THE EXTENDED MIND

The Power of Thinking Outside the Brain

ANNIE MURPHY PAUL

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Annie Murphy Paul

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For Sally, Billy, and Frankie

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Prologue

When you're writing a book about how to think well, your sources — the cognitive scientists, psychologists, biologists, neuroscientists, and philosophers who all have something to contribute on the subject — will often seem to be speaking, via their work, directly to you: *Yes, you there, writing a book!* They cajole and insist, they argue and debate, they issue warnings and pass judgment; as you lay out their recommendations for the reader, they inquire pointedly: *Are you taking your own advice?*

I entered into one such intimate exchange when I read, with a jolt of recognition, a passage written more than 130 years ago; it was as if the author were reaching through the pages that lay open on my desk. Making the meeting more intense, the writer in question was a distinctly intimidating character: the German philosopher Friedrich Nietzsche, he of the severe gaze and vaguely sinister mustache.

"How quickly we guess how someone has come by his ideas," Nietzsche slyly observed, "whether it was while sitting in front of his inkwell, with a pinched belly, his head bowed low over the paper — in which case we are quickly finished with his book, too! Cramped intestines betray themselves — you can bet on that — no less than closet air, closet ceilings, closet narrowness."

The room in which I was writing suddenly seemed rather airless and small.

I encountered his words as I was working on a chapter about how bodily movement affects the way we think. The quote from Nietzsche appears in a book titled *A Philosophy of Walking,* by the contemporary French philosopher Frédéric Gros; Gros has his own thoughts to add. Don't think of a book as issuing only from an author's head, he advises. "Think of the scribe's body: his hands, his feet, his shoulders and legs. Think of the book as an expression of physiology. In all too many books the reader can sense the seated body, doubled up, stooped, shriveled in on itself."

My seated body shifted guiltily in its chair, which it had occupied all morning.

Far more conducive to the act of creation, Gros continues, is "the walking body"—which, he says, is "unfolded and tensed like a bow: opened to wide spaces like a flower to the sun." Nietzsche, he reminds us, wrote that we should "sit as little as possible; do not believe any idea that was not born in the open air and of free movement."

The philosophers were ganging up on me; I closed my laptop and went for a walk.

I was acting not only on their say-so, of course; by this point in my research I had read dozens of empirical studies showing that a bout of physical activity sharpens our attention, improves our memory, and enhances our creativity. And in fact, I found that the forward movement of my legs, the flow of images past my eyes, the slight elevation of my heart rate did work some kind of change on my mind. Upon sitting back down at my desk, I wasted no time resolving a knotty conceptual problem that had tormented me all morning. (I can only hope that the prose I produced also "retains and expresses the energy, the springiness of the body," in Gros's formulation.) Could my brain have solved the problem on its own, or did it require the assist provided by my ambulatory limbs?

Our culture insists that the brain is the sole locus of thinking, a cordoned-off space where cognition happens, much as the workings of my laptop are sealed inside its aluminum case. This book argues otherwise: it holds that the mind is something more like the nest-building bird I spotted on my walk, plucking a bit of string here, a twig there, constructing a whole out of available parts. For humans these parts include, most notably, the feelings and movements of our bodies; the physical spaces in which we learn and work; and the other minds with which we interact—our classmates, colleagues, teachers, supervisors, friends. Sometimes all three elements come together in especially felicitous fashion, as they did for the brilliant intellectual team of Amos Tversky and Daniel Kahneman. The two psychologists carried out much of their groundbreaking work on heuristics and biases—the human mind's habitual shortcuts and distortions—by talking and walking together, through the bustling streets of Jerusalem or along the rolling hills of the California coast. "I did the best thinking of my life on leisurely walks with Amos," Kahneman has said.

Many tomes have been written on human cognition, many theories proposed and studies conducted (Tversky and Kahneman's among them). These efforts have produced countless illuminating insights, but they are limited by their assumption that thinking happens only inside the brain. Much less attention has been paid to the ways people use the world to think: the gestures of the hands, the space of a sketchbook, the act of listening to someone tell a story, or the task of teaching someone else. These "extra-neural" inputs change the way we think; it could even be said that they constitute a part of the thinking process itself. But where is the chronicle of *this* mode of cognition? Our scientific journals mostly proceed from the premise that the mental organ is a disembodied, placeless, asocial entity, a "brain in a vat"; our history books spin tales that attribute world-changing breakthroughs to individual men, thinking great thoughts on their own. Yet a parallel narrative has existed in front of us all along—a kind of secret history of thinking outside the brain. Scientists, artists, authors; leaders, inventors, entrepreneurs: they've all used the world as raw material for their trains of thought. This book aims to exhume that hidden saga, reclaiming its rightful place in any full accounting of how the human race has achieved its remarkable feats of intellect and creativity.

We'll learn about how geneticist Barbara McClintock made her Nobel Prize–winning discoveries by imaginatively "embodying" the plant chromosomes she studied, and about how pioneering psychotherapist and social critic Susie Orbach senses what her patients are feeling by tuning in to the internal sensations of her own body (a capacity known as *interoception*). We'll contemplate how biologist James Watson determined the double-helix structure of DNA by physically manipulating cardboard cutouts he'd made himself, and how author Robert Caro plots the lives of his biographical subjects on an intricately detailed wall-sized map. We'll explore how virologist Jonas Salk was inspired to complete his work on a polio vaccine while wandering a thirteenth-century Italian monastery, and how the artist Jackson Pollock set off a revolution in painting by trading his apartment in frenetic downtown Manhattan for a farmhouse on the verdant south fork of Long Island. We'll find out how Pixar director Brad Bird creates modern movie classics like *Ratatouille* and *The Incredibles* by arguing—vehemently—with his longtime producer, and how physicist Carl Wieman, another Nobel Prize winner, figured out that inducing his students to talk with one another was the key to getting them to think like scientists.

Such stories push back against the prevailing assumption that the brain can, or should, do it all on its own; they are vivid testimony to the countervailing notion that we think best when we think with our bodies, our spaces, and our relationships. But as with Friedrich Nietzsche's commendation of the virtues of walking, the evidence supporting the efficacy of thinking outside the brain is far from merely anecdotal. Research emerging from three related areas of investigation has convincingly demonstrated the centrality of extra-neural resources to our thinking processes.

First, there is the study of *embodied cognition,* which explores the role of the body in our thinking: for example, how making hand gestures increases the fluency of our speech and deepens our understanding of abstract concepts. Second, there is the study of *situated cognition,* which examines the influence of place on our thinking: for instance, how environmental cues that convey a sense of belonging, or a sense of personal control, enhance our performance in that space. And third, there is the study of *distributed cognition,* which probes the effects of thinking with others—such as how people working in groups can coordinate their individual areas of expertise (a process called "transactive memory"), and how groups can work together to produce results that exceed their members' individual contributions (a phenomenon known as "collective intelligence").

As a journalist who has covered research in psychology and cognitive science for more than twenty years, I read the findings generated by these fields with growing excitement. Together they seemed to indicate that it's the stuff *outside* our heads that makes us smart—a proposition with enormous implications for what we do in education, in the workplace, and in our everyday lives. The only problem: there was no "together," no overarching framework that organized these multitudinous results into a coherent whole. Researchers working within these three disciplines published in different journals and presented at different conferences, rarely drawing connections among their areas of specialization. Was there some unifying idea that could pull together these deeply intriguing findings?

Once again a philosopher came to my rescue: this time it was Andy Clark, professor of cognitive philosophy at the University of Sussex in England. In 1995 Clark had co-written a paper titled "The Extended Mind," which opened with a deceptively simple question: "Where does the mind stop and the rest of the world begin?" Clark and his coauthor, philosopher David Chalmers, noted that we have traditionally assumed that the mind is contained within the head—but, they argued, "there is nothing sacred about skull and skin." Elements of the world outside may effectively act as mental "extensions," allowing us to think in ways our brains could not manage on their own.

Clark and Chalmers initially focused their analysis on the way *technology* can extend the mind—a proposal that quickly made the leap from risibly preposterous to self-evidently obvious, once their readers acquired smartphones and began offloading large chunks of their memories onto their new devices. (Fellow philosopher Ned Block likes to say that Clark and Chalmers's thesis was false when it was written in 1998 but subsequently became true—perhaps in 2007, when Apple introduced the first iPhone.)

Yet as early as that original paper, Clark hinted that other kinds of extensions were possible. "What about socially extended cognition?" he and Chalmers asked. "Could my mental states be partly constituted by the states of other thinkers? We see no reason why not." In the years that followed, Clark continued to enlarge his conception of the kinds of entities that could serve as extensions of the mind. He observed that our physical movements and gestures play "an important role in an extended neural-bodily cognitive economy"; he noted that humans are inclined to create "designer environments"—carefully appointed spaces "that alter and simplify the computational tasks which our brains must perform in order to solve complex problems." Over the course of many more published papers and books, Clark mounted a broad and persuasive argument against what he called the "brainbound" perspective—the view that thinking happens only inside the brain—and in favor of what he called the "extended" perspective, in which the rich resources of our world can and do enter into our trains of thought.

Consider me a convert. The notion of the extended mind seized my imagination and has not yet released its grip. During my many years of reporting, I had never before encountered an idea that changed so much about how I think, how I work, how I parent, how I navigate everyday life. It became apparent to me that Andy Clark's bold proposal was not (or not only!) the esoteric thought experiment of an ivory tower philosopher; it was a plainly practical invitation to think differently and better. As I began to catalog the dozens of techniques for thinking outside the brain that researchers have tested and verified, I eagerly incorporated them into my own repertoire.

These include methods for sharpening our interoceptive sense, so as to use these internal signals to guide our decisions and manage our mental processes; they encompass guidelines for the use of specific types of gesture, or particular modes of physical activity, to enhance our memory and attention. This research offers instructions on using time in nature to restore our focus and increase our creativity, as well as directions for designing our learning and working spaces for greater productivity and performance. The studies we'll cover describe structured forms of social interaction that allow other people's cognition to augment our own; they also supply guidance on how to offload, externalize, and dynamically interact with our thoughts—a much more effective approach than doing it all "in our heads."

In time I came to recognize that I was acquiring a second education—one that is increasingly essential but almost always overlooked in our focus on educating the brain. Over many years of elementary school, high school, and even college and graduate school, we're never explicitly taught to think outside the brain; we're not shown how to employ our bodies and spaces and relationships in the service of intelligent thought. Yet this instruction is available if we know where to look; our teachers are the artists and scientists and authors who have figured out these methods for themselves, and the researchers who are, at last, making these methods the object of study.

For my own part, I'm convinced that I could not have written this book without the help of the practices detailed within it. That's not to say that I didn't sometimes fall back into our culture's default position. Before Friedrich Nietzsche's fortuitous intervention that morning, I was in full brainbound mode, my "head bowed low" over my keyboard, working my poor brain ever harder instead of looking for opportunities to extend it. I'm grateful for the nudge my research supplied; it's that gentle push in a more productive direction that this book seeks to offer its own readers.

Frédéric Gros, the French philosopher who brought Nietzsche's words to my attention, maintains that thinkers ought to get moving in a "quest for a different light." As he observes, "Libraries are always too dark," and books written among the stacks manifest this dull dimness — while "other books reflect piercing mountain light, or the sea sparkling in sunshine." It's my hope that this book will cast a different light, bring a bracing gust of fresh air to the thinking we do as students and workers, as parents and citizens, as leaders and creators. Our society is facing unprecedented challenges, and we'll need to think well in order to solve them. The brainbound paradigm now so dominant is clearly inadequate to the task; everywhere we look we see problems with attention and memory, with motivation and persistence, with logical reasoning and abstract thinking. Truly original ideas and innovations seem scarce; engagement levels at schools and in companies are low; teams and groups struggle to work together in an effective and satisfying way.

I've come to believe that such difficulties result in large part from a fundamental misunderstanding of how — and *where* — thinking happens. As long as we settle for thinking inside the brain, we'll remain bound by the limits of that organ. But when we reach outside it with intention and skill, our thinking can be transformed. It can become as dynamic as our bodies, as airy as our spaces, as rich as our relationships — as capacious as the whole wide world.

Introduction:
Thinking Outside the Brain

USE YOUR HEAD.

How many times have you heard that phrase? Perhaps you've even urged it on someone else—a son or daughter, a student, an employee. Maybe you've muttered it under your breath while struggling with an especially tricky problem, or when counseling yourself to remain rational: *Use your head!*

The command is a common one, issued in schools, in the workplace, amid the trials of everyday life. Its refrain finds an echo in culture both high and low, from Auguste Rodin's *The Thinker,* chin resting thoughtfully on fist, to the bulbous cartoon depiction of the brain that festoons all manner of products and websites—educational toys, nutritional supplements, cognitive fitness exercises. When we say it, we mean: call on the more than ample powers of your brain, draw on the magnificent lump of tissue inside your skull. We place a lot of faith in that lump; whatever the problem, we believe, the brain can solve it.

But what if our faith is misplaced? What if the directive to "use your head," ubiquitous though it may be, is misguided? A burgeoning body of research suggests that we've got it exactly backwards. As it is, we use our brains entirely too much—to the detriment of our ability to think intelligently. What we need to do is think *outside* the brain.

Thinking outside the brain means skillfully engaging entities external to our heads—the feelings and movements of our bodies, the physical spaces in which we learn and work, and the minds of the other people around us—drawing them into our own mental processes. By reaching beyond the brain to recruit these "extra-neural" resources, we are able to focus more intently, comprehend more deeply, and create more imaginatively—to entertain ideas that would be literally unthinkable by the brain alone. It's true that we're more accustomed to thinking *about* our bodies, our spaces, and our relationships. But we can also think *with* and *through* them—by using the movements of our hands to understand and express abstract concepts, for example, or by arranging our workspace in ways that promote idea generation, or by engaging in social practices like teaching and storytelling that lead to deeper understanding and more accurate memory. Rather than exhorting ourselves and others to use our heads, we should be applying extra-neural resources to the project of thinking *outside* the skull's narrow circumference.

But wait, you may be asking: What's the need? Isn't the brain, on its own, up to the job? Actually, no. We've been led to believe that the human brain is an all-purpose, all-powerful thinking machine. We're deluged with reports of discoveries about the brain's astounding abilities, its lightning quickness and its protean plasticity; we're told that the brain is a fathomless wonder, "the most complex structure in the universe." But when we clear away the hype, we confront the fact that the brain's capacities are actually quite constrained and specific. The less heralded scientific story of the past several decades has been researchers' growing awareness of the brain's *limits.* The human brain is limited in its ability to pay attention, limited in its capacity to remember, limited in its facility with abstract concepts, and limited in its power to persist at a challenging task.

Importantly, these limits apply to *everyone's* brain. It's not a matter of individual differences in intelligence; it's a matter of the character of the organ we all possess, its biological nature and its evolutionary history. The brain *does* do a few things exquisitely well—things like sensing and moving the body, navigating through space, and connecting with other humans. These activities it can manage fluently, almost effortlessly. But accurately recalling complex information? Engaging in rigorous logical reasoning? Grasping abstract or counterintuitive ideas? Not so much.

Here we arrive at a dilemma—one that we all share: The modern world is extraordinarily complex, bursting with information, built around non-intuitive ideas, centered on concepts and symbols. Succeeding in this world requires focused attention, prodigious memory, capacious bandwidth, sustained motivation, logical rigor, and proficiency with abstractions. The gap between what our biological brains are capable of, and what modern life demands, is large and getting larger each day. With every experimental discovery, the divide between the scientific account of the world and our intuitive "folk" understanding grows more pronounced. With every terabyte of data swelling humanity's store of knowledge, our native faculties are further outstripped. With every twist of complexity added to the world's problems, the naked brain becomes more unequal to the task of solving them.

Our response to the cognitive challenges posed by contemporary life has been to double down on what the philosopher Andy Clark calls "brainbound" thinking—those very capacities that are, on their own, so woefully inadequate. We urge ourselves and others to grit it out, bear down, "just do it"—to *think harder.* But, as we often find to our frustration, the brain is made of stubborn and unyielding stuff, its vaunted plasticity notwithstanding. Confronted by its limits, we may conclude that we ourselves (or our children or our students or our employees) are simply not smart enough, or not "gritty" enough. In fact, it's the way we handle our mental shortcomings—which are, remember, endemic to our species—that is the problem. Our approach constitutes an instance of (as the poet William Butler Yeats put it in another context) "the will trying to do the work of the imagination." The smart move is not to lean ever harder on the brain but to learn to reach beyond it.

In *The Middle Class Gentleman,* a comedy written by the seventeenth-century French playwright Molière, the would-be aristocrat Monsieur Jourdain is delighted by a realization that follows upon his learning the difference between prose and verse. "By my faith! For more than forty years I have been speaking prose without knowing anything about it!" he exclaims. Likewise, we may be impressed to learn that we have long been drawing extra-neural resources into our thinking processes—that we *already* think outside the brain.

That's the good news. The bad news is that we often do it haphazardly, without much intention or skill. It's no wonder this is the case. Our efforts at education and training, as well as management and leadership, are aimed almost exclusively at promoting brainbound thinking. Beginning in elementary school, we are taught to sit still, work quietly, think hard—a model for mental activity that will prevail during all the years that follow, through high school and college and into the workplace. The skills we develop and the techniques we are taught are those that involve using our heads: committing information to memory, engaging in internal reasoning and deliberation, endeavoring to self-discipline and self-motivate.

Meanwhile, there is no corresponding cultivation of our ability to think outside the brain—no instruction, for instance, in how to tune in to the body's internal signals, sensations that can profitably guide our choices and decisions. We're not trained to use bodily movements and gestures to understand highly conceptual subjects like science and mathematics, or to come up with novel and original ideas. Schools don't teach students how to restore their depleted attention with exposure to nature and the outdoors, or how to arrange their study spaces so that they extend intelligent thought. Teachers and managers don't demonstrate how abstract ideas can be turned into physical objects that can be manipulated and transformed in order to achieve insights and solve problems. Employees aren't shown how the social practices of imitation and vicarious learning can shortcut the process of acquiring expertise. Classroom groups and workplace teams aren't coached in scientifically validated methods of increasing the collective intelligence of their members. Our ability to think outside the brain has been left almost entirely uneducated and undeveloped.

This oversight is the regrettable result of what has been called our "neurocentric bias"—that is, our idealization and even fetishization of the brain—and our corresponding blind spot for all the ways cognition extends beyond the skull. (As the comedian Emo Philips has remarked: "I used to think that the brain was the most wonderful organ in my body. Then I realized who was telling me this.") Seen from another perspective, however, this near-universal neglect represents an auspicious opportunity—a world of unrealized potential. Until recently, science shared the larger culture's neglect of thinking outside the brain. But this is no longer the case. Psychologists, cognitive scientists, and neuroscientists are now able to provide a clear picture of how extra-neural inputs shape the way we think. Even more promising, they offer practical guidelines for enhancing our thinking through the use of these outside-the-brain resources. Such developments are unfolding against the backdrop of a broader shift in how we view the mind—and, by extension, how we understand ourselves.

But first — to gain a sense of where we've been and where we're headed, it's worth taking several steps back in time, to the moment when our current ideas about the brain were born.

On February 14, 1946, a breathless bustle filled the halls of the Moore School of Electrical Engineering in Philadelphia. On this day, the school's secret jewel was going to be revealed to the world: the ENIAC. Inside a locked room at Moore hummed the Electronic Numerical Integrator and Computer, the first machine of its kind capable of performing calculations at lightning speed. Weighing thirty tons, the massive ENIAC used around eighteen thousand vacuum tubes, employed about six thousand switches, and encompassed upwards of half a million soldered joints; it had taken more than 200,000 man-hours to build.

The bus-sized contraption was the brainchild of John Mauchly and J. Presper Eckert Jr., two young scientists at the University of Pennsylvania, Moore's parent institution. With funding from the US Army, the ENIAC had been developed for the purpose of computing artillery trajectories for American gunners fighting the war in Europe. Compiling trajectory tables — necessary for the effective use of new weapons being introduced by the military — was a laborious process, requiring the service of teams of human "computers" working in shifts around the clock. A machine that could do their job with speed and accuracy would give the army an invaluable edge.

Now, six months after V-Day, the demands of wartime were giving way to the needs of an expanding economy, and Mauchly and Eckert had called a press conference to introduce their invention to the world. The two men had prepared for the event with deliberate care, and no small amount of stagecraft. As the ENIAC chugged away at a given task, some three hundred neon lights built into the machine's accumulators flickered and flashed. Presper Eckert, known to all as "Pres," judged the effect of these small bulbs insufficiently impressive. On the morning of the press conference, he ran out and purchased an armful of Ping-Pong balls, each of which he cut in half and marked with a number. The plastic domes, glued over the neon bulbs, now cast a dramatic glow — especially once the room's overhead lights were dimmed.

At the appointed hour, the door to the room that held the ENIAC was opened, and a gaggle of officials, academics, and journalists filed in.

Standing in front of the hulking machine, lab member Arthur Burks welcomed the group and sought to impart to them a sense of the moment's magnitude. The ENIAC was engineered to carry out mathematical operations, he explained, and these operations, "if made to take place rapidly enough, might in time solve almost any problem." Burks announced that he would begin the day's demonstration by asking the ENIAC to multiply 97,367 by itself five thousand times. The reporters in the room bent over their notepads. "Watch closely, you may miss it," he warned, and pushed a button; before the newsmen had time to look up, the task was complete, executed on a punch card delivered to Burks's hand.

Next Burks fed the machine a problem like those for which it had been designed: the ENIAC would now calculate the trajectory of a shell taking thirty seconds to travel from the gun to its target. Such a task would take a team of human experts three days to compute; the ENIAC completed the job in twenty seconds, faster than the shell itself could fly. Jean Bartik, one of a group of pioneering female engineers who helped program the ENIAC, was on hand for the demonstration. She recalled, "It was unheard of that a machine could reach such speeds of calculation, and everyone in the room, even the great mathematicians, were in complete wonder and awe at what they had just seen."

The next day, admiring accounts of the ENIAC appeared in newspapers all over the world. "PHILADELPHIA—One of the war's top secrets, an amazing machine which applies electronic speeds for the first time to mathematical tasks hitherto too difficult and cumbersome for solution, was announced here tonight by the War Department," the *New York Times* reported on its front page. The *Times* reporter, T. R. Kennedy Jr., sounded dazzled by what he'd seen. "So clever is the device," he wrote, "that its creators have given up trying to find problems so long that they cannot be solved."

The introduction of the ENIAC was not just a milestone in the history of technology. It was a turning point in the story of *how we understand ourselves*. In its early days, Mauchly and Eckert's invention was frequently compared to a human brain. Newspaper and magazine articles described the ENIAC as a "giant electronic brain," a "robot brain," an "automatic brain," and a "brain machine." But before long, the analogy got turned around. It became a commonplace that the *brain* is like a *computer*. Indeed, the "cognitive revolution" that would sweep through American universities in the 1950s and 1960s was premised on the belief that the brain could be understood as a flesh-and-blood computing machine. The first generation of cognitive scientists "took seriously the idea that the mind is a kind of computer," notes Brown University professor Steven Sloman. "Thinking was assumed to be a kind of computer program that runs in people's brains."

Since those early days at the dawn of the digital age, the brain-computer analogy has become only more pervasive and more powerful, engaged not just by researchers and academics but by the rest of us, the public at large. The metaphor provides us with a model, sometimes conscious but often implicit, of how thinking works. The brain, according to this analogy, is a self-contained information-processing machine, sealed inside the skull as the ENIAC was sequestered in its locked room. From this inference emerges a second: the human brain has attributes, akin to gigabytes of RAM and megahertz of processing speed, that can be easily measured and compared. Following on these is the third and perhaps most significant supposition of all: that some brains, like some computers, are just *better;* they possess the biological equivalent of more memory storage, greater processing power, higher-resolution screens.

To this day, the computer metaphor dominates the way we think and talk about mental activity—but it's not the only one that shapes our notion of the brain. A half-century after the ENIAC was unveiled, another analogy rose to prominence.

"New research shows That the Brain Can Be Developed Like a Muscle," read the headline of the news article, set in bold type. The year was 2002, and Lisa Blackwell, a graduate student at Columbia University working with psychology professor Carol Dweck, was handing out copies of the article to a classroom full of seventh-graders at a public school in New York City. Dweck and Blackwell were testing a new theory, investigating the possibility that the way we conceptualize the brain can affect how well we think. The study's protocol required Blackwell to guide the students through eight informational sessions; in this, the third session in the sequence, students were to take turns reading the text of the article aloud.

"Many people believe that a person is born either smart, average, or dumb—and stays that way," one student began. "But new research shows that the brain is more like a muscle—it changes and gets stronger when you use it." Another student picked up the thread: "Everyone knows that when you lift weights, your muscles get bigger and you get stronger. A person who can't lift 20 pounds when they start exercising can get strong enough to lift 100 pounds after working out for a long time. That's because the muscles become larger and stronger with exercise. And when you stop exercising, the muscles shrink and you get weaker. That's why people say, 'Use it or lose it!'" A giggle rippled through the room. "But," a third pupil read on, "most people don't know that when they practice and learn new things, parts of their brain change and get larger, a lot like muscles do when they exercise."

Dweck's idea, which she initially called "the incremental theory of intelligence," would eventually become known to the world as the "growth mindset": the belief that concerted mental effort could make people smarter, just as vigorous physical effort could make people stronger. As she and her colleagues wrote in an account of their early research in schools, "The key message was that learning changes the brain by forming new connections, and that students are in charge of this process." From these beginnings, growth mindset became a popular phenomenon—spawning a book, *Mindset,* that has sold millions of copies, and inspiring an untold number of speeches, presentations, and workshops, delivered to corporate and organizational audiences as well as to students and teachers.

At the center of it all is a metaphor: the brain as muscle. The mind, in this analogy, is akin to a biceps or a quadriceps—a physical entity that varies in strength among individuals. The comparison has been incorporated into another hugely popular concept originating in academic psychology: "grit." Angela Duckworth, the University of Pennsylvania psychologist who defines grit as "perseverance and passion for long-term goals," echoes Dweck in her own book. "Like a muscle that gets stronger with use, the brain changes itself when you struggle to master a new challenge," she wrote in the best-selling *Grit,* published in 2016. The emphasis in *Grit* on mustering more of one's own internal resources makes the brain-as-muscle analogy a perfect fit. The comparison is made even more explicitly by purveyors of so-called "cognitive fitness" exercises, which have drawn millions of hopeful users under names like "CogniFit" and "Brain Gym." (So pervasive is the metaphor that some scientists concerned about the spread of "neuromyths"—common misconceptions about the brain—have begun to point out that the brain is not *actually* a muscle but rather an organ made up of specialized cells known as neurons.)

These two metaphors—brain as computer and brain as muscle—share some key assumptions. To wit: the mind is a discrete thing that is sealed in the skull; this discrete thing determines how well people are able to think; this thing has stable properties that can easily be measured, compared, and ranked. Such assumptions feel comfortably familiar; indeed, they weren't particularly novel even at the moment they were first proposed. For centuries, brains had been likened to machines—to whichever appliance of the time appeared most advanced: a hydraulic pump, a mechanical clock, a steam engine, a telegraph machine.

In a lecture delivered in 1984, philosopher John Searle noted: "Because we do not understand the brain very well, we are constantly tempted to use the latest technology as a model for trying to understand it. In my childhood we were always assured that the brain was a telephone switchboard." Teachers, parents, and other adults all proffered the metaphor of brain as switchboard, recounted Searle, for "what else could it be?"

Brains had also long been likened to muscles that could be strengthened with exercise—a theme promulgated, for example, by physicians and health experts in the nineteenth and early twentieth centuries. In his *First Book in Physiology and Hygiene,* published in 1888, doctor John Harvey Kellogg made an argument that sounds very much like Carol Dweck's. "What do we do when we want to strengthen our muscles? We make them work hard every day, do we not?" Kellogg inquired of his intended youthful readership. "The exercise makes them grow large and strong. It is just the same with our brains. If we study hard and learn our lessons well, then our brains grow strong and study becomes easy."

Entrenched historical foundations support these metaphors; they rest upon deep cultural underpinnings as well. The computer and muscle analogies fit neatly with our society's emphasis on individualism—its insistence that we operate as autonomous, self-contained beings, in possession of capacities and competencies that are ours alone. These comparisons also readily conform to our culture's penchant for thinking in terms of good, better, best. Scientist and author Stephen Jay Gould once included in his list of "the oldest issues and errors of our philosophical traditions" our persistent inclination "to order items by ranking them in a linear series of increasing worth." Computers may be slow or fast, muscles may be weak or strong—and so it goes, we assume, with our own and others' minds.

There even appear to be hard-wired *psychological* factors underlying our embrace of these ideas about the brain. The belief that some core quantity of intelligence resides within each of our heads fits with a pattern of thought, apparently universal in humans, that psychologists call "essentialism"—that is, the conviction that each entity we encounter possesses an inner essence that makes it what it is. "Essentialism shows up in every society that has been studied," notes Yale University psychology professor Paul Bloom. "It appears to be a basic component of how we think about the world." We think in terms of enduring essences—rather than shifting responses to external influences—because we find such essences easier to process mentally, as well as more satisfying emotionally. From the essentialist perspective, people simply "are" intelligent or they are not.

Together, the historical, cultural, and psychological bases of our assumptions about the mind—that its properties are individual, inherent, and readily ranked according to quality—give them a powerful punch. Such assumptions have profoundly shaped the views we hold on the nature of mental activity, on the conduct of education and work, and on the value we place on ourselves and others. It's therefore startling to contemplate that the whole lot of it could be misconceived. To grasp the nature of this error, we need to consider another metaphor.

On the morning of April 18, 2019, computer screens went dark across a swath of Seoul, South Korea's largest city. Lights flickered out in schools and offices across the 234-square-mile metropolis, home to some 10 million people. Stoplights at street intersections blinked off, and electric-powered trains slowed to a halt. The cause of the blackout was as small in scale as its effects were widespread: a power outage caused by magpies, the black-and-white-feathered birds who build their nests on utility poles and transmission towers. Magpies—members of the corvid family, which also includes crows, jays, and ravens—are well known for making their nests out of whatever is available in the environment. The birds have been observed using an astonishing array of materials: not only twigs, string, and moss, but also dental floss, fishing line, and plastic Easter grass; chopsticks, spoons, and drinking straws; shoelaces, eyeglass frames, and croquet wickets. During the American Dust Bowl of the 1930s, which eliminated vegetation from huge swaths of the West, magpies' corvid cousins made nests out of barbed wire.

The densely packed urban neighborhoods of modern-day Seoul feature few trees or bushes, so magpies use what they can find: metal clothes hangers, TV antennas, and lengths of steel wire. These materials conduct electricity—and so, when the birds build their nests on the city's tall electrical transmission towers, the flow of electricity is regularly disrupted. According to KEPCO, the Korea Electric Power Corporation, magpies are responsible for hundreds of power outages annually in areas all across the country. Each year, KEPCO employees work to remove upwards of ten thousand nests, but just as quickly the magpies build them up again.

Magpies may pose a headache for power companies, but their activity supplies a felicitous analogy for the way the mind works. Our brains, it might be said, are like magpies, fashioning their finished products from the materials around them, weaving the bits and pieces they find into their trains of thought. Set beside the brain-as-computer and brain-as-muscle metaphors, it's apparent that the brain as magpie is a very different kind of analogy, with very different implications for how mental processes operate. For one thing: thought happens not only inside the skull but out in the world, too; it's an act of continuous assembly and reassembly that draws on resources external to the brain. For another: the kinds of materials available to "think with" affect the nature and quality of the thought that can be produced. And last: the capacity to think well—that is, to be intelligent—is not a fixed property of the individual but rather a shifting state that is dependent on access to extra-neural resources and the knowledge of how to use them.

This is, admittedly, a radically new way of thinking about thinking. It may not feel easy or natural to adopt. But a growing mass of evidence generated within several scientific disciplines suggests that it's a much more accurate rendering of how human cognition actually works. Moreover, it's a gratifyingly generative conceptualization, because it offers so many practical opportunities for improving how well we think. It has arrived just in time. Recasting our model of how the mind functions has lately become an urgent necessity, as we find ourselves increasingly squeezed by two opposing forces: we need ever more to think outside the brain, even as we have become ever more stubbornly committed to the brainbound approach.

First, as to that growing need to think outside the brain: as many of us can readily recognize—in the accelerated pace of our days and the escalating complexity of our duties at school and work—the demands on our thinking are ratcheting up. There's *more* information we must deal with. The information we have to process is coming at us *faster.* And the *kind* of information we must deal with is increasingly specialized and abstract. This difference in kind is especially significant. The knowledge and skills that we are biologically prepared to learn have been outstripped by the need to acquire a set of competencies that come far less naturally and are acquired with far more difficulty. David Geary, a professor of psychology at the University of Missouri, makes a useful distinction between "biologically primary" and "biologically secondary" abilities. Human beings, he points out, are born ready to learn certain things: how to speak the language of the local community, how to find their way around a familiar landscape, how to negotiate the challenges of small-group living. We are not born to learn the intricacies of calculus or the counterintuitive rules of physics; we did not evolve to understand the workings of the financial markets or the complexities of global climate change. And yet we dwell in a world where such biologically secondary capacities hold the key to advancement, even survival. The demands of the modern environment have now met, and exceeded, the limits of the biological brain.

For a time, it's true, humanity was able to keep up with its own ever-advancing culture, resourcefully finding ways to use the biological brain better. As their everyday environments grew more intellectually demanding, people responded by upping their cognitive game. Continual engagement with the mental rigors of modern life—along with improving nutrition, rising living conditions, and reduced exposure to infectious disease and other pathogens—produced a century-long climb in average IQ score, as measured by intelligence tests taken by people all over the globe. But this upward trajectory is now leveling off. In recent years, IQ scores have stopped rising, or have even begun to drop, in countries like Finland, Norway, Denmark, Germany, France, and Britain. Some researchers suggest that we have now pushed our mental equipment as far as it can go. It may be that "our brains are already working at near-optimal capacity," note Nicholas Fitz and Peter Reiner, writing in the journal *Nature*. Efforts to wrest more intelligence from this organ, they add, "bump up against the hard limits of neurobiology."

As if to protest this unwelcome truth, attempts to subvert such limits have received growing attention in recent years. Commercial brain-training regimens like Cogmed, Lumosity, and BrainHQ have attracted many who desire to improve their memory and increase their focus; Lumosity alone claims 100 million registered users in 195 countries. At the same time, so-called neuroenhancement—innovations like "smart pills" and electrical brain stimulation that claim to make their users more intelligent—have drawn breathless media coverage, as well as extensive investment from pharmaceutical and biotechnology companies.

So far, however, these approaches have yielded little more than disappointment and dashed hopes. A team of scientists who set out to evaluate all the peer-reviewed intervention studies cited on the websites of leading brain-training companies could find "little evidence" within those studies "that training improves everyday cognitive performance." Engaging in brain training does improve users' performance—but only on exercises highly similar to the ones they've been practicing. The effect does not seem to transfer to real-life activities involving attention and memory. A 2019 study of Cogmed concluded that such transfer "is rare, or possibly inexistent." A 2017 study of Lumosity determined that "training appears to have no benefits in healthy young adults"; similarly dismal results have been reported for older individuals. In 2016, Lumosity was forced to pay a $2 million fine for deceptive advertising to the US Federal Trade Commission. Smart pills haven't fared much better; a clinical trial of one "nootropic" drug popular among Silicon Valley tech workers found that a cup of coffee was more effective at boosting memory and attention.

Medications and technologies that might, someday, actually enhance intelligence remain in the early stages of laboratory testing. The best way—and, at least for now, the *only* way—for us to get smarter is to get better at thinking outside the brain. Yet we dismiss or disparage this kind of cognition, to the extent that we consider it at all. Our pronounced bias in favor of brainbound thinking is long-standing and well entrenched—but a bias is all it is, and one that can no longer be supported or sustained. The future lies in thinking outside the brain.

WE CAN BETTER grasp the future of thinking outside the brain by taking a look back at the time when the idea first emerged. In 1997, Andy Clark—then a professor of philosophy at Washington University in St. Louis, Missouri—left his laptop behind on a train. The loss of his usually ever-present computer hit him, he later wrote, "like a sudden and somewhat vicious type of (hopefully transient) brain damage." He was left "dazed, confused, and visibly enfeebled—the victim of the cyborg equivalent of a mild stroke." The experience, distressing as it was, provided fodder for a notion he had been pondering for some time. His computer, he realized, had in a sense become a *part* of his mind, an integral element of his thinking processes. His mental capacities were effectively extended by the use of his laptop, allowing his brain to overachieve—to think more efficiently and effectively, more *intelligently,* than it could without the device. His brain plus his computer equaled his mind, extended.

Two years earlier, Clark and his colleague David Chalmers had coauthored an article that named and described just this phenomenon. Their paper, titled "The Extended Mind," began by posing a question that would seem to have an obvious answer. "Where does the mind stop and the rest of the world begin?" it asked. Clark and Chalmers went on to offer an unconventional response. The mind does *not* stop at the standard "demarcations of skin and skull," they argued. Rather, it is more accurately viewed as "an extended system, a coupling of biological organism and external resources." A recognition of this reality, they acknowledged, "will have significant consequences"—in terms of "philosophical views of the mind," but also "in moral and social domains." The authors were aware that the vision they were setting out would require a thorough reimagining of what people are like and how they function, a reimagining they saw as necessary and right. Once "the hegemony of skin and skull is usurped," they concluded, "we may be able to see ourselves more truly as creatures of the world."

The world, at first, was not so sure. Before being published in *Analysis* in 1998, the paper received rejections from three other journals. Once in print, "The Extended Mind" was greeted with perplexity—and no small amount of derision. But the idea it proposed turned out to have surprising power, within the academy and well beyond it. What at first appeared radical and out-there quickly came to seem less so, as daily life in the digital age provided a continuous proof-of-concept demonstration of people extending their minds with their devices. Initially derided as wacky, the notion of the extended mind came to seem eminently plausible, even prescient.

In the more than twenty years since the publication of "The Extended Mind," the idea it introduced has become an essential umbrella concept under which a variety of scientific sub-fields have gathered. Embodied cognition, situated cognition, distributed cognition: each of these takes up a particular aspect of the extended mind, investigating how our thinking is extended by our bodies, by the spaces in which we learn and work, and by our interactions with other people. Such research has not only produced new insights into the nature of human cognition; it has also generated a corpus of evidence-based methods for extending the mind.

That's where this book comes in: it aims to *operationalize* the extended mind, to turn this philosophical sally into something practically useful. In chapter 1, we'll learn how to tune in to our interoception—the sensations that arise from within the body—and how to use these signals to make sounder decisions. In chapter 2, we'll find out how moving our bodies can nudge our minds toward deeper understanding. Chapter 3 looks at how the gestures we make with our hands can bolster our memory. Chapter 4 examines how time spent in natural spaces can restore our depleted attention. In chapter 5, we'll see how built spaces—the interiors we inhabit at school and at work—can be designed to promote creativity. In chapter 6, we will explore how moving our thoughts out of our heads and into "the space of ideas" can lead us to new insights and discoveries. Chapter 7 probes how we can think with the minds of experts; chapter 8 considers how we can think with classmates, colleagues, and other peers. Finally, in chapter 9, we'll examine how groups thinking together can become more than the sum of their members.

Across these varied instantiations of the extended mind, several common themes are apparent. The first of these concerns the source of Andy Clark's initial inspiration: the role of technology in extending our thinking. Our devices can and do extend our minds, of course—but not always; sometimes they lead us to think *less* intelligently, as anyone who's been distracted by clickbait or misled by a GPS system can tell you. The failure of our technology to consistently enhance our intelligence has to do with a metaphor we encountered earlier in this introduction: the computer as brain. Too often, those who design today's computers and smartphones have forgotten that users inhabit biological bodies, occupy physical spaces, and interact with other human beings. Technology itself is brainbound—but by the same token, technology itself could be extended, broadened to include the extra-neural resources that do so much to enrich the thinking we do in the offline world. In each of the chapters that follow, we'll encounter examples of such "extended technology"—from an online foreign-language-learning platform that encourages its users to make gestures and not just repeat words; to a Waze-like app that plots not the fastest route but the one most filled with nature's greenery; to a video game that induces players to look not at the screen but at one another, synchronizing their movements in pursuit of a shared experience.

A second theme to emerge from a review of research on the extended mind is its distinctive take on the nature of expertise. Traditional notions of what makes an expert are highly brainbound, focused on internal, individual effort (think of the late psychologist Anders Ericsson's famous finding that mastery in any field requires "10,000 hours" of practice). The literature on the extended mind suggests a different view: experts are those who have learned how best to marshal and apply extra-neural resources to the task before them. This alternative perspective has real implications for how we understand and cultivate superior performance. For example: although the conventional take on expertise highlights economy, efficiency, and optimality of action—geniuses and superstars "just do it"—research in the vein of the extended mind finds that experts actually do *more* experimenting, more testing, and more backtracking than beginners. They are more apt than novices to make skillful use of their bodies, of physical space, and of relationships with others. In most scenarios, researchers have found, experts are less likely to "use their heads" and more inclined to extend their minds—a habit that the rest of us can learn to emulate on our way to achieving mastery.

Finally, in surveying the study of the extended mind, there's one more theme that is impossible to ignore: the matter of what we might call "extension inequality." Our schools, our workplaces, the very structure of our society are based on the assumption that some people are able to think more intelligently than others. The reason for such individual differences is taken as self-evident: obviously it's because those people are smarter—because they have more of the stuff called "intelligence" inside their heads. Research on the extended mind points to a different explanation. That is: some people are able to think more intelligently because they are *better able to extend their minds.* They may have more knowledge about how mental extension works, the kind of knowledge that this book aims to make accessible. But it's also indisputable that the extensions that allow us to think well—the freedom to move one's body, say, or the proximity of natural green spaces; control over one's personal workspace, or relationships with informed experts and accomplished peers—are far from equally distributed. When reading the chapters that follow, we should keep in mind the way access, or lack of access, to mental extensions might be shaping the thinking of our students, employees, co-workers, and fellow citizens.

Metaphors are powerful, and none more so than the ones we use to understand our own minds. The value of the approach described in these pages ultimately lies in the novel analogy it offers, an analogy we can apply to our everyday efforts to learn and remember, to solve problems and imagine possibilities. We extend beyond our limits, not by revving our brains like a machine or bulking them up like a muscle—but by strewing our world with rich materials, and by weaving them into our thoughts.

PART I

THINKING WITH OUR BODIES

1

Thinking with Sensations

During his years of working as a financial trader at Goldman Sachs, Merrill Lynch, and Deutsche Bank, John Coates watched it happen again and again. "Using my best analytical efforts, drawing on my education"—Coates has a PhD in economics from the University of Cambridge—"and a wide reading of economic reports and statistics," he would devise a brilliant trade, one that was impeccable in its logic and unassailable in its reasoning. And—it would lose money, every time.

Then there were other occasions, equally puzzling. "I would catch a glimpse with peripheral vision of another possibility, another path into the future. It showed up as a mere blip in my consciousness, a momentary tug on my attention, but it was a flash of insight coupled with a gut feeling that gave it the imprimatur of the highly probable." When he obeyed these "gut feelings," Coates found, he was usually rewarded with a profitable outcome. Against all his assumptions, all his training, Coates was forced to arrive at an unconventional conclusion: "Good judgment may require the ability to listen carefully to feedback from the body."

Further, he observes, "some people may be better at this than others." On any Wall Street trading floor "you will find high-IQ, Ivy League–educated stars who cannot make any money at all, for all their convincing analyses; while across the aisle sits a trader with an undistinguished degree from an unknown university, who cannot keep up with the latest analytics, but who consistently prints money, to the bafflement and irritation of his seemingly more gifted colleagues." It is possible, muses Coates, "though odd to contemplate, that the better judgment of the money-making trader may owe something to his or her ability to produce bodily signals, and equally to listen to them."

Coates shares these reflections in a captivating book, *The Hour Between Dog and Wolf,* which draws on his years as a trader as well as on his surprising second career as an applied physiologist. Over time, the questions generated by his work in finance — "Could we tell whether one person has better gut feelings than another? Could we monitor feedback from their bodies?" — became more compelling than the work itself, and Coates left Wall Street to pursue the answers in scientific research. He presented the fruits of his inquiry in 2016, detailing the results of a collaboration with academic neuroscientists and psychiatrists in the journal *Scientific Reports.*

Coates and his new colleagues examined a group of financial traders working on a London trading floor, asking each one to identify the successive moments when he felt his heart beat — a measure of the individual's sensitivity to bodily signals. The traders, they found, were much better at this task than were an age- and gender-matched group of controls who did not work in finance. What's more, among the traders themselves, those who were the most accurate in detecting the timing of their heartbeats made more money, and tended to have longer tenures in what was a notably volatile line of work. "Our results suggest that signals from the body — the gut feelings of financial lore — contribute to success in the markets," the team concluded. Confirming Coates's informal observations, those who thrived in this milieu were not necessarily people with greater education or intellect, but rather "people with greater sensitivity to interoceptive signals."

Interoception is, simply stated, an awareness of the inner state of the body. Just as we have sensors that take in information from the outside world (retinas, cochleas, taste buds, olfactory bulbs), we have sensors inside our bodies that send our brains a constant flow of data from within. These sensations are generated in places all over the body — in our internal organs, in our muscles, even in our bones — and then travel via multiple pathways to a structure in the brain called the insula. Such internal reports are merged with several other streams of information — our active thoughts and memories, sensory inputs gathered from the external world — and integrated into a single snapshot of our present condition, a sense of "how I feel" in the moment, as well as a sense of the actions we must take to maintain a state of internal balance.

All of us experience these bodily signals—but some of us feel them more keenly than others. To measure interoceptive awareness, scientists apply the heartbeat detection test, the one John Coates used with his group of financial traders: test takers are asked to identify the instant when their heart beats, without placing a hand on the chest or resting a finger on a wrist. Researchers have found a surprisingly wide range in terms of how people score. Some individuals are interoceptive champions, able to determine accurately and consistently when their heartbeats happen. Others are interoceptive duds: they can't feel the rhythm. Few of us are aware that this spectrum of ability even exists, much less where we fall on it—so preoccupied are we with more conventionally brain-bound capacities. We may remember down to the point our SAT scores or our high school GPA, but we haven't given this particular aptitude a moment's thought.

Vivien Ainley recalls a clear demonstration of this common oversight. Ainley, an interoception researcher at Royal Holloway, University of London, was administering the heartbeat detection test to members of the public as part of an exhibit at London's Science Museum. Visitors to the exhibit were instructed to place a finger on a sensor that detected their pulse; the readout of the sensor was visible only to Ainley.

"Please tell me when your heart beats," she would say to each patron who stepped forward. An elderly couple who stopped by the booth had very different reactions to Ainley's request.

"How on earth would I know what my heart is doing?" the woman asked incredulously. Her husband turned and stared at her, equally dumbfounded.

"But of course you know," he exclaimed. "Don't be so stupid, everyone knows what their heartbeat is!"

"He had always been able to hear his heart, and she had never been able to hear hers," Ainley observed in an interview, smiling at the memory. "They had been married for decades, but they had never talked of or even recognized this difference between them."

Though we may not notice such differences, they are real, and even visible to scientists using brain-scanning technology: the size and activity level of the brain's interoceptive hub, the insula, vary among individuals and are correlated with their awareness of interoceptive sensations. How such differences arise in the first place is not yet known. All of us begin life with our interoceptive capacities already operating; interoceptive awareness continues to develop across childhood and adolescence. Differences in sensitivity to internal signals may be influenced by genetic factors, as well as by the environments in which we grow up, including the communications we receive from caregivers about how we should respond to our bodily prompts.

What we do know is that interoceptive awareness can be deliberately cultivated. A series of simple exercises can put us in touch with the messages emanating from within, giving us access to knowledge that we already possess but that is ordinarily excluded from consciousness—knowledge about ourselves, about other people, and about the worlds through which we move. Once we establish contact with this informative internal source, we can make wise use of what it has to tell us: to make sounder decisions, for example; to respond more resiliently to challenges and setbacks; to savor more fully the intensity of our emotions while also managing them more skillfully; and to connect to others with more sensitivity and insight. The heart, and not the head, leads the way.

To understand how interoception can act as such a rich repository, it's important to recognize that the world is full of far more information than our conscious minds can process. Fortunately, we are also able to collect and store the volumes of information we encounter on a *non-conscious* basis. As we proceed through each day, we are continuously apprehending and storing regularities in our experience, tagging them for future reference. Through this information-gathering and pattern-identifying process, we come to *know* things—but we're typically not able to articulate the content of such knowledge or to ascertain just how we came to know it. This trove of data remains mostly under the surface of consciousness, and that's usually a good thing. Its submerged status preserves our limited stores of attention and working memory for other uses.

A study led by cognitive scientist Pawel Lewicki demonstrates this process in microcosm. Participants in Lewicki's experiment were directed to watch a computer screen on which a cross-shaped target would appear, then disappear, then reappear in a new location; periodically they were asked to predict where the target would show up next. Over the course of several hours of exposure to the target's movements, the participants' predictions grew more and more accurate. They had figured out the pattern behind the target's peregrinations. But they could not put this knowledge into words, even when the experimenters offered them money to do so. The subjects were not able to describe "anything even close to the real nature" of the pattern, Lewicki observes. The movements of the target operated according to a pattern too complex for the conscious mind to accommodate—but the capacious realm that lies below consciousness was more than roomy enough to contain it.

"Nonconscious information acquisition," as Lewicki calls it, along with the ensuing application of such information, is happening in our lives all the time. As we navigate a new situation, we're scrolling through our mental archive of stored patterns from the past, checking for ones that apply to our current circumstances. We're not aware that these searches are under way; as Lewicki observes, "The human cognitive system is not equipped to handle such tasks on the consciously controlled level." He adds, "Our conscious thinking needs to rely on notes and flowcharts and lists of 'if-then' statements—or on computers—to do the same job which our non-consciously operating processing algorithms can do without external help, and instantly."

But—if our knowledge of these patterns is not conscious, how then can we make use of it? The answer is that, when a potentially relevant pattern is detected, it's our interoceptive faculty that tips us off: with a shiver or a sigh, a quickening of the breath or a tensing of the muscles. The body is rung like a bell to alert us to this useful and otherwise inaccessible information. Though we typically think of the brain as telling the body what to do, just as much does the body guide the brain with an array of subtle nudges and prods. (One psychologist has called this guide our "somatic rudder.") Researchers have even captured the body in mid-nudge, as it alerts its inhabitant to the appearance of a pattern that she may not have known she was looking for.

Such interoceptive prodding was visible during a gambling game that formed the basis of an experiment led by neuroscientist Antonio Damasio, a professor at the University of Southern California. In the game, presented on a computer screen, players were given a starting purse of two thousand "dollars" and were shown four decks of digital cards. Their task, they were told, was to turn the cards in the decks face-up, choosing which decks to draw from such that they would lose the least amount of money and win the most. As they started clicking to turn over cards, players began encountering rewards—bonuses of $50 here, $100 there—and also penalties, in which small or large amounts of money were taken away. What the experimenters had arranged, but the players were not told, was that decks A and B were "bad"—they held lots of large penalties in store—and decks C and D were "good," bestowing more rewards than penalties over time.

As they played the game, the participants' state of physiological arousal was monitored via electrodes attached to their fingers; these electrodes kept track of their level of "skin conductance." When our nervous systems are stimulated by an awareness of potential threat, we start to perspire in a barely perceptible way. This slight sheen of sweat momentarily turns our skin into a better conductor of electricity. Researchers can thus use skin conductance as a measure of nervous system arousal. Looking over the data collected by the skin sensors, Damasio and his colleagues noticed something interesting: after the participants had been playing for a short while, their skin conductance began to spike when they contemplated clicking on the bad decks of cards. Even more striking, the players started avoiding the bad decks, gravitating increasingly to the good decks. As in the Lewicki study, subjects got better at the task over time, losing less and winning more.

Yet interviews with the participants showed that they had no awareness of why they had begun choosing some decks over others until late in the game, long after their skin conductance had started flaring. By card 10 (about forty-five seconds into the game), measures of skin conductance showed that their bodies were wise to the way the game was rigged. But even ten turns later—on card 20—"all indicated that they did not have a clue about what was going on," the researchers noted. It took until card 50 was turned, and several minutes had elapsed, for all the participants to express a conscious hunch that decks A and B were riskier. Their bodies figured it out long before their brains did. Subsequent studies supplied an additional, and crucial, finding: players who were more interoceptively aware were more apt to make smart choices within the game. For them, the body's wise counsel came through loud and clear.

Damasio's fast-paced game shows us something important. The body not only grants us access to information that is more *complex* than what our conscious minds can accommodate. It also marshals this information at a pace that is far *quicker* than our conscious minds can handle. The benefits of the body's intervention extend well beyond winning a card game; the real world, after all, is full of dynamic and uncertain situations, in which there is no time to ponder all the pros and cons. If we rely on the conscious mind alone, we lose.

HERE, THEN, is a reason to hone our interoceptive sense: people who are more aware of their bodily sensations are better able to make use of their non-conscious knowledge. Mindfulness meditation is one way of enhancing such awareness. The practice has been found to increase sensitivity to internal signals, and even to alter the size and activity of that key brain structure, the insula. One particular component appears to be especially effective; this is the activity that often starts off a meditation session, known as the "body scan." Rooted in the Buddhist traditions of Myanmar, Thailand, and Sri Lanka, the body scan was introduced to Western audiences by mindfulness pioneer Jon Kabat-Zinn, now a professor emeritus at the University of Massachusetts Medical School. "People find the body scan beneficial because it reconnects their conscious mind to the feeling states of their body," says Kabat-Zinn. "By practicing regularly, people usually feel more in touch with sensations in parts of their body they had never felt or thought much about before."

To practice the body scan, he explains, we should first sit or lie down in a comfortable place, allowing our eyes to close gently. He recommends taking a few moments to feel the body as a whole and to sense the rising and falling of the abdomen with each in-breath and out-breath. We then begin a "sweep" of the body, starting with the toes of the left foot. Advises Kabat-Zinn, "As you direct your attention to your toes, see if you can channel your breathing to them as well, so that it feels as if you are breathing in *to* your toes and out *from* your toes." After focusing on the toes for a few breaths, we shift our attention to the sole of our foot, the heel, the ankle, and so on up to the left hip. The same procedure is repeated for the right leg, focusing on each section for the length of a few breaths. The roving spotlight of our attention now travels up through the torso, the abdomen and chest, the back and shoulders, then down each arm to the elbows, wrists, and hands. Finally, the attentional spotlight