PROFILES APRIL 25, 2011 ISSUE

THE POSSIBILIAN

What a brush with death taught David Eagleman about the mysteries of time and the brain.

By Burkhard Bilger
April 18, 2011

When David Eagleman was eight years old, he fell off a roof and kept on falling. Or so it seemed at the time. His family was living outside Albuquerque, in the foothills of the Sandia Mountains. There were only a few other houses around, scattered among the bunchgrass and the cholla cactus, and a new construction site was the Eagleman boys' idea of a perfect playground. David and his older brother, Joel, had ridden their dirt bikes to a half-finished adobe house about a quarter of a mile away. When they'd explored the rooms below, David scrambled up a wooden ladder to the roof. He stood there for a few minutes taking in the view—west across desert and subdivision to the city rising in the distance—then walked over the newly laid tar paper to a ledge above the living room. "It looked stiff," he told me recently. "So I stepped onto the edge of it."

"Time is this rubbery thing," Eagleman said. The best example of that is the so-called oddball effect. Photograph by Dan Winters

In the years since, Eagleman has collected hundreds of stories like his, and they almost all share the same quality: in life-threatening situations, time seems to slow down. He remembers the feeling clearly, he says. His body stumbles forward as the tar paper tears free at his feet. His hands stretch toward the ledge, but it's out of reach. The brick floor floats upward—some shiny nails are scattered across it—as his body rotates weightlessly above the ground. It's a moment of absolute calm and eerie mental acuity. But the thing he remembers best is the thought that struck him in midair: this must be how Alice felt when she was tumbling down the rabbit hole.

Eagleman is thirty-nine now and an assistant professor of neuroscience at Baylor College of Medicine, in Houston. Physically, he seems no worse for the fall. He did a belly flop on the bricks, he says, and his nose took most of the impact. "He made a one-point landing," as his father puts it. The cartilage was so badly smashed that an emergency-room surgeon had to remove it all, leaving Eagleman with a rubbery proboscis that he could bend in any direction. But it stiffened up eventually, and it's hard to tell that it was ever injured. Eagleman has puckish, neatly carved features, with a lantern jaw and modish sideburns. In Baylor's lab-coated corridors, he wears designer jeans and square-toed ankle boots, and walks with a bounce in his step that's suspiciously close to a strut, like Pinocchio heading off to Pleasure Island.

If Eagleman's body bears no marks of his childhood accident, his mind has been deeply imprinted by it. He is a man obsessed by time. As the head of a lab at Baylor, Eagleman has spent the past decade tracing the neural and psychological circuitry of the brain's biological clocks. He has had the good fortune to arrive in his field at the same time as fMRI scanners, which allow neuroscientists to observe the brain at work, in the act of thinking. But his best results have often come through more inventive means: video games, optical illusions, physical challenges. Eagleman has a talent for testing the untestable, for taking seemingly sophomoric notions and using them to nail down the slippery stuff of consciousness. "There are an infinite number of boring things to do in science," he told me. "But we live these short life spans. Why not do the thing that's the coolest thing in the world to do?"

The Eagleman lab, on the ground floor of Baylor's Ben Taub General Hospital, could be the lair of a precocious but highly distractible teen-ager. The doors are pinned with cartoons, the counters strewn with joysticks and other gizmos. The conference table is flanked by a large red rubber ball, for use as a chair or a Hippity Hop. When Eagleman first moved in, he had the walls painted baby blue, with a shiny finish designed to be erasable. By now, they've been covered from floor to ceiling with equations, graphs, time lines, to-do lists, aphorisms, and sketches of brain waves—a Pollocky palimpsest of red, green, purple, and black scribblings. "The old stuff is really hard to erase," Eagleman told me. "It's like memory that way."

Although Eagleman and his students study timing in the brain, their own sense of time tends to be somewhat unreliable. Eagleman wears a Russian wristwatch to work every morning, though it's been broken for months. "The other day, I was in the lab," he told me, "and I said to Daisy, who sits in the corner, 'Hey, what time is it?' And she said, 'I don't know. My watch is broken.' It turns out that we're all wearing broken watches." Scientists are often drawn to things that bedevil them, he said. "I know one lab that studies nicotine receptors and all the scientists are smokers, and another lab that studies impulse control and they're all overweight." But Eagleman's ambivalence goes deeper. Clocks offer at best a convenient fiction, he says. They imply that time ticks steadily, predictably forward, when our experience shows that it often does the opposite: it stretches and compresses, skips a beat and doubles back.

The brain is a remarkably capable chronometer for most purposes. It can track seconds, minutes, days, and weeks, set off alarms in the morning, at bedtime, on birthdays and anniversaries. Timing is so essential to our survival that it may be the most finely tuned of our senses. In lab tests, people can distinguish between sounds as little as five milliseconds apart, and our involuntary timing is even quicker. If you're hiking through a jungle and a tiger growls in the underbrush, your brain will instantly home in on the sound by comparing when it reached each of your ears, and triangulating between the three points. The difference can be as little as nine-millionths of a second.

Yet "brain time," as Eagleman calls it, is intrinsically subjective. "Try this exercise," he suggests in a recent essay. "Put this book down and go look in a mirror. Now move your eyes back and forth, so that you're looking at your left eye, then at your right eye, then at your left eye again. When your eyes shift from one position to the other, they take time to move and land on the other location. But here's the kicker: you never see your eyes move." There's no evidence of any gaps in your perception—no darkened stretches like bits of blank film—yet much of what you see has been edited out. Your brain has taken a complicated scene of eyes darting back and forth and recut it as a simple one: your eyes stare straight ahead. Where did the missing moments go?

The question raises a fundamental issue of consciousness: how much of what we perceive exists outside of us and how much is a product of our minds? Time is a dimension like any other, fixed and defined down to its tiniest increments: millennia to microseconds, aeons to quartz oscillations. Yet the data rarely matches our reality. The rapid eye movements in the mirror, known as saccades, aren't the only things that get edited out. The jittery camera shake of everyday vision is similarly smoothed over, and our memories are often radically revised. What else are we missing? When Eagleman was a boy, his favorite joke had a turtle walking into a sheriff's office. "I've just been attacked by three snails!" he shouts. "Tell me what happened," the sheriff replies. The turtle shakes his head: "I don't know, it all happened so fast."

A few years ago, Eagleman thought back on his fall from the roof and decided that it posed an interesting research question. Why

W does time slow down when we fear for our lives? Does the brain shift gears for a few suspended seconds and perceive the world at half speed, or is some other mechanism at work? The only way to know for sure was to re-create the situation in a controlled setting. Eagleman and one of his graduate students, Chess Stetson, who is now at Caltech, began by designing and programming a "perceptual chronometer." About the size of a pack of cards, it had an L.E.D. display connected to a circuit board and powered by a nine-volt battery. The unit could be strapped to a subject's wrist, where it would flash a number at a rate just beyond the threshold of perception. If time slowed down, Eagleman reasoned, the number would become visible. Now he just needed a good, life-threatening situation.

Late one afternoon in October, Eagleman and I pulled into a gravel parking lot northwest of Dallas. A dingy cinder-block ticket office stood to one side, with a sign above the door that said "Zero Gravity." Inside, past a low chain-link fence, a collection of giant steel structures rose several stories into the sky. To the left was a rickety-looking platform with a rubber rope dangling from it; to the right, a monstrous orange windmill with seats attached to the tips of its blades. "We had to shut down the Scraper," one of the park attendants told me, pointing at it. "It's waitin' for a part from Germany."

Zero Gravity was billed as a thrill park, but it looked more like an abandoned construction site—or an arena for death matches in a post-apocalyptic film. When Eagleman first went there, five years ago, he knew it was the place for him. He had tried to test the chronometer on his grad students, on a field trip to Six Flags AstroWorld, in Houston, but even the largest roller coasters proved insufficiently terrifying. He needed something completely safe yet plausibly deadly. "I really chewed on this for a while," he told me. "I couldn't put people in a car accident." Then he heard about the SCAD.

The ride stood in the middle of the lot at Zero Gravity, like a half-built oil derrick. A steel gondola hung between its four legs and could be lifted to the top by thick cables. SCAD was short for suspended catch air device—a phrase more confusing than its acronym. But the idea was simple: when the rider reached the top of the tower, he'd be hooked to a cable and lowered through a hole in the floor of the gondola. His back would be to the ground, his eyes looking straight up. When the cable was released, he would plummet a hundred and ten feet, in pure free fall, until a net caught him near the bottom. "I've been up this thing three times, and it's gotten scarier every time," Eagleman said. "The second you drop, every part of you locks up. Your abs are rock solid, and you can't breathe. You're falling backward, going fifty miles an hour when you hit the net."

We scanned the lot for potential volunteers, but the park was deserted. There are only two SCADs in the country, both of which, until recently, had pristine safety records. Then, in July, a SCAD operator in the Wisconsin Dells triggered a drop before the net had been lifted fully into place. When the rider—a twelve-year-old girl named Teagan Marti—landed in the net, her momentum stretched it to the ground. The impact fractured her skull and broke her spine in ten places. Afterward, the SCAD operator was put on leave for reasons of mental health. "It was just human error," the attendant in Dallas assured us. Nothing like that had happened here.

Just then, a young couple wandered into the park. They were both in their early twenties, moonfaced and a little fidgety. April had small round glasses and a long ponytail; T.J. had a baggy black T-shirt with a purple sword on it, and a modest mullet combed back on top. They'd met at the Walmart in Weatherford, an hour away, they told us. April had found this place online but already seemed to regret it: she clutched T.J.'s hand and peered at the SCAD, her shoulders hunched up around her ears. He followed her gaze. "I've jumped off cliffs into lakes before," he said. "But that's about it."

When Eagleman showed them the perceptual chronometer, they looked a little dubious. Eagleman's excitement about his research is usually infectious. He's a good talker, with a gift for distillation and off-the-cuff analogy, and he tends to gather steam as he goes, leaping from idea to idea until his voice is hoarse and his mind is catapulting off to distant dimensions. ("What if we were to land on a planet with aliens who live at a different time scale from us?" he asked me at one point. "Would we seem like statues to them the way trees do to us?") In this setting, though, it was a little hard to take him seriously. The more sober and scientific he tried to sound, the more April and

T.J. seemed to take him for some unhinged Trekkie babbling on about his time machine.

Still, they agreed to give it a try. The attendant fitted them with harnesses, latched them into the gondola, and sent them lurching into the Texas sky. I could see April's ponytail whipping around above her head like a wind sock. "What is it, Tuesday?" Eagleman said. "How does someone, on a Tuesday, wake up and decide, 'This is the day that I'm going to scare myself to death'?" Then he pulled a stopwatch from his pocket and waited for the bodies to drop.

Eagleman traces his research back to psychophysicists in Germany in the late eighteen-hundreds, but his true forefather may be the American physiologist Hudson Hoagland. In the early nineteen-thirties, Hoagland proposed one of the first models for how the brain keeps time, based partly on his wife's behavior when she had the flu. She complained that he'd been away from her bedside too long, he later recalled, when he'd been gone only a short while. So Hoagland proposed an experiment: she would count off sixty seconds while he timed her with his watch. It's not hard to imagine her annoyance at this suggestion, or his smugness afterward: when her minute was up, his clock showed thirty-seven seconds. Hoagland went on to repeat the experiment again and again, presumably over his wife's delirious objections (her fever rose above a hundred and three). The result was one of the classic graphs of time-perception literature: the higher his wife's temperature, Hoagland found, the shorter her time estimate. Like a racing engine, her mental clock went faster the hotter it got.

Psychologists spent the next few decades trying to identify this mechanism. They worked with mice, rats, fish, turtles, cats, and pigeons, then moved on to monkeys, children, and brain-damaged adults. They shocked their subjects with electrodes, strapped them into heated helmets, dunked them in water baths, and irritated them with insistent clicks, hoping to speed up or slow down their internal clocks. Hoagland believed that timing was a "unitary chemical process" tied to metabolism. But later studies suggested a hodgepodge of systems, each devoted to a different time scale—the cerebral equivalent of a sundial, an hourglass, and an atomic clock. "Mother Nature's a tinkerer instead of an engineer," Eagleman says. "She doesn't just invent something and check it off the list. Everything is layers on layers built on top of each other, and that provides tremendous robustness." Parkinson's disease can impair our ability to time intervals of a few seconds, for instance, but leave split-second timing intact.

Just how many clocks we contain still isn't clear. The most recent neuroscience papers make the brain sound like a Victorian attic, full of odd, vaguely labelled objects ticking away in every corner. The circadian clock, which tracks the cycle of day and night, lurks in the suprachiasmatic nucleus, in the hypothalamus. The cerebellum, which governs muscle movements, may control timing on the order of a few seconds or minutes. The basal ganglia and various parts of the cortex have all been nominated as timekeepers, though there's some disagreement on the details. The standard model, proposed by the late Columbia psychologist John Gibbon in the nineteen-seventies, holds that the brain has "pacemaker" neurons that release steady pulses of neurotransmitters. More recently, at Duke, the neuroscientist Warren Meck has suggested that timing is governed by groups of neurons that oscillate at different frequencies. At U.C.L.A., Dean Buonomano believes that areas throughout the brain function as clocks, their tissue ticking with neural networks that change in predictable patterns. "Imagine a skyscraper at night," he told me. "Some people on the top floor work till midnight, while some on the lower floors may go to bed early. If you studied the patterns long enough, you could tell the time just by looking at which lights are on."

Time isn't like the other senses, Eagleman says. Sight, smell, touch, taste, and hearing are relatively easy to isolate in the brain. They have discrete functions that rarely overlap: it's hard to describe the taste of a sound, the color of a smell, or the scent of a feeling. (Unless, of course, you have synesthesia—another of Eagleman's obsessions.) But a sense of time is threaded through everything we perceive. It's there in the length of a song, the persistence of a scent, the flash of a light bulb. "There's always an impulse toward phrenology in neuroscience—toward saying, 'Here is the spot where it's happening,' " Eagleman told me. "But the interesting thing about time is that there is no spot. It's a distributed property. It's metasensory; it rides on top of all the others."

The real mystery is how all this is coördinated. When you watch a ballgame or bite into a hot dog, your senses are in perfect synch: they see and hear, touch and taste the same thing at the same moment. Yet they operate at fundamentally different speeds, with different inputs. Sound travels more slowly than light, and aromas and tastes more slowly still. Even if the signals reached your brain at the same time, they would get processed at different rates. The reason that a hundred-metre dash starts with a pistol shot rather than a burst of light, Eagleman pointed out, is that the body reacts much more quickly to sound. Our ears and auditory cortex can process a signal forty milliseconds faster than our eyes and visual cortex—more than making up for the speed of light. It's another vestige, perhaps, of our days in the jungle, when we'd hear the tiger long before we'd see it.

In Eagleman's essay "Brain Time," published in the 2009 collection "What's Next? Dispatches on the Future of Science," he borrows a conceit from Italo Calvino's "Invisible Cities." The brain, he writes, is like Kublai Khan, the great Mongol emperor of the thirteenth century. It sits enthroned in its skull, "encased in darkness and silence," at a lofty remove from brute reality. Messengers stream in from every corner of the sensory kingdom, bringing word of distant sights, sounds, and smells. Their reports arrive at different rates, often long out of date, yet the details are all stitched together into a seamless chronology. The difference is that Kublai Khan was piecing together the past. The brain is describing the present—processing reams of disjointed data on the fly, editing everything down to an instantaneous now. How does it manage it?

The mind-body problem has been vexing Eagleman longer than most. Even as a boy, his mother told me, he had a tendency to "dissociate himself"—to assess his own inner workings from a cool, analytical distance. "My brain can do this," he'd say. His mother was a biology teacher, his father a psychiatrist often called upon to evaluate insanity pleas, but their son was a creature outside their usual experience. "There were things about Dave that were a little bit funny," his mother says. He wrote his first words at the age of two, on an Underwood typewriter. At twelve, he was explaining relativity to them. One of his favorite tricks was to ask for a list of random objects, then repeat it back from memory—in reverse order, if people wished. His record was four hundred items.

As an undergraduate at Rice, Eagleman wanted to be a writer, but his parents persuaded him to major in electrical engineering instead. "It was like chewing on autumn leaves," he says. An extended sabbatical ensued. After his sophomore year, Eagleman joined the Israeli Army as a volunteer, then spent a semester at Oxford studying political science and literature, and finally moved to Los Angeles to become a screenwriter and a standup comic. Nothing took. "I knew I had some intellectual horsepower," he says. "But I didn't know where my tires would catch purchase." Back at Rice, he began to read books about the brain in his spare time and decided to take a course in neurolinguistics. "I was immediately enchanted just by the idea of it," Eagleman says. "Here was this three-pound organ that was the seat of everything we are—our hopes and desires and our loves. They had me at page one."

Mathematicians, like rock musicians, tend to do their best work in their twenties and thirties. Not so neuroscientists. The Nobel Prizes in the field are usually earned in mid-career, after a few false starts and fruitless sidetracks. "Biology is special that way," Eagleman says. "It takes years for people to get a feeling for the organism—for how nature actually works. Young people come in all the time knowing a bunch of fancy math. They say, 'What if it's like this computational model, this physical problem?' They're terrific ideas, but they're wrong. Nothing works the way you think it should."

Eagleman was speaking from experience. As a grad student at Baylor, he leaned especially hard on his math skills at first, having had so little training in biology. ("I would ask the professors what they were doing, and they would say, 'Yes, yes . . . Greek, Greek, Latin, Latin,'" he says of his admissions interview.) For his doctoral work, he programmed a piece of virtual neural tissue so complex that it tied up the Texas Medical Center's new supercomputer for days, prompting complaints from all over the university. "I remember, when he was writing it, he had a sack of raw potatoes under his desk," his dissertation adviser, Read Montague, told me. "He would cook a potato in the microwave, put it in a cup, and lean over and bite it while he was typing. It kind of set the tone for my lab for the succeeding decade. It chased away the faint of heart."

Eagleman's program was a theoretical as well as a technical feat: it showed that brain cells can exchange information not just through neurotransmitters but through the ebb and flow of calcium atoms. He went on to earn a postdoc at the prestigious Salk Institute, near San Diego. Once there, though, he fell under the spell of Francis Crick, a biologist interested in more than clever simulations. Crick was eighty-three when Eagleman met him, in 1999. He had won the Nobel Prize with James Watson almost forty years earlier, for deciphering the structure of DNA, but his research had taken a hard left turn since then, from genetics to the study of consciousness. "We'd have these seminars and he'd sit there and his head would nod, and I'd think, Oh, poor guy, the tolls of senescence," Eagleman recalls. "Then he'd get this smile on his face and raise his hand—and just disembowel the speaker. I'd never seen anything like that."

For decades, brain researchers had taken their lead from behaviorists like B. F. Skinner. They treated their subject as a machine like any other, with inputs, outputs, and a shadowy mechanism in between. But Crick and a handful of other researchers believed that it was time to pry open Skinner's black box—to at least begin to identify the mechanics of individual awareness. "When I started out, you basically weren't allowed to talk about it," Eagleman says. "Why does it feel like something to be alive? Why, when you put together millions of parts, does something suddenly have a sense of itself? All of this went out the window after B. F. Skinner. And it took a guy with Crick's gravitas to come in and say, 'You know what? This is a scientific problem—the most exciting of our time.' " Crick called it the scientific search for the soul.

Eagleman had to wait a few weeks to be granted an audience with Crick. ("I kind of became pals with his secretary," he told me.) But they quickly hit it off and met regularly after that. Like Crick, Eagleman was fascinated by consciousness. He thought of time not just as a neuronal computation—a matter for biological clocks—but as a window on the movements of the mind. In a paper published in *Science* in 2000, for instance, Eagleman looked at an optical illusion known as the flash-lag effect. The illusion could take many forms, but in Eagleman's version it consisted of a white dot flashing on a screen as a green circle passed over it. To determine where the dot hit the circle, Eagleman found, his subjects' minds had to travel back and forth in time. They saw the dot flash, then watched the circle move and calculated its trajectory, then went back and placed the dot on the circle. It wasn't a matter of prediction, he wrote, but of *postdiction*.

Something similar happens in language all the time, Dean Buonomano told me. If someone says, "The mouse on the desk is broken," your mind calls forth a different image than if you hear, "The mouse on the desk is eating cheese." Your brain registers the word "mouse," waits for its context, and only then goes back to visualize it. But language leaves time for second thoughts. The flash-lag effect seems instantaneous. It's as if the word "mouse" were changed to "track pad" before you even heard it.

The explanation for this is both simple and profoundly strange. Eagleman first described it to me on the way from Houston to the Zero Gravity thrill park in Dallas. "Imagine that there's an accident on the highway up ahead," he began. "One of these cars runs into that bridge." If the crash were to occur a hundred yards away, we'd see the car hit the bridge in silence. The sound, like a peal of thunder, would take a moment to reach us. The closer the impact, the shorter the delay, but only up to a point: at a hundred and ten feet, sight and sound would suddenly lock together. Under that threshold, Eagleman explained, the signals reach the brain within a hundred milliseconds of one another, and any differences in processing are erased. In the early days of television, Eagleman told me, broadcasters noticed a similar phenomenon. Their engineers went to a great deal of trouble to synchronize sound and image, but it soon became clear that perfectionism was pointless. As long as the delay was less than a hundred milliseconds, no one noticed it.

The margin of error is surprisingly wide. If the brain can distinguish sounds as little as five milliseconds apart, why don't we notice a delay twenty times longer? A possible answer began to emerge in the late nineteen-fifties, in the work of Benjamin Libet, a physiologist at the University of California, San Francisco. Libet worked with patients at a local hospital who had been admitted for neurosurgery and had had a hole drilled into their skull to expose the cortex. In one experiment, he used an electrode to shock the brain tissue with electrical pulses. The cortex is wired straight to the skin and various body parts, so the subjects would feel a tingle in the corresponding area. But not right away: the shock didn't register for up to half a second—an eternity in brain time. "The implications are quite astounding," Libet later wrote. "We are not conscious of the actual moment of the present. We are always a little late."

Libet's findings have been hard to replicate (zapping a patient's exposed brain is frowned upon these days), and they remain controversial. But to Eagleman they make a good deal of sense. Like Kublai Khan, he says, the brain needs time to get its story straight. It gathers up all the evidence of our senses, and only then reveals it to us. It's a deeply counterintuitive idea in some ways. Touch your finger to an ember or prick it on a needle and the pain is immediate. You feel it *now*—not in half a second. But perception and reality are often a little out of register, as the saccade experiment showed. If all our senses are slightly delayed, we have no context by which to measure a given lag. Reality is a tape-delayed broadcast, carefully censored before it reaches us.

"Living in the past may seem like a disadvantage, but it's a cost that the brain is willing to pay," Eagleman said. "It's trying to put together the best possible story about what's going on in the world, and that takes time." Touch is the slowest of the senses, since the signal has to travel up the spinal cord from as far away as the big toe. That could mean that the over-all delay is a function of body size: elephants may live a little farther in the past than hummingbirds, with humans somewhere in between. The smaller you are, the more you live in the moment. (Eagleman suspects that the speed of an animal's mating call—from the piping of a chickadee to the plainchant of a humpback—is a proxy for its sense of time.) "I once mentioned this in an NPR interview and I got flooded by e-mails from short people," Eagleman said. "They were so pleased. For about a day, I was the hero of the short people."

A lot can happen in half a second. At fifty miles an hour, for instance, a body can fall almost forty feet. April, the young woman from Weatherford, Texas, seemed well aware of this when she rode the SCAD later that afternoon. I could hear her strangled "*Ayiiiiiiiiii!*" as she plummeted from the top of the tower. Eagleman watched her streak past, then punched his stopwatch. "That's funny," he said. "They never scream." April took a moment to extricate herself from the safety net and walked unsteadily to a nearby bench. When we joined her, she was blinking and glancing vaguely around—she'd taken off her glasses before the ride—her eyes wide with shock.

"Was it worth it?" Eagleman asked.

"No," she said.

"It wasn't thrilling when you landed?"

"No. It hurt."

A few minutes later, her boyfriend, T.J., joined her on the bench. He'd jammed a Budweiser cap backward on his head, and his features had a shiny, blown-back look. When Eagleman asked him how the ride went, he held his forearms out in front of him: his fingers were shaking uncontrollably.

Eagleman and Chess Stetson, his grad student, ran the first round of SCAD experiments in 2007, with twenty subjects. They programmed the perceptual chronometer to flash its numbers just a little too fast to be legible. Then they stationed one observer at the top of the tower, to make sure the riders looked at the chronometer as they fell, and another on the ground. Afterward, the riders would report their chronometer readings, then take a stopwatch and go back over the experience in their minds, timing it from start to finish. Eagleman knew how long the fall had taken in real time; now he wanted to know how long it felt. April was too jittery to manage this at first, but then she took a deep breath and tried again. When she opened her eyes, the stopwatch showed just over three and a half seconds—about thirty per cent longer than the actual drop.

April's timing was typical: on average, Eagleman's subjects overestimate the length of their fall by thirty-six per cent. To his surprise

April's timing was typical: on average, Eagleman's subjects overestimate the length of their fall by thirty-six per cent. To his surprise, though, the speed of their perception doesn't change as they drop: no matter how hard they stare at the chronometer, they can't read the numbers. "In some sense, that's more interesting than what we thought was going on," Eagleman told me. "It suggests that time and memory are so tightly intertwined that they may be impossible to tease apart."

One of the seats of emotion and memory in the brain is the amygdala, he explained. When something threatens your life, this area seems to kick into overdrive, recording every last detail of the experience. The more detailed the memory, the longer the moment seems to last. "This explains why we think that time speeds up when we grow older," Eagleman said—why childhood summers seem to go on forever, while old age slips by while we're dozing. The more familiar the world becomes, the less information your brain writes down, and the more quickly time seems to pass.

Like Eagleman's comments about short people, the SCAD study triggered a flood of correspondence when it was published, by the Public Library of Science, four years ago. "It was like a propagating shock wave," he told me. "I got e-mails from paratroopers and cops and race-car drivers, people in motorcycle accidents and car accidents." One letter was from a former curator at a museum who had accidentally knocked over a Ming vase. "He said the thing took fucking forever to fall," Eagleman said. During the next few years, he plans to study the stories—some two hundred so far—by going back to the authors with a questionnaire. In the meantime, it's easy to pick out the common threads—not just the sense of time slowing down but the strange calm and the touch of the surreal that he remembers from his own childhood fall. In one story, a man is thrown off his motorcycle after colliding with a car. As he's sliding across the road, perhaps to his death, he hears his helmet bouncing against the asphalt. The sound has a catchy rhythm, he thinks, and he finds himself composing a little ditty to it in his head.

"Time is this rubbery thing," Eagleman said. "It stretches out when you really turn your brain resources on, and when you say, 'Oh, I got this, everything is as expected,' it shrinks up." The best example of this is the so-called oddball effect—an optical illusion that Eagleman had shown me in his lab. It consisted of a series of simple images flashing on a computer screen. Most of the time, the same picture was repeated again and again: a plain brown shoe. But every so often a flower would appear instead. To my mind, the change was a matter of timing as well as of content: the flower would stay onscreen much longer than the shoe. But Eagleman insisted that all the pictures appeared for the same length of time. The only difference was the degree of attention that I paid to them. The shoe, by its third or fourth appearance, barely made an impression. The flower, more rare, lingered and blossomed, like those childhood summers.

Before Francis Crick died, in 2004, he gave Eagleman some advice. "Look," he said. "The dangerous man is the one who has only one idea, because then he'll fight and die for it. The way real science goes is that you come up with lots of ideas, and most of them will be wrong."

Eagleman may have taken the words a little too much to heart. When I was in Houston, he had more than a dozen studies running simultaneously, and spent his time racing from laboratory to lecture hall to MRI machine to brain-surgery ward and back. "We're using the full armamentarium of modern neuroscience," he told me. One of his nine lab members was studying the neurological roots of empathy; another was looking at free will. Two were studying timing disorders in schizophrenics; one had helped create the world's foremost database of synesthetes. Eagleman had projects on epilepsy, counterfeiting, decision-making in courts, and timing deficits among brain-damaged veterans of Iraq and Afghanistan, as well as four books at various stages of completion. In early April, Eagleman was awarded a Guggenheim Fellowship for his work on synesthesia. In May, Pantheon will publish "Incognito," his popular account of the unconscious.

"Did I mention my paper on the asp caterpillar?" he asked me one day. He pulled up a picture on his computer of what looked like a grub in a fancy fur coat. It was a highly venomous insect, he assured me. He knew this because one of them had crawled up his leg seven years earlier. "It felt like someone had just poured a glass of acid on my shin," he said. In the hospital that night, an emergency-room doctor called him a wimp. "Haven't you been bitten by a bug before?" he said. So Eagleman, by way of reply, spent the next few years rounding up every known case report of asp-caterpillar envenomation. He created the first map of the caterpillar's distribution in North America, as well as graphs of a hundred and eighty-eight attacks, broken down by month and symptom. Then he published his report, extensively footnoted, in the journal *Clinical Toxicology*. "It turns out that I'm the world's expert on this thing," he told me, grinning.

Eagleman's colleagues occasionally grumble that he's overreaching, or seeking publicity. But he has an impressive record of peer-reviewed publications, and even his wackiest projects tend to bear up under scrutiny. "The data are solid," Dean Buonomano told me. "The interpretations can sometimes be a bit dreamy." Eagleman's bigger problem is time, in a practical as well as a theoretical sense. He gets seven hours of sleep a night, he says, but only by working seven days a week, mostly without pause. (His last vacation was three years ago, a weekend wedding in Hawaii.) For years, Eagleman was a confirmed bachelor and "serial dater," as one of his friends put it, with a tidy bungalow that he liked to call the Eagle's Nest. Then, last October, he surprised everyone by marrying Sarah Alwin, a twenty-six-year-old doctoral candidate who studies the electrophysiology of vision at the University of Texas in Houston. "We're a terrific match," he told me. "She's as much of a workaholic as I am." They hope to have children soon, before the DNA in his sperm deteriorates too much with age. "I used to be such a cynic about marriage," he said. "Now I even want to spawn!"

Eagleman has never lost his childhood tendency to observe himself from a distance, treating his own brain as a research subject. When we were winding our way through Baylor's labyrinthine corridors, he credited his sense of direction to a fine hippocampus. And when we sat down to a meal at a restaurant he complained that he'd much rather ingest a "compressed bar of nutrients." As for his wildly varied research: it's just another version of the oddball effect, he told me. By leaping from topic to topic, he forces his brain to give each problem far more attention than familiarity would allow. "Emerson did the same thing," he said. "He had a lazy Susan with multiple projects on it. When he'd get bored, he would just spin it and start on something else."

Early this winter, I joined Eagleman in London for his most recent project: a study of time perception in drummers. Timing studies tend to be performed on groups of random subjects or on patients with brain injuries or disorders. They've given us a good sense of average human abilities, but not the extremes: just how precise can a person's timing be? "In neuroscience, you usually look for animals that are best at something," Eagleman told me, over dinner at an Italian restaurant in Notting Hill. "If it's memory, you study songbirds; if it's olfaction, you look at rats and dogs. If I were studying athletes, I'd want to find the guy who can run a four-minute mile. I wouldn't want a bunch of chubby high-school kids."

The idea of studying drummers had come from Brian Eno, the composer, record producer, and former member of the band Roxy Music. Over the years, Eno had worked with U2, David Byrne, David Bowie, and some of the world's most rhythmically gifted musicians. He owned a studio a few blocks away, in a converted stable on a cobblestoned cul-de-sac, and had sent an e-mail inviting a number of players to participate in Eagleman's study. "The question is: do drummers have different brains from the rest of us?" Eno said. "Everyone who has ever worked in a band is sure that they do."

Eno first met Eagleman two years ago, after a publisher he knew sent him a book of Eagleman's short stories, called "Sum." Modelled on the cerebral fiction of Borges and Calvino, "Sum" is a natural outgrowth of Eagleman's scientific concerns—another spin of the lazy Susan that has circled back to the subject of time. Each of its forty chapters is a kind of thought experiment, describing a different version of the afterlife. Eagleman establishes a set of initial conditions, then lets the implications unfold logically. In one chapter, the dead are doomed to spend eternity playing bit parts in the dreams of the living. In another, they share the hereafter with all possible versions of themselves—from the depressing failures to the irritating successes. "I'm a minimalist at heart. I like short, big ideas," Eno said. "I asked my friend when he was publishing it, and he said, 'Next February.' We had a big argument. I said, 'Just get the bloody thing out!' "

"Sum" had taken years to find a publisher—Eagleman began writing it while still in graduate school—but it quickly found an audience. In England, it was praised by publications as disparate as *Nature* ("rigorous and imaginative") and the *Observer*, where the author Geoff Dyer called it "stunningly original" and saw in it "the unaccountable, jaw-dropping quality of genius." Eagleman had considered writing under a pseudonym, thinking that he'd be vilified by scientists and religious readers alike. Instead, both groups claimed the book for their own. Atheists like Philip Pullman wrote enthusiastic blurbs, while the editors of an interfaith Web site named it one of the best spiritual books of 2009. At a Unitarian church in Massachusetts, members of the congregation took turns reading chapters from the pulpit.

Eno and Eagleman had struck up an e-mail correspondence by then, and Eno had suggested that they collaborate on a staged reading of the book. The production premièred at the Sydney Opera House in June, 2009, with an ambient score by Eno. (A full-fledged operatic version, with music by Max Richter, is scheduled to be produced by the Royal Opera House, in London, in 2012.) It was while they were there that Eno told Eagleman the story that inspired the drumming study.

"I was working with Larry Mullen, Jr., on one of the U2 albums," Eno told me. " 'All That You Don't Leave Behind,' or whatever it's called." Mullen was playing drums over a recording of the band and a click track—a computer-generated beat that was meant to keep all the overdubbed parts in synch. In this case, however, Mullen thought that the click track was slightly off: it was a fraction of a beat behind the rest of the band. "I said, 'No, that can't be so, Larry,' " Eno recalled. " 'We've all worked to that track, so it must be right.' But he said, 'Sorry, I just can't play to it.' "

Eno eventually adjusted the click to Mullen's satisfaction, but he was just humoring him. It was only later, after the drummer had left, that Eno checked the original track again and realized that Mullen was right: the click was off by six milliseconds. "The thing is," Eno told me, "when we were adjusting it I once had it two milliseconds to the wrong side of the beat, and he said, 'No, you've got to come back a bit.' Which I think is absolutely staggering."

Eagleman arrived at Eno's studio late the next morning, carrying a pair of laptops and a wireless EEG monitor. "This thing is so cool!" he said, pulling the latter from its foam-cushioned case. "They did the full T.S.A. search on me at the airport." He clamped the EEG on his head—it looked like a giant tarantula perched there—then watched as sixteen wavering lines appeared onscreen, in candy-stripe colors. Each line represented the electrical activity at a different point in his brain. The drummers would wear this while taking a set of four tests, Eagleman explained. The tests were like simple video games, designed by his lab to measure different forms of timing: keeping a steady beat, comparing the lengths of two tones, synchronizing a beat to an image, and comparing visual or audible rhythms to one another. "The EEG can pick up twenty-thousandths of a second," he said. "Brain activity doesn't even go that fast, so we're oversampling by a lot. But why not?"

While Eagleman set up testing areas in two rooms, Eno bustled around the studio tidying up, talking to his cats, and brewing tea. The stable had been converted into an airy, skylit space with a circular staircase that led to the former hayloft, now filled with computer workstations. The back corner was flanked by a pair of enormous monochords: single-stringed electric instruments of Eno's design, made of railroad ties. Eno was clean-shaven and dressed all in black. He had a round, impish face and rectangular glasses with a pixellated pattern punched along the temples.

"Drummers are very hard to control," he said, stuffing some Christmas cards into their envelopes. "I didn't hear anything for days. Then suddenly everybody decided to come, and to bring their friends. So we may have a flood of drummers. Or we may have no one at all." He was a little worried that they'd get hungry or bored. ("They're probably more likely to come if there's a sort of 'scene' going on," he'd written Eagleman a few weeks earlier.) So he sent an assistant to buy pastries and mixed nuts, and brought out "various entertainments" for the drummers to play with, including a drum synthesizer.

"The more competitive they feel about this, the better," Eagleman said. "A big part of it is making sure they pay attention."

"That will be hard," Eno replied.

The first subject wandered in at around noon—a scruffy, swivel-hipped young redhead named Daniel Maiden-Wood, who played drums for the singer Anna Calvi. By midafternoon, the place was full. Larry Mullen, Jr., was on tour in Australia, but the makings of a remarkable rhythm section were sprawled on Eno's sofas and chairs. Among them were jazz musicians, Afro-Cuban percussionists, and the drummer for Razorlight, a British band with a pair of multi-platinum albums. Will Champion, of Coldplay, came in looking like a lumberjack who'd taken a wrong turn. (When he removed his yarn cap to reveal a large bullet head, Eagleman said it was perfect for the EEG.) Champion had worked with Eno on "Viva la Vida," the 2008 album that topped both the British and the American charts, solidifying Coldplay's standing as the world's best-selling rock group. "He's like a human metronome," Eno said. "If you say to him, 'What is seventy-eight beats per minute?,' he will go tap, tap, tap. And he's dead on."

The friendly rivalry that Eagleman had imagined among players never quite materialized. (He might have had better luck with a roomful of lead singers.) Instead, they told drummer jokes. How do you know when there's a drummer at your door? The knocking gets faster and faster. Had we heard about the drummer who tried to commit suicide? He threw himself behind a train. Eno had been recording drum parts most of his life, but he claimed to be rhythmically challenged. "I suffer from what my friend Leo Abrahams calls the honky offset—the tendency of white players to be early on the beat," he said. "It's eleven milliseconds. If you delay the recording by that much, it sounds much better."

Nevertheless, as pairs of drummers shuffled back and forth from the testing stations, a certain wounded professional pride was in evidence. The players had no trouble comparing a tone or keeping a steady beat, but the visual-timing tests were giving them fits. Eagleman had promised that the results would be kept anonymous, but he'd programmed each battery of tests to end with a cheeky evaluation: "You're a rock star," for those who scored in the top twenty-five per cent; "Ready for the big time," for the second quartile; "Ready for open-mike night," for those in the next group; and "Go back to band camp," for the bottom quarter. No one wanted to go to band camp.

A drummer's timing is a physical thing, they agreed, like dancing. Tapping a rhythm on a trackpad robs it of all sense of movement or muscle memory. Yet many of them played to click tracks even onstage, and their sense of tempo had been conditioned and codified by years in the studio. Hip-hop was eighty or ninety beats per minute, they said, Afrobeat around a hundred and ten. Disco stuck so insistently to a hundred and twenty that you could run the songs one after another without missing a beat. "There wasn't a fraction of deviance," Eno said. In the heat of a performance, drummers sometimes rushed the beat or hung back a little, to suit the mood. But as click tracks became more common such deviations had to be re-created artificially. To Champion's amusement, Coldplay had lately taken to programming elaborate "tempo maps" for its live shows, with click tracks designed to speed up or slow down during a song. "It re-creates the excitement of a track that's not so rigid," Champion said.

When it was his turn to take Eagleman's test, Champion spent nearly twice as long at the computer as the others—his competitive spirit roused at last. He needn't have worried. Eagleman's results later showed a "huge statistical difference," as he put it, between the drummers' timing and that of the random control subjects he'd tested back in Houston. When asked to keep a steady beat, for instance, the controls wavered by an average of thirty-five milliseconds; the best drummer was off by less than ten. Eno was right: drummers do have different brains from the rest. "They kicked ass over the controls," Eagleman said. His next task would be to use the EEG data to locate the most active areas of the drummers' brains, then target them with bursts of magnetic stimulation to see if he could disrupt their timing. "Now that we know that there is something anatomically different about them," he said, "we want to see if we can mess it up."

Whether they'd want to participate again was another matter. Champion, for one, looked a little punch-drunk after his test. "It's hard not to feel like it's a sort of personal evaluation," he said, as he was putting on his coat. "Hopefully, it will be useful for some larger purpose. But you still want to feel like you're up to snuff." He shrugged. "Luckily, it told me that I should be a rock star. So it's nice to know that *that* wasn't wasted."

It was close to midnight when Eagleman and I finally left Eno's studio, the laptops and the EEG tucked under our arms. The streets felt muffled and close beneath the starless sky; the sidewalks were slick with snow. Walking back to our hotel, I thought of the countless sensory signals careering around me: the glimmer of street lamps off pub windows, the rumble of tube trains underground, the scent of wood smoke and spilled beer, and the curve of cobblestones beneath my feet. From billions of such fragments my brain had pieced together this simple story—a winter's night in Notting Hill—and I was happy to have it.

What would it be like to have a drummer's timing? I wondered. Would you hear the hidden rhythms of everyday life, the syncopations of the street? When I asked the players at Eno's studio this, they seemed to find their ability as much an annoyance as a gift. Like perfect pitch, which dooms the possessor to hear every false note and flat car horn, perfect timing may just make a drummer more sensitive to the world's arrhythmias and repeated patterns, Eagleman said—to the flicker of computer screens and fluorescent lights. Reality, stripped of an extra beat in which the brain orchestrates its signals, isn't necessarily a livelier place. It's just filled with badly dubbed television shows.

"We're stuck in time like fish in water," Eagleman said, oblivious of its currents until a bubble floats by. It's usually best that way. He had spent the past ten years peering at the world through such gaps in our perception, he said. "But sometimes you get so far down deep into reality that you want to pull back. Sometimes, in a great while, I'll think, What if I find out that this is all an illusion?" He felt this most keenly with his schizophrenic subjects, who tended to do poorly on timing tests. The voices in their heads, he suspected, were no different from anyone else's internal monologues; their brains just processed them a little out of sequence, so that the thoughts seemed to belong to someone else. "All it takes is this tiny tweak in the brain, this tiny change in perception," he said, "and what you see as real isn't real to anyone else."

Eagleman was brought up as a secular Jew and became an atheist in his teens. Lately, though, he'd taken to calling himself a Possibilian—a denomination of his own invention. Science had taught him to be skeptical of cosmic certainties, he told me. From the unfathomed complexity of brain tissue—"essentially an alien computational material"—to the mystery of dark matter, we know too little about our own minds and the universe around us to insist on strict atheism, he said. "And we know far too much to commit to a particular religious story." Why not revel in the alternatives? Why not imagine ourselves, as he did in "Sum," as bits of networked hardware in a cosmic program, or as particles of some celestial organism, or any of a thousand other possibilities, and then test those ideas against the available evidence? "Part of the scientific temperament is this tolerance for holding multiple hypotheses in mind at the same time," he said. "As Voltaire said, uncertainty is an uncomfortable position. But certainty is an absurd one."

A garden-variety agnostic might have left it at that. But Eagleman, as usual, took things a step further. Two years ago, in an interview on a radio show, he declared himself the founder of a new movement. Possibilianism had a membership of one, he said, but he hoped to attract more. "I'm not saying here is the answer," he told me. "I'm just celebrating the vastness of our ignorance." The announcement was only half serious, so Eagleman was shocked to find, when he came home from his lab later that night, that his e-mail in-box was filled, once again, with messages from listeners. "You know what?" most of them said. "I'm a Possibilian, too!" The movement has since drawn press from as far away as India and Uganda. At last count, close to a thousand Facebook members had switched their religious affiliation to Possibilianism.

Francis Crick, the patron saint of intellectual long shots, might have approved. ♦

Published in the print edition of the April 25, 2011, issue.

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