbook of the 15th century, was said to have used the loci method to memorize the Bible, the entire legal canon, 200 of Cicero's speeches, and 1,000 verses of Ovid. For leisure, he would reread books cached away in his memory palaces. "When I left my country to visit as a pilgrim the cities of Italy, I can truly say I carry everything I own with me," he wrote.

It's hard for us to imagine what it must have been like to live in a culture before the advent of printed books or before you could carry around a ballpoint pen and paper to jot notes. "In a world of few books, and those mostly in communal libraries, one's education had to be remembered, for one could never depend on having continuing access to specific material," writes Mary Carruthers, author of *The Book of Memory*, a study of the role of memory techniques in medieval culture. "Ancient and medieval people reserved their awe for memory. Their greatest geniuses they describe as people of superior memories." Thirteenth-century theologian Thomas Aquinas, for example, was celebrated for composing his *Summa Theologica* entirely in his head and dictating it from memory with no more than a few notes. Roman philosopher Seneca the Elder could repeat 2,000 names in the order they'd been given to him. Another Roman named Simplicius could recite Virgil by heart —backward. A strong memory was seen as the greatest of virtues since it represented the internalization of a universe of external knowledge. Indeed, a common theme in the lives of the saints was that they had extraordinary memories.

After Simonides' discovery, the art of memory was codified with an extensive set of rules and instructions by the likes of Cicero and Quintilian and in countless medieval memory treatises. Students were taught not only what to remember but also techniques for how to remember it. In fact, there are long traditions of memory training in many cultures. The Jewish Talmud,

Jeanne Boylan recovers fragmented impressions of shapes and textures etched deep in memory by trauma. The veteran forensic artist, who has helped solve some of the most notorious crimes of the past 30 years, says her crucial skill is not drawing, but simply listening—often for hours. "Witnesses surprise themselves," she says, "with what they remember."



Memorizing sequences of playing cards, a classic mental exercise, helps Raemon Matthews's students at Samuel Gompers High School in New York's South Bronx hone their skills for tougher academic challenges. Almost a fourth of the competitors in this year's USA Memory Championships were Matthews's pupils.

embedded with mnemonics—techniques for preserving memories—was passed down orally for centuries. Koranic memorization is still considered a supreme achievement among devout Muslims. Traditional West African griots and South Slavic bards recount colossal epics entirely from memory.

But over the past millennium, many of us have undergone a profound shift. We've gradually replaced our internal memory with what psychologists refer to as external memory, a vast superstructure of technological crutches that we've invented so that we don't have to store information in our brains. We've gone, you might say, from remembering everything to remembering awfully little. We have photographs to record our experiences, calendars to keep track of our schedules, books (and now the Internet) to store our collective knowledge, and Post-it notes for our scribbles. What have the implications of this outsourcing of memory been for ourselves and for our society? Has something been lost?