

## Your Brain Knows a Lot More Than You Realize

Neuroscientist David Eagleman explores the processes and skills of the subconscious mind, which our conscious selves rarely consider.

by *David Eagleman*

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*Only a tiny fraction of the brain is dedicated to conscious behavior. The rest works feverishly behind the scenes regulating everything from breathing to mate selection. In fact, neuroscientist David Eagleman of Baylor College of Medicine argues that the unconscious workings of the brain are so crucial to everyday functioning that their influence often trumps conscious thought. To prove it, he explores little-known historical episodes, the latest psychological research, and enduring medical mysteries, revealing the bizarre and often inexplicable mechanisms underlying daily life.*

*Eagleman's theory is epitomized by the deathbed confession of the 19<sup>th</sup>-century mathematician James Clerk Maxwell, who developed fundamental equations unifying electricity and magnetism. Maxwell declared that "something within him" had made the discoveries; he actually had no idea how he'd achieved his great insights. It is easy to take credit after an idea strikes you, but in fact, neurons in your brain secretly perform an enormous amount of work before inspiration hits. The brain, Eagleman argues, runs its show incognito. Or, as Pink Floyd put it, "There's someone in my head, but it's not me."*

There is a looming chasm between what your brain knows and what your mind is capable of accessing. Consider the simple act of changing lanes while driving a car. Try this: Close your eyes, grip an imaginary steering wheel, and go through the motions of a lane change. Imagine that you are driving in the left lane and you would like to move over to the right lane. Before reading on, actually try it. I'll give you 100 points if you can do it correctly.

It's a fairly easy task, right? I'm guessing that you held the steering wheel straight, then banked it over to the right for a moment, and then straightened it out again. No problem.

Like almost everyone else, you got it completely wrong. The motion of turning the wheel rightward for a bit, then straightening it out again would steer you off the road: you just piloted a course from the left lane onto the sidewalk. The correct motion for changing lanes is banking the wheel to the right, then back through the center, and continuing to turn the wheel just as far to the left side, and only then straightening out. Don't believe it? Verify it for yourself when you're next in the car. It's such a simple motor task that you have no problem accomplishing it in your daily driving. But when forced to access it consciously, you're flummoxed.

The lane-changing example is one of a thousand. You are not consciously aware of the vast majority of your brain's ongoing activities, nor would you want to be—it would interfere with the brain's well-oiled processes. The best way to mess up your piano piece is to concentrate on your fingers; the best way to get out of breath is to think about your breathing; the best way to miss the golf ball is to analyze your swing. This wisdom is apparent even to children, and we find it immortalized in poems such as "The Puzzled Centipede":

A centipede was happy quite,  
Until a frog in fun  
Said, "Pray tell which leg comes after which?"  
This raised her mind to such a pitch,  
She lay distracted in the ditch  
Not knowing how to run.

The ability to remember motor acts like changing lanes is called procedural memory, and it is a type of implicit memory—meaning that your brain holds knowledge of something that your mind cannot explicitly access. Riding a bike, tying your shoes, typing on a keyboard, and steering your car into a parking space while speaking on your cell phone are examples of this. You execute these actions easily but without knowing the details of how you do it. You would be totally unable to describe the perfectly timed choreography with which your muscles

contract and relax as you navigate around other people in a cafeteria while holding a tray, yet you have no trouble doing it. This is the gap between what your brain can do and what you can tap into consciously.

The concept of implicit memory has a rich, if little-known, tradition. By the early 1600s, René Descartes had already begun to suspect that although experience with the world is stored in memory, not all memory is accessible. The concept was rekindled in the late 1800s by the psychologist Hermann Ebbinghaus, who wrote that “most of these experiences remain concealed from consciousness and yet produce an effect which is significant and which authenticates their previous existence.”

To the extent that consciousness is useful, it is useful in small quantities, and for very particular kinds of tasks. It's easy to understand why you would not want to be consciously aware of the intricacies of your muscle movement, but this can be less intuitive when applied to your perceptions, thoughts, and beliefs, which are also final products of the activity of billions of nerve cells. We turn to these now.

#### Chicken Sexers and Plane Spotters

When chicken hatchlings are born, large commercial hatcheries usually set about dividing them into males and females, and the practice of distinguishing gender is known as chick sexing. Sexing is necessary because the two genders receive different feeding programs: one for the females, which will eventually produce eggs, and another for the males, which are typically destined to be disposed of because of their uselessness in the commerce of producing eggs; only a few males are kept and fattened for meat. So the job of the chick sexer is to pick up each hatchling and quickly determine its sex in order to choose the correct bin to put it in. The problem is that the task is famously difficult: male and female chicks look exactly alike.

Well, almost exactly. The Japanese invented a method of sexing chicks known as vent sexing, by which experts could rapidly ascertain the sex of one-day-old hatchlings. Beginning in the 1930s, poultry breeders from around the world traveled to the Zen-Nippon Chick Sexing School in Japan to learn the technique.

The mystery was that no one could explain exactly how it was done. It was somehow based on very subtle visual cues, but the professional sexers could not say what those cues were. They would look at the chick's rear (where the vent is) and simply seem to know the correct bin to throw it in.

And this is how the professionals taught the student sexers. The master would stand over the apprentice and watch. The student would pick up a chick, examine its rear, and toss it into one bin or the other. The master would give feedback: yes or no. After weeks on end of this activity, the student's brain was trained to a masterful—albeit unconscious—level.

Meanwhile, a similar story was unfolding oceans away. During World War II, under constant threat of bombings, the British had a great need to distinguish incoming aircraft quickly and accurately. Which aircraft were British planes coming home and which were German planes coming to bomb? Several airplane enthusiasts had proved to be excellent “spotters,” so the military eagerly employed their services. These spotters were so valuable that the government quickly tried to enlist more spotters—but they turned out to be rare and difficult to find. The government therefore tasked the spotters with training others.

It was a grim attempt. The spotters tried to explain their strategies but failed. No one got it, not even the spotters themselves. Like the chicken sexers, the spotters had little idea how they did what they did—they simply saw the right answer.

With a little ingenuity, the British finally figured out how to successfully train new spotters: by trial-and-error feedback. A novice would hazard a guess and an expert would say yes or no. Eventually the novices became, like their mentors, vessels of the mysterious, ineffable expertise.