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THE POWER of NOT THINKING

How Our Bodies
Learn and Why
We Should
Trust Them



SIMON ROBERTS

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OceanofPDF.com

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For Lucy, and Joe, Martha and Kit

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INTRODUCTION

HOW TO DRIVE A CAR

Picture a nondescript, single-story office block in a Silicon Valley backstreet. Red, green, and yellow bicycles used by Google employees to shuttle between their nearby campuses stand discarded at a junction. There are few clues that this small building contains a group of highly qualified roboticists, computer scientists and researchers attempting to solve a very difficult problem. This team is trying to replicate something that many people do every day, a skill so natural that most people barely give it any thought and would find it hard to explain how they do it.

Driving a car is so commonplace that it is largely unremarked upon. We get in, start the engine, put the car into gear, and drive off. If we have passengers, we are able to talk to them without slowing down. Different conditions, bar the most treacherous snow, ice, or fog, barely faze most

drivers and unfamiliar roads and novel traffic situations present us with few problems. We quickly become used to our own cars, but we are more than capable of jumping into a different one and driving on unfamiliar roads.

These are the fluid, intuitive and highly adaptable skills of human drivers that the team inside this building is trying to replicate. Across the automotive industry, scientists are trying to create driverless cars that can operate anywhere and under any conditions, a goal known as “level five autonomy.” To date, test vehicles have clocked up many millions of miles, and progress has certainly been impressive, yet such capability remains some way off and the jury is still out on whether it is possible.

The apparent simplicity of driving belies the fact that it is one of the most complex tasks that humans perform. Drivers don’t just steer and navigate; they are constantly performing acts of perception, planning, and prediction as they make sense of what is happening on the road around them, what other people (and not just other drivers) are doing, and what might happen next. And we perform all these tasks instinctively, people maneuvering a large chunk of fast-moving metal that becomes an extension of our own bodies once we’re behind the wheel.

Peer into the trunk of an autonomous vehicle and you will see how much computing power they require; there is no room for a suitcase, let alone a bag of groceries. A car that’s full of computers is a good reminder of how much intelligence is required to drive a car. Talk to the engineers in this Silicon Valley facility for a few minutes about the enormity of the mission they are engaged in—one’s a former NASA roboticist who worked on the Mars Exploration Rover mission team—and you start to appreciate just how smart humans are and how hard that is to mimic.

But what is the nature of this smartness? It is hard to articulate what we are doing as we drive, and any attempt to explain these actions raises more questions than it

answers. Consider these instructions on the simple act of starting a car written by the RAC, a motoring organization in the UK:

Put the key in the ignition and turn all the way until the engine starts.

Put the clutch pedal down (this is the pedal on the left).

Move the gear stick into first gear.

Use your right foot to press down on the accelerator gently to increase the engine's revs very slightly.

Slowly lift the clutch pedal using your left foot until it starts to vibrate gently.

Remove the handbrake and the car should start to move slowly.

Increase the revs while slowly raising your foot off the clutch until you are moving forward.

If you can already drive a car, these instructions will make sense; if you can't, they are unlikely to help very much. The odds are that if a new driver were to follow these commands they would under-or over-rev, lurch forward ungracefully, and stall the car. These instructions are certainly a helpful reminder of the steps required and the order to perform them in, but they seem hopelessly basic when you consider how many individual actions, and repetitions of them, are required to hop in a car and drive off.

No one learns to drive through the memorization of procedures or by following a list of instructions. We're not able to drive because we know what it means to "slowly lift the clutch pedal using your left foot until it starts to vibrate"; we are able to move off smoothly because we have a feel for how gently to take our foot off the clutch and how much we should depress the accelerator pedal to avoid stalling. And as we learn, we quickly develop a sense of how this varies on different road surfaces or inclines, gaining an

intuitive feel for how to perform the action, improving with experience.

When you start to learn to drive a car it is hard, because you are grappling with what is known as “propositional knowledge,” the discrete steps outlined by the RAC. You are initially grinding through the mental gears as you try to remember what order to perform which task in:

Clutch down, engage first gear, bit of accelerator, off the clutch a little, a little more accelerator.

Now you’re over-revving. Back off the accelerator a little.

Come off the clutch too quickly. Stall.

Try again.

This cycle of learning involves the brain and body working in tandem, as the body learns to process the sensations from how the car responds to our actions. In slightly more technical terms, what is happening is that the instructions or propositions are being translated into what are known as “sensorimotor procedures” that can be performed effectively without thinking. While a driver continues to “think out loud” as they perform these procedures, this is a sign that they are still learning. It is “only when they don’t think about what they are doing in words,” remarks anthropologist Maurice Bloch, “that drivers are truly experts.”

Over time, a driver achieves some fluency in their actions. They know when they need to change gear from the sound of the engine and become familiar with the idiosyncrasies of their vehicle. They’re able to sense when they’re going too fast, and their foot moves from accelerator to brake without conscious thought. They can act without thinking or, more precisely, without thinking about thinking. Their actions become automatic. Their body, and not just

their brain, has developed the knowledge of how to drive a car.

But how do they understand and take into account others on the road? Take the driver who, looking ahead, sees a person walking into the road. Is he getting into the passenger seat of the parked car ahead, or is he going to cross the road? Is the car at the crossroads waiting for us to proceed, or is it about to move off? Humans interpret these situations without applying much conscious thought to it, but building a machine that can make sense of scenarios like these is very hard.

Developing autonomous vehicles is about more than programming actions, procedures and the rules of the road into a computer; it's a challenge of replicating a capability that is highly practical and adaptable and which also depends on our ability to process a huge number of signals from the environment that inform our understanding of both what's happening and what we should do next.

The human skill of driving a car and the difficulty of building autonomous vehicles illustrates the central premise of this book: that our intelligence does not just arise from our brains. It is not merely the product of our brains "processing" abstract information or representations of the world, nor can it be programmed as a set of rules or propositions that enables us to think in particular ways or perform particular actions. Instead, our understanding of the world arises from our bodies' interactions with and perceptions of the world—and it is through these interactions that our bodies acquire knowledge.

The knowledge we generate with and store in our bodies is extremely hard to replicate through computing. If we were able to reduce the act of driving to a set of rules and procedures, and if the world and its drivers was entirely predictable, writing algorithms for autonomous vehicles would be reasonably simple. However, every driver and every pedestrian we encounter is different, and

unpredictably so. To make matters more complicated still, no scenario a driver confronts is ever the same as one they've experienced before.

Driving is a complex task, yet most who set out to learn how to do it are able to acquire and retain the skill. They might not be perfect at it but they achieve the ability to understand a situation and assess what's important and what the appropriate response might be. And they do all this without thinking about it.

We are able to handle the complexity of driving by using our brains and bodies together. Driving a car is a prime example of what I call "embodied knowledge": a form of knowledge where we have acquired practical understanding and ability through perception or experience. When we have embodied knowledge we instinctively know how to act. As the term suggests, it is not knowledge that resides in our brains but one that comes to inhabit our bodies.

In this book we will encounter embodied knowledge in all sorts of areas of life. We will discover how philosophers, neuroscientists, cognitive scientists, roboticists and artificial intelligence experts are all hitching their wagons to the idea that the body is critical to the formation and retention of intelligence, an embodied view of knowledge that rejects the idea that it only emerges from, and resides in, the mind. Instead, this perspective sees the body itself as able to acquire, retain, and use knowledge. When we appreciate how it does this, we can begin to grasp that it is not merely a device for hauling the brain around but a source of our intelligence.

BRING BACK THE BODIES!

For much of the twentieth century, a school of philosophical thought called phenomenology has sought to put the body

at the center of our understanding of how we experience the world. This has, in turn, encouraged disciplines like anthropology to come to new ways of understanding how cultural knowledge is acquired and communicated and how skills are learned. The flourishing discipline of neuroscience, which might at first appear to be in the “brain-focused” camp, has demonstrated the indissoluble connection between brain and body. For example, experiments have shown that abstract concepts are understood better when accompanied by bodily experiences. In recent years, psychologists and cognitive scientists, especially those exploring the possibilities of artificial intelligence, speak of “embodied cognition,” the idea that the mind must be understood in the context of its relationship to a physical body. Their work shows that we think as much with our body as we do our brains. Relatedly, the idea that we use the world around us as “scaffolding” for our thinking, has gained widespread acceptance. In *The Power of Not Thinking*, I will explore these theories and the science behind them.

In this book we will encounter people who are putting some of these principles to work, from the Silicon Valley developers swapping brainstorming for “bodystorming” to act out how cutting-edge technologies will work, to an ambassador who hitches rides with haulers to understand how frictionless trade between Britain and Europe works. We will meet a charity worker who puts people through a “refugee simulation” at the World Economic Forum in Davos to teach them about the experience of displaced people. We will discover how architects learn about ageing by putting their bodies rather than their minds to work. And in a Californian national park near the Mexican border, we’ll encounter business executives camping during a week-long immersion into their customers’ world.

I designed and participated in several of the experiences I use to tell the story of how people develop embodied knowledge. Over the course of my career in consulting I

have grown convinced that we should put experience at the heart of how policymakers, global businesses, and other organizations understand the world. I'm an anthropologist and work with many such organizations, and in recent years I've focused on applying the theory and practice of embodied knowledge to how my clients comprehend the world.

I was trained to depend not on large-scale data sets but on my own experience, having immersed myself in other people's worlds. In the mid-1990s, while living among north Indian households to explore the impact of the arrival of satellite television, I experienced the acute embarrassment families felt when *Baywatch* appeared on their screens. I shared the discomfort of women who averted their eyes or left the room when Pamela Anderson came bounding down the beach in her trademark red swimsuit. This was when it dawned on me that the world is both experienced and expressed through the body.

My career working as an anthropologist in consulting has also coincided with a growing dedication within business to big data. Big data analytics relies on millions of data points originating from people's digital footprint and behaviors, as well as massive computing power to make sense of them. Cheerleaders for big data promise profound insights into every aspect of our lives. Big business and policymakers have bet big on capabilities that are all about scale and objectivity, with the goal of producing a detached, rational view of the world. Yet at the same time, the application in business of the relatively esoteric field of anthropology has been booming. Anthropologists work at a very small scale, with sample sizes in the teens rather than the millions, and their principal tool is their own body and the experiences they share with the people they live among, rather than "data lakes," servers, and computational thinking.

On the face of it, the result is the clash between two opposing, incompatible ways of understanding the world:

one is “of the head,” large scale and objective, while the other is “of the heart,” small scale and subjective. It is easy for proponents of one view to dismiss the other, but my belief is that we can make better use of data when we’ve had embodied experiences that allow us to make sense of it. In other words, since we use both bodies and brains to make sense of world, though we have tended to focus on the latter to the neglect of the former, it is time to restore some balance.

This book is born of my conviction that it is impossible to know the world through data alone and, more positively, that our bodies are immensely powerful tools for understanding and making sense of data. It is directly informed by my experience of working with business—I have seen first-hand how executives struggle to make sense of reports and abstract data and how understanding drops into place when they engage directly in other people’s worlds. Foundational understanding of the world, derived from direct experience, can allow us to imbue the numbers with meaning and be confident in our judgments about what they are telling us.

THE WORLD ACCORDING TO THE BRAIN

Ask someone to point to the part of their body responsible for their intelligence and it is highly likely that they will point to their head. This assumption is understandable, given that this is what we’ve been told to think for centuries. We call clever people “brainy” and literary and artistic portrayals of intelligence typically tell the same story: it is what is between our ears that counts. Intelligence, so the story goes, resides in the brain.

The ideas of seventeenth-century philosopher René Descartes are usually seen as the starting point for this tendency to grant the brain preeminence in matters of intelligence. His familiar formulation “cogito ergo sum,” or “I think therefore I am,” made the being (“sum”) contingent on the thinking (“cogito”); he claimed that the mind merely uses the body to receive inputs and produce outputs and that the body might mislead the mind. This dualistic view—with the body playing a supporting role to the mind at best, and at worst being a handicap to rational thinking—continues to exert a strong influence today.

One significant way in which this brain-focused account of intelligence is borne out is in the way computers are held to be similar to brains. We’ve been making this comparison since the advent of the computer punched card reader, but it actually began at around the same time as Descartes was writing, when the idea that our brain was like a hydraulic system gave way to the theory that minute mechanical motions in the brain made thinking possible. In his 1958 book *The Computer and the Brain*, the great mathematician John von Neumann brought this comparison up to date, drawing many parallels not just between how brains and computers are built but how they function. He claimed that the nervous system had the appearance of being “digital.”

The tradition throughout history has been for humans to think of intelligence—and more specifically the brain—in terms of the most advanced technologies of each age. For example, the metaphor of “brain as telegraph” arose with the arrival of the first commercial telegraph in the 1830s, but after the emergence of machines that could perform logical thinking, a new analogy materialized: the first computers were called “electronic brains.” Given how powerful computers have become, and given our species’ superiority complex, it is unsurprising that we still compare our mind to these machines.

Yet while this comparison is tempting, brains and computers really aren't that similar. The brain doesn't operate like a computer: it doesn't run on algorithms or have physical memories, and it doesn't store and retrieve information in the way we commonly think. A computer is a calculating machine that works on the symbolic representations of the world that it is fed, and it follows the rules of the programs that it is running. It is what the cognitive scientist Andy Clark called a "disembodied logical reasoning device." New computing systems, especially those designed to create artificial intelligence, may have deployed architectures that mimic neurological processes, but brains and computers are for the most part really quite different.

When you take a photo of the food on your plate to put on social media, it is represented by a unique sequence of millions of zeros and ones—and to a computer that is all this picture is. A computer knows nothing about the smell of the food or the experience of preparing or eating it. Computers are unable to comprehend what this plate of food represents to me or anyone else. Their intelligence relies on the manipulation of abstract symbols and doesn't extend any further; for the computer, that plate of food is nothing but a serving of zeros and ones.

Compare this to human interactions with that same plate of food. We can use our senses to taste it, while the smell of it may well trigger powerful memories, emotions, and associations. Humans experience that meal and attribute meaning to it, which they can then communicate or share with others. Our thinking about the food is not just raw cognition, but the result of our experience of it and our ability to make meaning from it.

Equating brains to computers comes from a simple shorthand that has been pervasive for many centuries, because Western thought has tended to downplay the role of the body and perpetuate the idea of brains as logical

reasoning machines. However, even if comparing human and computer intelligence made sense in terms of how they each operate, which it doesn't, it assumes that human intelligence is solely a feature of our brains, which it is not. We must challenge this received wisdom, though it may feel odd.

The current fascination with AI reflects the idea that racks of servers running algorithms can reproduce or even outclass human intelligence. This idea that intelligence resides solely in our brains is taken to its logical and almost comic conclusion by start-ups like Nectome, which recently began offering a service for uploading the human brain to the cloud. This continues a long tradition of Silicon Valley visionaries and transhumanists such as Ray Kurzweil dreaming of human brains isolated from their body and running inside computer simulations. The assumption is that what is in the brain constitutes intelligence, even when it is isolated from the body.

It is time to stop neglecting the role the body plays in our acquisition of knowledge and explore how it is that brain and body combine to deliver what we regard as human intelligence. More profoundly, we might even ask whether intelligence can exist in the absence of a body. This book explores both questions and will demonstrate that intelligence is corporeal as well as cerebral.

THE JANITOR

In 2016, Google's DeepMind team announced that artificial intelligence had helped them to reduce the cooling bill in one of their vast data centers by 40 percent. Some of the world's most sophisticated machine-learning experts, from the team whose AlphaGo program famously beat world champion Lee Sedol at the ancient game of Go, had used

neural networks to help them predict future temperature and energy usage in a complex, dynamic environment.

Data centers are often located in places with cool, wet climates like the American Pacific north-west. It was in the basement of an old high school building in Oregon that a team from the microprocessor giant Intel learned the story of a janitor who had supervised an assortment of electric, pneumatic, and mechanical devices that controlled his school's ventilation. This janitor, like many of his colleagues in other schools across the state, had tended to his building for more than a decade and knew its idiosyncrasies—why certain windows didn't shut, which radiators needed bleeding more often than others, and which taps were prone to leaking. But then something changed.

In 2006, the Portland public school system installed technology that would allow them to understand what was going on in nearly eighty schools from behind a desk. The laudable aim of this initiative was to increase energy efficiency and manage costs. Sensors were installed and centralized administrators were given control over data and reports from each school, taking control of the schools' systems. The janitor, a friendly figure whose job extended far beyond managing the heating system, was unhappy to have been replaced with temperature sensors and energy usage monitors and eventually retired, fed up with the powerlessness of his new role.

At both the Google data center and the school, computation was being used to monitor and control a building. However, while energy usage and administrative costs at Google fell, the school's bills rose—with children around to leave windows open or fiddle with the thermostat and with its old leaky buildings, it was a very different environment from Google's state-of-the-art data centers. It turned out that the janitor was difficult to replace because he had exactly the kind of knowledge that was perfect for managing such an idiosyncratic building.

The world we live in looks far more like the school building in Oregon than the Google server farm: it's irregular, unstable, and has a significant number of variables at play, making it hard to be reduced to a series of computable zeros and ones. However, the idea that we can develop accurate models about the world if we collect enough data continues to gain credence. We experience that in our everyday lives when we're asked to evaluate our experience of a shop or airport security on a five-point scale—our businesses are run by increasingly strict adherence to data and the models and forecasts they enable. Closer to home, smart devices measure many aspects of our lives, including sleep, steps, or social connections, providing us with what is often presented as objective information. The people our dating apps connect us with, the songs our music streaming services queue up, and the recommendations our shopping apps make are all the result of computational or algorithmic thinking.

In 1973, the American sociologist Daniel Bell popularized the term “post-industrial society” and predicted the rise of an “intellectual technology” that would, he said, sit alongside the emerging information and computing technologies. What he was anticipating was a way of thinking and understanding the world that corresponded to, and was supported by, the logic of computing. Society, he suggested, would be characterized by the use of data to describe the world, on which judgments would be based. Bell's prediction now appears prescient. Computing has not just provided the firepower for processing the world around us; it has provided an intellectual framework that claims to be able to map, model, and understand the world.

The tale of the janitor in Oregon is the story of two different types of knowledge. One is produced by an array of sensors distributed through a building and the analysis of the data they produce, while the other is a form of knowledge acquired over time by learning about a building

as a living entity, with quirks that have to be experienced to be understood. Google's success in using artificial intelligence to lower their electricity bill was due to the fact that these environments are purpose-designed. The similar, if slightly less technologically sophisticated, approach taken in the Portland schools failed because these buildings were varied and unpredictable. The embodied knowledge that the janitor had developed of his building enabled him to attend to its systems to keep everything running smoothly. His understanding had been acquired through a body that could perceive changes in the environment and interact with the building's boilers and cooling and heating systems. His knowledge of how these machines behaved, developed through experience, was invaluable in tweaking them to get the required outcome. His understanding of the school extended far beyond the printouts from its newly installed sensors, which made him uniquely able to perform his role.

BODIES OF KNOWLEDGE

In order to highlight the differences between a big data-controlled school system and a janitor, we can follow philosopher Shaun Gallagher in comparing "brains in vats" with "flesh and blood creatures equipped with beating hearts." Gallagher, author of the influential book *How the Body Shapes the Mind*, wanted to distinguish between two ways of thinking about a brain. One view is of 85 billion nerve cells and the 150 trillion connections between them whirring away without any connection to the world: a disembodied calculating machine. A brain in a vat is a powerful organ cut off from the world, leaving it unable to interact with its environment.

The second view recognizes that human brains are located in bodies that have beating hearts, legs that move

them around the world, and hands that allow them to manipulate it. More than that, these bodies also have sensory capacities that allow them to experience the world. The janitor is a flesh-and-blood creature who uses his perceptual appreciation of the building, and an accumulated understanding of how it works, to manage it. To say his intelligence is embodied is to state the obvious: brains are part of our bodies. The human mind emerges from a brain that is located in a head that sits on the shoulders of a body that is in, and of, the world around it. The brain and body work together to enable us to make sense of the world: the sensors on our bodies help us smell, taste, feel, and hear the world around us. It is worth trying to imagine what intelligence your brain would have without your five senses and a body—what information could it receive and what use would it be? It was this thought experiment that Gallagher was alluding to when he talked about brains in vats.

If we subscribe to the idea that our body is integral to our intelligence, it is possible that it might also shape how we think, and that intelligence can have a bodily dimension. The common-sense way of thinking about smiling is that it is a facial expression that comes from us being happy, just as we tend to think that we tremble when we are scared. However, there's evidence that smiling causes us to be happy and that rather than trembling because we are frightened, we feel fear when we tremble. If the physical movement or sensations of the body shape how we feel, they also inform how we retain knowledge. Over time, and through experience, we acquire knowledge, much of which becomes embodied.

We all have embodied knowledge; we use it every day. Have you ever stood in front of a cash machine and struggled to remember your PIN, only to tap out the numbers in the air and find that you can recall it after all? Can you cook a meal brilliantly without using a recipe and without thinking about what you're doing? Are you able to

read the mood of a crowd or a room at a party? Or do you ever find yourself remarking, when confronted with a difficult decision, “My gut says ... ?” If you answered “yes” to any of these questions, it is because you have a body. It is because your brain is not a collection of neurons in a vat but is connected to a tactile, mobile, sensor-laden body that can move around in and experience the world. And none of these displays of intelligence, memory, knowledge acquisition, or sense-making would be possible if your brain wasn’t part of your body.

We tend to think we owe our intelligence to what’s above rather than below our shoulders. The title of this book, *The Power of Not Thinking*, reflects the fact that when our bodies understand their surroundings and know how to respond to it they do so without conscious instruction from the brain. It also serves as a reminder that visceral experiences of the world are key to how we make sense of it and don’t always require us to engage our minds consciously. In an age when we’re led to believe that data is everything and AI is the future, the idea of embodied knowledge is a reminder that intelligence depends on a body that makes sense of the world.

However, this is not a book that urges us to ignore the brain or exchange our fascination with it for a simple focus on the body; rather, it’s a call to rebalance our understanding of where intelligence comes from and where it resides. My hope is that bringing the body back into focus we can understand better what role it has in contributing to what makes us human.

The Power of Not Thinking explores the limits of brain-first knowledge and the often limited understanding of the world it produces, before proposing an alternative starting point for understanding intelligence: the body. You will discover why it is a good idea to learn with and trust your body and what it feels and knows.

In [part 1](#) I will explore how the mind came to dominate our view of intelligence and knowledge. We will learn about the philosophy that first distinguished the mind from the body and understand how the mind came to be understood as the seat of reason and intelligence. We will explore how this perspective has manifested itself in the “intellectual technology” of the modern world, a way of thinking that encourages disengagement, abstraction, and the preeminence of reason over feeling. We learn how this perspective gained expression in the modern age through GPS, big data, and education, all of which determine how we experience and make sense of the world, after which I will outline the consequences of this mind-first approach.

[Part 2](#) explains how the body is central to how we acquire understanding and explores the unique qualities of embodied knowledge:

- ◆ **Observation.** We acquire knowledge through immersion and imitation.
- ◆ **Practice.** The body learns skills through their repeated performance.
- ◆ **Improvisation.** Embodied knowledge is practical, which allows us to handle the unfamiliar.
- ◆ **Empathy.** It is through our bodies that we understand other people’s intentions, emotions, and feelings.
- ◆ **Retention.** Our bodies retain and can recall knowledge.

[Part 3](#) shows embodied knowledge in action, across business, politics and policy, design, and in the fields of AI and robotics. We will first see how businesses and management teams can thrive when they focus on acquiring embodied knowledge through experience rather than obsessing over big data. Then we will discover how policymakers are using embodied approaches to understand

the drivers of populism and global issues such as the refugee crisis. The shape of our world is defined through the products and experiences we encounter every day and in the third chapter of this part we will learn how embodied knowledge plays out in creative and design endeavors. Finally, we will see how the theory of embodied knowledge informs the development of the progress of artificial intelligence and robots.

COMING TO OUR SENSES

We are invited to ignore experience, instinct and intuition in favor of hard data in many areas of life, on the basis that the former is merely “feeling” while the latter has an objectivity that cannot be argued with. We have been led to think that “computable” knowledge is more reliable and trustworthy and less likely to deceive us than knowledge, which we derive from our own experiences of the world. Accordingly, we have attempted to rein in our senses, emotions and feelings.

The rise of computing has both played into and reinforced this tendency. It is unfortunate that at the moment when artificial intelligence is dominating the headlines, our confidence in what is special about our own species’ intelligence is waning. Embodied knowledge is what separates us from the artificial intelligence that increasingly defines how our lives are lived—it is our competitive advantage.

I hope that after reading this book you will better understand what embodied knowledge is and how we use it in nearly all aspects of our lives. I’m not proposing that it is a fix-all silver bullet—the antidote to big data, cold rationalism, and reductionism—but I hope that by naming

the concept and showing it in action, we can learn to trust what we know through our experience of the world.

If there's a single practical message to be taken from this book, it is that we should give more credit to the body as a resource for understanding the world. That means a more "sleeves rolled up" and engaged way of "learning by doing" rather than by rational detachment.

The more actively we develop embodied knowledge, the better placed we will be to cope with uncertainty and make good decisions based on an empathetic understanding of the world. It is time to recognize that how we know, think, and feel emerges from the interactions between our minds, bodies, environments, and experiences. We should acknowledge and exploit the advantages that embodied knowledge gives us and rejoice in being human.

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Part 1

THE MIND ASCENDANT

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Chapter 1

DESCARTES'S MECHANICAL DAUGHTER

“It seems almost as if computers were designed with the intention of our becoming more like them.”

BRIAN CHRISTIAN

While sailing to Sweden from Holland on rough seas, the captain of a ship made the discovery. In one of the cabins he found a “diabolical” lifelike doll of a young girl. One account reports that believing it to be responsible for the bad weather his crew were encountering, he instructed them to throw it overboard. According to legend the doll, or automaton, belonged to the seventeenth-century philosopher René Descartes who was a passenger on the vessel.

Although there is only a brief mention of the episode in a book published in 1699, nearly four decades after Descartes’s death the story has been retold across the centuries. The details of the story change with each retelling, but most begin with the indisputable facts. Descartes had fathered a daughter called Francine with a

maidservant in the house of a bookseller in Amsterdam, where he was living at the time. This daughter died of scarlet fever at a young age in 1640 and Descartes sailed to Sweden, where he subsequently died of pneumonia.

However, with these bare facts established, the story took on a life of its own in each recasting. In some accounts the doll is made of glass, while in others it is made of wood. Some mention its ability to talk, and others say that she could move. One retelling mentions a “beautiful blonde automaton ... discovered in a packing case on board a ship and dumped over the side by the captain in his horror of apparent witchcraft.” While Descartes’s daughter Francine and her tragic early death was real, there is no evidence that he built an automaton as has been described over the subsequent centuries, or that any such creation was aboard this boat.

Mechanical devices and toys like this were very fashionable curiosities and playthings at this point in history. In seventeenth- and eighteenth-century Europe, decorative and horological automata were ubiquitous in gardens and churches. Anatomical and astronomical models, water clocks, and playful mechanical animals were all the rage among the intellectual and affluent classes. Descartes himself was reputed to have designed, but never built, a dancing man, a mechanical spaniel that could chase a pheasant, and a flying pigeon. Automata were entertaining and brought gardens and homes alive, but they were more than just toys in the salons and summer houses of the affluent; these mechanical objects embodied the mechanistic thinking of the age.

In seventeenth-century Europe, ideas about how the universe and bodies worked were dominated by mechanical explanations. The operation of the universe and the movement of the planets was explained by mechanical principles. Plenty of references were made to the clockwork universe and bodies were seen as operating under the same

machine-like principles. Automata moved because they were powered by external forces, water in the case of garden ornaments, or clockwork in mechanical animals.

The anatomical and philosophical thinking of the time suggested that natural bodies also only had movement when they were instructed by an external force. The human body acted only because it had a soul that directed the mind which, in turn, commanded the body. Descartes made such an argument in his *Treatise of Man*:

I should like you to consider that these functions (including passion, memory, and imagination) follow from the mere arrangement of the machine's organs every bit as naturally as the movements of a clock or other automaton follow from the arrangement of its counter-weights and wheels.

Descartes was viewed with suspicion by the Church because he sought to provide non-mystical explanations and relied on mechanistic explanations, which compared machines and bodies. As he saw it, the actions of both were performed on the instruction of intelligent forces. For an automaton like his mechanical daughter that was a complex clockwork mechanism, while a human body was instructed by its mind.

THE GHOST IN THE MACHINE

Descartes distinguished between two “substances” that make up humans. On the one hand, he suggested, there is the immaterial, active thinking soul or mind, and on the other there is the material, unthinking, passive body. It is the mind, he contended, that animates the mechanical and lifeless body, and that is the source of our intellect. The

body, on the other hand, is lifeless flesh and bone and has no intelligence of its own. It can only do as it is instructed by the mind, just as clockwork toys can only operate when their mechanisms are wound up by their owners.

This distinction between mind and body—known as the Cartesian dualism—has echoed through the centuries. The idea that we have bodies and souls that are distinct and that our immortal souls endure beyond the death of our bodies, is important in the Christian faith. The phrase “ghost in the machine” is another vestige of this dualism. Originating in philosophy but now part of science fiction, it refers to the idea of consciousness or of the soul being contained in a physical body, further entrenching the idea that mental and physical activity may be simultaneous but still quite separate. The division between the role of minds and bodies is frequently invoked in characters in popular culture like Pinocchio, or in the film *Mannequin*.

However, Descartes’s perspective on the mind-body division extended beyond the assertion that they are separate and distinguishable entities and informed his account of the role each play in our understanding of the world. In the second of his *Meditations*, he suggests that perceiving and thinking have no connection to our bodies and dismisses the body as a source of knowledge altogether. He acknowledged that mind and body interact, but suggested that our bodily senses have the capacity to deceive us. He uses the example of a round tower that we think we see on the horizon. We may indeed be correct in thinking it is round, but perhaps our eyes are deceiving us and it might be square. It is only through mathematics and geometry, Descartes proposed, that we can reveal its true nature. We perform math with our minds not our bodies, Descartes argues, so it is our minds that we must trust as being responsible for an accurate understanding of the world.



Descartes did have a daughter, but there's no proof that he ever had a robotic version of her. When the story of his mythical mechanical daughter was first reported in 1699, it was "a mere two-sentence tale with a clear and simple significance, an attempt by a possibly fictional Cartesian to erase the existence of Francine Descartes by replacing her with a machine." In other words, the story was a means of saving the reputation of someone who had fathered an illegitimate child, which would have been regarded as highly scandalous at the time—a doppelgänger to throw his critics off the scent. Yet subsequent accounts of the story have presented different interpretations, one being that he made the automaton to help him cope after the death of his actual daughter. In his 1791 book *Curiosities of Literature*, Isaac Disraeli, father of future British prime minister Benjamin, featured "The Wooden Daughter of Descartes" and suggested that the doll was the philosopher's attempt to prove that "beasts have no souls, and that they are but machines."

The story has become an intellectual fable and the meaning of the story has evolved with each retelling, each new account speaking to the concerns of its audience and revealing its prejudices. Over the years, Descartes's automaton has been represented as a beautiful brunette, like Ava in the 2014 film *Ex Machina*, fitting a growing representation of automatons designed to offer seductive visions of a possible robot future. Yet the growth in references to the story speaks to other concerns. In recent years, with the emergence of artificial intelligence and the convergence of biological and digital technologies, the story of "Descartes's daughter" has added resonance in light of the practical, moral and social conundrums these developments raise. Films such as *Blade Runner*, *The*

Terminator, and *Her* explore issues of machine sentience and the relationship between mind and body. In *Blade Runner*, Harrison Ford plays Rick Deckard, whose job it is to assess whether replicants need to be killed or “retired,” a task he pursues with the help of an empathy test: rescuing a tortoise marooned on its back is a sign of emotion that distinguishes humans from replicants.

The myth of Descartes’s mechanical daughter is an early science fiction story that casts him both as philosopher and the original Dr. Frankenstein, the creator of a terrifying automaton. However, it also illustrates the emergence of a specific set of ideas about the relationship between mind and body that have had a profound impact on the way we view knowledge.

What is known as Descartes’s *cogito*—“I think therefore I am”—is arguably the most famous phrase in Western philosophy and expresses a clear distinction between mind and body. It asserts that we can know of our own existence because we can think. With these words, thought becomes a defining feature of our separation from animals. Thought leads to knowledge, and it is from this foundational Cartesian idea that three further viewpoints followed, all of which have profoundly informed theories in which the body’s role in knowledge is seen as secondary.

The first of these ideas is that our bodies may be complex but are fundamentally no more intelligent than the mechanical toys of Descartes’s era. As he saw it, human bodies are reliant on an intelligent mind for instruction and animation—just as a mechanical toy needs winding up, so a body needs a mind to guide it. Bodies don’t actively contribute to our intelligence but are merely devices for transporting our minds around in the world.

Secondly, this mind-body dualism involves the idea that the role of the body in the acquisition of knowledge should be limited because our bodily senses misinform and mislead. Reliable knowledge, Descartes suggested, is only

available to us when we put our emotions to one side and apply our minds. In making this argument, he was laying the foundations for centuries of distrust of the body as a source of understanding.

Thirdly, Descartes's mind-body distinction suggests that the mind exists independently of the body in which it is located. The mind's elevated position atop the body endows it with an objective vantage point from which, he suggested, we should view and understand the world. As the sociologist William Davies puts it, Descartes saw the mind as "an observatory, through which the physical world—from which it is separate and different—can be inspected and criticized." In Descartes's view, the mind is what enables us to build accurate representations of the world.

Taken together, these three ideas establish a very distinctive and enduring division between minds and bodies. Minds are superior, the animating source of knowledge and truth, while bodies are transportation devices at best and sources of sensory deception at worst.

DESCARTES'S LEGACY

Descartes lived at a time when great scientists like Galileo were forcing a rethink of our position within the universe, and Descartes was central in this change. However, he saw that Galileo's theory that the Earth revolved around the sun had angered the powerful Catholic church and pulled the publication of writings in which he raised similar ideas. His work not only involved anatomy, mathematics, and geometry but the theory and practice of science. He sought to base his knowledge in experience *and* in experiment. To him, reason was essential to the development of knowledge, a position that resulted in him helping to establish science as a process of data collection and analysis. This new

scientific method was central to the Enlightenment, the period of rigorous scientific, political, and philosophical discourse that characterized European society during the eighteenth century.

This “age of reason,” as it came to be known, was a period of exploration, invention, and technological leaps, and it saw a shift in the way people thought about knowledge and how it might be gained. It also saw the flourishing of the scientific method as it is understood today, a method that claims objective knowledge as its goal and proceeds through falsification. The methods, ideas, and inventions of the Enlightenment laid the foundations for the modern world, a world of “high technology, mathematical physics, calculators and robots, molecular biology and genetic engineering.” The result is that, as Richard Wilson writes, “the world is Cartesian to the core.”

This age of reason confirmed the mind as the means for achieving knowledge; in Descartes’s philosophy it didn’t just relegate the body but actively warned against it since, he argued, reason and certainty come from physical disengagement and dominion over our senses. Since he was a mathematical genius, it is perhaps natural that he opted to represent the world through models, so that the world could be visualised in new ways. With these new representations, the world could be controlled, harnessed, and dominated.

This is why Descartes’s mind-body dualism is important and not just an esoteric idea from the seventeenth century. His view on the different roles played by mind and body in how we understand the world has left a lasting legacy. We live in a world that sanctifies the brain. “Brain-centric” ways of talking about intelligence are commonplace—when our thinking needs a boost we “pick someone’s brain” and we credit people with being “the brains behind things.” As the science writer George Zarkadakis notes, we are living in “the century of the brain.” One only needs consider the rise

of neuroscience and our fascination with technologies such as fMRI brain scanning and their application in non-clinical fields such as marketing to see how we have become attached to a cortical model of intelligence.

Another dimension of Descartes's legacy is that the acquisition of knowledge came to be viewed as an exercise in data collection and its processing by the brain. This led to a cognitive view of intelligence, in which understanding the world is seen as involving data collection, processing, calculation, and analysis. It is a view that assumes that intelligence involves a set of mental representations (propositions, images, facts, or mathematical symbols) and a set of rational processes that operate on them. These ideas had a profound impact on subsequent theories of knowledge for they led to attempts to reproduce mechanically the cognitive processes of the mind. With the emergence of "thinking" machines came the amplification of specific ideas about what is responsible for our intelligence.

AUTOMATING THOUGHT

As a product of his time, Descartes was not the only thinker with new ideas about humans and the operation of the universe. His fellow Frenchman and contemporary Blaise Pascal was a mathematician, physicist, inventor, and theologian, who had started building calculating machines as a teenager to help his father, a tax collector. After experimenting with over fifty prototypes, he had perfected his first "machine d'arithmétique," which became known as the Pascaline. It was able to add and subtract two numbers, as well as performing multiplication and division. In 1649, King Louis XIV gave Pascal a royal privilege (similar to a patent), which granted him the exclusive right to design and

manufacture such machines; just over twenty years later, the German mathematician Gottfried Leibniz produced a calculating machine with some similarities to Pascal's, though it is unclear if he had ever seen the Frenchman's device. These were not the world's first counting machines, which had emerged in China, but they were the first mechanical ones.

A series of mathematicians, philosophers, and scientists worked on the development and improvement of such machines during the eighteenth century, but a breakthrough was achieved in 1822 when the English mathematician Charles Babbage developed his "difference engine." This device was distinct from the machines that had preceded it because it could use the results of a previous calculation in the subsequent one: the next level of mechanized arithmetical complexity had been achieved. Twelve years later, Babbage started designing his Analytical Engine, which could use punched cards to read data. It would become the blueprint for the room-sized mainframe computers of the early twentieth century that, in turn, ushered in the computers of the modern era.

However, it was Augusta Lovelace, more commonly known as Ada and the daughter of poet Lord Byron, who was able to see the potential of these machines. She developed a close working relationship with Babbage, who called her the "Enchantress of Numbers" and made two big leaps that led to the idea that thinking could be automated. Her first insight was that the Analytical Engine, Babbage's proposed mechanical general-purpose computer, "might act upon other things besides numbers, were objects found whose mutual fundamental relations could be expressed by those of the abstract science of operations." In other words, if a problem or its constituent parts were expressed in a suitable notation, the machine could solve the problem. As the computing historian Doron Swade puts it,

What Lovelace saw was that number could represent entities other than quantity. So once you had a machine for manipulating numbers, if those numbers represented other things, letters, musical notes, then the machine could manipulate symbols of which number was one instance, according to rules. It is this fundamental transition from a machine which is a number cruncher to a machine for manipulating symbols according to rules that is the fundamental transition from calculation to computation—to general-purpose computation.

Lovelace's second contribution was the idea that, like a mind, a computer could be responsible for acts beyond those they had been programmed to perform. Suppose, she wrote, the science of harmony and musical composition were susceptible to being expressed in some mathematical form, then "the engine might compose elaborate and scientific pieces of music of any degree of complexity or extent." In a single passage, she lay down the gauntlet to mathematicians and computer scientists of the future to create a mind that could think and be responsible for its own creative acts, musical or otherwise.

Lovelace is the namesake of an annual award for the achievements of women in science, technology, engineering, and math, and she was the original computer scientist. She sits at the top of a long line of inventors and thinkers whose work led to the aspiration to automate thought and reasoning. This line flows from mechanical ducks and mechanical daughters, via Babbage and Lovelace, to mainframe computers, big data, and artificial intelligence. All these innovations depend on the distinction between mind and body and the emergence of the idea that intelligence is the preserve either of the mind or "mind-like" entities.

Start with the idea that abstract representations are processed in the mind and then proceed to reproduce and mechanize it; once you have achieved that, so the logic suggests, you will have created mechanical intelligence. If intelligence can be mechanized as machines and computers become more powerful, this intelligence can become faster and formidable, and the realm of intelligence itself can be extended. The information age has followed this logic, which animates computer scientists and especially those working in artificial intelligence.

Both the shift from early mechanical calculating machines to the promise of machines that can “think” for themselves and the reproduction of human-level intelligence, known as artificial general intelligence, are founded on the idea that intelligence emerges from the mind, the operations of which represent a form of pure information processing. When viewed in those terms, the body in which the processor is located plays little or no role in this “higher” form of intelligence and is ignored as subsidiary.

Yet as we will see throughout this book, this idea is being called into question. Our bodies are not just lifeless entities directed by the mind as early modern philosophers contended; they have a much more profound influence. They are at least equal partners in our intelligence and play a central role in our acquisition of knowledge. In the next chapter we will explore the computational theory of mind in more detail and see where it has led us—it has shaped the nature of everyday experience as well as how businesses and countries run, and not always in a positive way.

Chapter 2

MEASURING THE WORLD

“The map appears to us more real than the land.”

D.H. LAWRENCE

MAPPING THE WORLD

In his 2005 bestseller *Measuring the World*, German novelist Daniel Kehlmann told the story of two legendary figures in the world of scientific and mathematical discovery, weaving together the lives of Alexander von Humboldt and Carl Friedrich Gauss. While Gauss was a mathematician and physicist, Humboldt was a polymath who lived a full and varied life. Born into minor Prussian nobility, he was publishing articles in scientific journals by the time he was a teenager and must have been a challenge to keep occupied at home, which he mocked as “the Castle of Boredom.” Precociously talented, he completed a three-year academic course on mining in just eight months and quickly progressed to become a surveyor

of mines with additional duties in the diplomatic corps tagged on. It was the death of his mother in his twenties and his subsequent receipt of an inheritance that allowed him to venture on a five-year exploration of South America between 1799 and 1804 with the French botanist Aimé Bonpland.

It has been said that Humboldt was the last man to know everything. As he traveled up the Orinoco river in a forty-foot boat filled with scientific instruments and animal cages, climbed peaks or lowered himself into volcanoes, he measured everything—angles, heights, pressures, flows, distances, and temperatures. He believed that an ordered universe could be precisely mapped, and Humboldtian science refers to the use of instruments to make careful measurements of interconnected phenomena. Data was, in his view, the basis of all scientific understanding and in many ways Humboldt embodied the age of reason in seeking to detach myth from reason.

Humboldt, geographer, naturalist, and explorer, made many discoveries. He noted the decrease in intensity of Earth's magnetic field as one moved toward the equator, and there are numerous species (including the Humboldt penguin), sea currents, glaciers, rivers, and mountains that bear his name. Humboldt was also a man of maps and made significant contributions to the mapping of New Spain, the Spanish territories in South and Central America. While he was there, he took the time to conduct a census of the indigenous and colonial populations of these territories and also to chart their trading patterns.

In his fascination with mapping, Humboldt was a disciple of Descartes, for it was the Frenchman who had developed the system of coordinates that would allow the world to be translated into a system of numbers. This system underlies much of the modern world, from the efforts of explorers and scientists like Humboldt to the Google Maps application that runs on the smartphone in your pocket.

Descartes had habitually been a late riser and was lying in bed one morning when he became intrigued by a fly in his room. He wondered whether it might be possible to chart its path and realized that if he mirrored the shape of his room with two perpendicular axes in an L-shape, he could use one corner of the room as a fixed reference point. Any point on that graph, he reasoned, could be represented by two numbers expressing how far up or down or to the left or right the fly was located. A set of numbers could be used to mark the position of the fly and a sequence of numbers would enable a description of its movement through space. Descartes published *La Géométrie* in 1637, a work outlining this and other discoveries that allowed things that couldn't be physically constructed or easily imagined to be given a numerical expression for the first time. What became known as Cartesian or coordinate geometry had been created and it enabled the visual and spatial world to be mapped in a way that was easily communicable. With the help of mathematics, the world could now be mapped.

It is not surprising that Descartes lends his name to a large Canadian company that makes logistics software that helps maintain the finely balanced “just-in-time” supply chains, keeping shop shelves stocked and ensuring that factories have the parts they need—all this depends on the mapping that his geometry enabled. Many everyday but largely invisible systems rely on a network of thirty-one satellites that comprise Global Positioning System, a system which can describe a location to within meters. This technology can track where the fruit traveling from farm to store has reached on its journey, and can optimize the routes that the delivery vehicles take to ensure their efficient and timely arrival. And all this depends on the system of coordinates made possible by Descartes's grasp of geometry and algebra.

GPS was originally developed by the US military but it was made available for civilian use in the 1990s and can

now be found in a bewildering array of everyday technologies. It is used to track fleets of cars and trucks, and it underpins cellular telephony and can be used to geo-tag digital objects like photos. It also powers the mobile phone-based games that require your location, but the most obvious application is in the navigational tools we use in our everyday lives—from satnav systems in cars to the apps which help us navigate cities by advising on the best route to get from A to B.

Walk around any urban environment today and you will see people who are immersed in the glow of their smartphone screen. Their heads down, pedestrians check they haven't missed their turn. It is sometimes difficult to remember what it was like to navigate with a map or to make arrangements to meet a friend before smartphones, now that we can agree to something vague and finesse arrangements in real time. Car journeys have been similarly transformed: we can rely on accurate estimates of arrival times, be warned of impending travel problems and receive recommendations of new routes and warnings of speed cameras.

IGNORING THE WORLD

Stories of tourists driving into canals while following the instructions of satnav systems make it easy to criticize GPS as infantilizing, and studies exploring their impact on drivers report that they do “eliminate much of the need to pay attention.” A study by researchers at Cornell University suggested that these systems provide navigation and geographic orientation as freely available commodities, which means we don't need to think about where we are while driving and less skill and attention is demanded of us as a result. The more immersed we are in the virtual world

displayed by the satnav, the less engaged we are in the environment around us as we “interact” with the world through the information display on our dashboards.

As a result of us engaging less with our surroundings and blindly following instructions, we have a reduced understanding of our landscape. We are no longer required to pay attention to what is beyond the navigation screen, so we don’t attend to landmarks nor commit to memory places or streets that might be useful in the future. Our understanding of the landscape around us consequently becomes more disembodied.

The clash between this understanding and that of a city understood through lived experience and repeated exposure to its streets is nowhere more evident than when the embodied knowledge of a London black cab driver meets the technological smarts of a satnav. Licensed taxi drivers in London have to pass “The Knowledge” before they are permitted to drive the iconic black cab. This requires them to demonstrate to examiners—on multiple occasions known as “appearances”—that they can navigate using the shortest route from any two locations or landmarks within a six-mile radius of Charing Cross in central London.

The acquisition of The Knowledge is often regarded as a triumph of memory, and studies have shown that the hippocampus, the area of the brain held to be responsible for spatial and navigational information, is enlarged in London taxi drivers. But would-be drivers acquire The Knowledge not sitting in a classroom but on a scooter, covering upward of sixty thousand miles a year for three years while practicing one of the 320 routes that they can expect to be tested on. One element of this process involves “pointing”—getting a feel for London streets by noting businesses, plaques on buildings, the arrival of new blocks of flats, and historical monuments. Drivers are required to navigate not just by street name but by landmarks, large and small. They learn on a bike, soaking up as much detail

as they can in the hope that they will be able to recall what they have absorbed when they make an appearance.

London cab drivers are famously dismissive of satnav and even more violently opposed to services like Uber that such systems have made possible. Not only does Uber undercut their fares, but cabbies claim that Uber drivers don't *know* London's streets and how traffic works on them. The battle between these expert taxi drivers and satnav is easy to view as one between tradition and modernity, or of vested interests seeking to dismiss democratizing technologies. Although some cab drivers have a satnav on their dashboard, they regard their "Knowledge" as special. They are not reliant on the abstract representations of space that satnav users depend on and they don't need to follow instructions. They can sense the flow and density of traffic and make adjustments to a route, and they claim they can spot roadwork before the information from GPS systems has updated on the devices in other people's cars. Without the need to focus on a screen on their dashboards, they are able to drive while entertaining their passengers with the banter for which they are known.

To label GPS and many of the devices it enables as "disembodied technologies" is not to dismiss them but rather to highlight one aspect of their character. GPS excels at being accurate, but it cannot deliver the intimate sense of place that is hard for technology to articulate. Search for a restaurant on Google and you'll see a selection of indisputably useful information: an address, opening times, a phone number, and even reviews. Recently Google have started to display how busy the location might be, which while useful, tells us little about the sort of people who frequent the place, let alone its atmosphere or the mood there. Busyness is measured by Google by the number of smartphones it can detect in the building, but a restaurant that's full of couples having a romantic evening is quite different from one that's full of partying students. The

atmosphere on a Friday night is likely to be quite different from that on a Monday evening, but such details are not a feature of such a representation of busyness. As the scholar of semantics Alfred Korzybski noted when he said “the map is not the territory,” the description of the thing is not the thing itself. Models of the worlds cannot purport to describe how it really is.

Another way to think about what’s going on here is to think of the difference between knowledge by description and knowledge by experience. What Google can tell us about the restaurant is the former: a set of features and characteristics that, when taken together, provide a partial description of a venue. However, knowledge by acquaintance depends not just on what can be articulated but what we know to be the case through our own experience. Curiously, we have been dazzled by technologies that offer “knowledge by description” to the extent that we often trust it instead of what we know through acquaintance.

GPS is a defining technology of the modern world and one, as we have seen, that has its roots in a period in history where the mind enjoyed primacy over the body. The journey from Descartes’s desire to map the flight of the fly in his bedroom to coordinate geometry has resulted in more than the transformation of our everyday trips; we have replaced embodied engagement with the world around us with a form of disembodied efficiency that helps us cut through space quickly without seeming to engage with it. This sense of efficiency without an accompanying sense of experience, of knowledge without a sense of understanding, is evident in another technology that, like GPS, represents an expression of the primacy of mind over body. The emergence of big data analytics is another example of a scientific practice that purports to provide objective rather than experiential understanding of the world—it is an

intellectual technology that is founded on the distinction between mind and body.

BIG DATA

There is no clear agreement on the first use of the term “big data,” but multiple sources suggest it was Roger Magoulas of O’Reilly Media, an American technology company, who first uttered the words in 2003. By the early 2000s, the number of people and devices online had resulted in a huge volume of data, and multiple attempts were launched to discover how much information was being produced annually. What quickly became clear was that the variety and volume of data in existence had reached unimagined levels. A study led by Val Harian, chief economist at Google, estimated that in 2003 five exabytes of information had been created, which was equivalent to the information contained in 37,000 libraries the size of the Library of Congress. The World Economic Forum predicts that by 2025, with nearly four billion internet users globally and a plethora of new sensors and internet-connected devices, 463 exabytes of data will be created each day.

Traditional data processing tools are unable to handle such quantities of “big data.” One such tool is the spreadsheet, which first appeared as a piece of software called VisiCalc in 1979. Comprising columns and rows of data, spreadsheets are yet another technology that owe a debt to Descartes’s geometry, since each cell can be located with coordinates, just like the fly in his bedroom. But just like the spreadsheet, big data has a history that connects it to the Cartesian dualism that distinguishes mind from body.

Big data is so called because of its volume, variety, and velocity. The amount of data being produced is growing

because of the proliferation of devices that emit a “digital exhaust,” be they sensors on cars or lampposts, or the phone in your pocket. Each and every visit to a website also produces a “clickstream” of unique data. Many of the world’s big companies’ business models depend on the collection, storage, and analysis of big data—its great promise, so its proponents claim, is that it can help people understand the current and future behavior not only of people but also of large-scale systems like traffic, climate, or the oceans.

The link between society and systems in nature is not accidental and helps us understand the origins and motivations behind big data. Though they never met, Galileo, a contemporary of Descartes, was inspired by the ancient Greek idea of monism, one strand of which asserted the existence of a “oneness” that allows a variety of things to be explained in terms of a single reality. Monism claims that the natural and social world conform to one set of universal principles.

Galileo developed the idea to argue that mathematics provided the underlying set of principles that were the key to understanding the world. He wrote that the “book of nature is written in the language of mathematics” and that without it, “one wandered about in a dark labyrinth.” If society, he argued, takes the same shape as nature, which can be explained through math, then society could also be revealed by numbers. This idea of turning mathematical understandings of the natural world into social understandings meant that many scientists of the seventeenth century turned their expertise in understanding nature to modeling society. These scientists can be regarded as the first big data scientists, using math to describe and explain the world.

The astronomer Edmond Halley, best known for his discovery of a comet, turned from astrophysics to the life insurance business in the early eighteenth century,

inventing actuarial science by identifying statistical regularities in large-scale mortality data. John Graunt had earlier trawled through large data sets of disease in London to lay down the intellectual foundations of epidemiology, the study of the incidence and distribution of disease, during the middle of the seventeenth century. And some of the foundations of modern economics are present in work by William Petty, who compiled national statistics on wealth and income at around the same time.

These men were exponents of what the Belgian astronomer and statistician Adolphe Quetelet called “social physics.” In 1835 he published a book based on exhaustive analysis of Parisian crime statistics, which he claimed produced predictions of “terrifying exactitude.” Less than two hundred years later, it would be reported that the New York Police Department was building a crime forecasting system called HunchLab, which draws on data such as the temporal patterns (time of day, day of week, seasonality) of crime, the weather, environmental risk factors (such as locations of bars and bus stops), socioeconomic indicators, and historic crime levels as a way to predict the incidence of crime. New York is not alone, and predictive systems are also used in other cities and other areas of the criminal justice system. Controversially, American courts are using big data to inform decisions about bail, sentencing, and parole.

What unites these ideas and implementations, from the seventeenth century to the present day, is a belief that social life is governed and can be revealed by statistical laws. One such advocate of this philosophy was George Zipf, a mid-twentieth-century academic who was obsessed by the search for mathematical laws in language, literature, and music. As he wrote in a 1942 paper on the unity of nature that revealed his intellectual debt to the monists, “the same natural law governs the structure and behavior of our planet, of life on our planet, and indeed, of even the

smallest minutiae of living activity including the most subtle emotional and intellectual elaborations of the human mind.” Find a pattern in one field, Zipf, believed, and it could be found elsewhere.

Zipf could deservedly be considered a leading influence on the cult of big data and his legacy shows up in the most surprising of everyday settings. If you listen to music on a streaming service like Spotify, you’ve probably played songs mathematically selected on the likelihood that you will find them enjoyable based on a wide range of factors including the mathematical properties of the music such as its key or beats per minute. Indeed, computer scientists have claimed that they can use the Zipf-Mandelbrot law to “describe” mathematically what aesthetically pleasing music sounds like. Applied to a music service, that means that statistical laws can be used to define what is aesthetically agreeable and then to prune the less enjoyable outliers, resulting in what can be a homogeneous selection of music. Mathematical probability comes to define not only what we may like but also to what we listen.

Big data has moved from its moment of “discovery,” accompanied by breathless predictions in the business press about what it can make possible, to the trough of disappointment in a short space of time. In part it has been supplanted by the rise of artificial intelligence, but it has also fallen victim to the disappointment that often accompanies unmet expectations. Yet big data is now regarded as essential to business, while dictums like “data is the new oil” (coined in 2006 by Clive Humby, the British mathematician and data scientist who designed the Tesco Clubcard reward program) reveal the extent to which businesses feel like it is their primary raw material.

With digital data available about nearly all aspects of human life, big data proponents make big claims for their predictive computational models, but these models rely on theories of human behaviors about which data scientists can

claim little knowledge. While big data devotees make claims about what it can make visible through its recognition of patterns, it also makes plenty invisible; what gets lost or ignored in big data analytics are the real human beings who can never be described in numerical terms alone. Social relations, emotions, feelings, and inner worlds are not revealed by today's social physicists.

What big data can't do—or what it excludes—lies in the ideas of the philosophers and thinkers whose work provided its origins, like Petty, Quetelet, and Zipf. The mind-body duality supports the idea that an objective representation of society without feeling, emotion, or the interference of subjectivity is possible. Zipf took this line of thinking to its logical extreme. He thought his brand of social physics “could be applied to everything ... down to and including man's innermost dreams.” “The soul,” he suggested, “offers a perfectly legitimate problem to science” and he felt it could be represented by numbers. Zipf and his disciples rubbished those who felt science could use “subjective description” or a term like “personality” to describe a community. They had no patience for small-scale or experientially derived understandings of the world, or for an embodied understanding of the world that emphasizes its attention to people's feelings and the intricacies of the world.

The early social physicists and proponents of big data are direct descendants of the Cartesian view that the world could be represented through abstract scientific models that can render it numerically. Big data extends the work of social physicists by pulling in more data points than was ever previously possible and using powerful computing processes. Yet the underlying techniques and intention are the same: the development of explanatory and predictive models. Proponents of big data have invited us to believe that this map is the territory; indeed, sometimes, as D. H. Lawrence suggested, “the map appears to us more real than

the land.” It is often comforting to look at an uncomplicated model of the world rather than have to deal with its true messiness. We’ve been encouraged to defer to computational models that encompass more data points than a single person can access and have been led to believe that scale equates with accuracy.

This is not to dismiss outright the current and potential utility of big data, and there are large swathes of science, business and policymaking that can benefit significantly from such approaches. However, there are also plenty of occasions where our own experience of the world needs to be brought to bear on what the data is purporting to tell us. Having faith in our sense-making abilities requires a different perspective on intelligence from that which is inculcated in us early on in our education.

MAKING AND CREATING INTELLIGENCE

Carl Friedrich Gauss, whose story Kehlmann brings to life in *Measuring the World*, has been described as “the Mozart of mathematics.” He astonished his teachers at school and to cure him of his precocity he was told to study the “hardest mathematical textbook in German.” When he returned it the following morning, having read it, his teacher objected, saying that “nobody could study it in a day, and most particularly not an eight-year-old with a running nose.” Yet after thirty minutes of interrogation he concluded that he was teaching a genius and proceeded to beat the young boy for his precocity.

Unlike Humboldt, the explorer who ventured to foreign lands in pursuit of experiences and knowledge, Gauss lived an interior intellectual life, choosing to explore equations and exotic ideas in his head. He had sudden epiphanies and invented new theories with stunning imaginative leaps.

Kehlmann portrays him as absorbed by his mental universe with an inquisitive mind that is the perfect counterpoint to Humboldt's swashbuckling body. While both added vastly to human knowledge, Gauss discovered non-Euclidean geometry and published his magnum opus on number theory, *Disquisitiones Arithmeticae*, when he was only twenty-one: it is he who cuts a figure that is more in tune with the view of intelligence that is dominant today.

The educational thinker and campaigner Sir Ken Robinson points out that as children get older, their Western education drifts away from the body to the brain. In the early years, education is highly practical and physical, encouraging exploration and experiment, but as we progress through school it becomes more cerebral and stationary and any activity that involves the body or the senses is, Robinson suggests, systematically excluded. Ask a teacher what skills young children need to learn at school and somewhere near the top of the list will be the ability to sit still. As they sit in stillness and silence, math teacher and author Kester Brewin concludes, children become "straight-backed automatons."

What we are taught is drawn from a prescribed set of subjects which increasingly favor the so-called "STEM subjects," science, technology, engineering, and math, at the expense of more creative disciplines that involve the body, be that sport or the arts. In tandem with a narrower focus on what is being taught, technology is increasingly applied to teaching and assessment. The so-called "EdTech" market, which promises operational and cost efficiencies, is forecast to be worth \$252 billion by 2020. Yet Brewin suggests that "by over-emphasising 'academic' skills and assuming that they are best learned in stiff silence—or digitally sedating children and failing to pay heed to the vital role that movement plays in knowledge acquisition and assimilation—we risk failing a generation," since much evidence shows that both practical and conceptual

understanding arises through practical engagement with the world and physical artifacts. The example of language acquisition in babies is a case in point. Their parents might use the word “bottle” before passing the object to the child, and in that way the word and the object become associated. The child is also able to play with the bottle and learn about its properties—the fact that it only stands upright when it’s the right way up, or that it rolls when it is on its side.

It not just in teaching that technology is increasingly used but also in marking. The race to deploy artificial intelligence to make marking children’s work more “effective and efficient” is on, and not just in the Western world. According to a 2018 report in the *South China Morning Post*, one in every four schools in China is testing AI to mark pupils’ work. The technology is designed to “understand the general logic and meaning of the text and make a reasonable, human-like judgement about the essay’s overall quality.”

The designers and promoters of such technology nearly always insist that these systems are designed to assist rather than to replace teachers, although Anthony Seldon, a leading educationalist, predicts that “the essential job of instilling knowledge into young minds will wholly be done by artificially intelligent computers” in ten years’ time. Yet perhaps we shouldn’t panic, at least for the foreseeable future; the Chinese AI marking systems are reported to fall well below human levels of performance and a study from Oxford University predicts that senior schoolteachers have a 0.8 percent risk of being replaced by AI or automation. Instead, what is most intriguing about Seldon’s comment is that it reveals a deep-set assumption that education is all about mind rather than body.

In the AI-infused classroom Seldon describes, “extraordinarily inspirational machines will instil knowledge into young minds.” Yet, he continues, while “you’ll still have the humans there walking around during school time, the

inspiration in terms of intellectual excitement will come from the lighting-up of the brain which the machines will be superbly well-gearred for. The machines will know what it is that most excites you and give you a natural level of challenge that is not too hard or too easy, but just right for you.” Given that much of the focus of school revolves around sitting, listening and consuming information communicated from an authority, this prediction comes as no surprise. It’s a continuation of a narrow view of intelligence, which is increasingly seen as something that can be efficiently delivered online via digital learning platforms from machine to mind that don’t require the costly intervention of a teacher. This is not to say that classrooms should be stripped of technology or that teachers won’t benefit from having more time to inspire and engage pupils, but it does mean we should recognize that a particular view of intelligence continues to dominate how schools are organized, curriculums are designed and teaching is delivered.

Over the years the technology in teaching has changed—from blackboards to interactive whiteboards to individual tablets—but the underlying view remains the same. First, brains are regarded as hard drives ready to be filled with information parceled into discrete chunks by discipline. Second, learning is largely an intellectual rather than an experiential enterprise that can take place in the decontextualized environment of the classroom and, where possible for the sake of “efficiency,” with the use of online systems. Third, this sort of intelligence can be measured by psychometric or intelligence quotient (IQ) tests, an idea that is expressed in the addiction to assessment that characterizes many education systems.

IQ tests assess intellectual ability and while exams also evaluate understanding, they are often a measure of how much explicit knowledge has been retained. Such information is often factual in nature—dates, spellings,

names, symbols or formulas—that we require children to commit to memory and that we can test. That knowledge is not without merit, but it's an entirely different sort of understanding from that which arises from interaction with the world. This sort of knowledge is not situational—if you know it, you know it, regardless of circumstance—and can be transmitted through speech or the written word without loss of meaning. It can be acquired in isolation from the context of its application but as a result lacks the tactility that comes with knowledge acquired in more experiential ways.

Yet as a result of the biases of contemporary education that view intelligence as a property of cognition and the mind as an abstract information processor, there is a clear focus on factual knowledge. Modern education downplays experience and movement, despite the existence of a large body of research confirming the belief of Maria Montessori, the founder of an education movement, that movement helps learning. Montessori wrote in 1912 that “one of the greatest mistakes of our day is to think of movement by itself, as something apart from the higher functions ... Mental development must be connected with movement and be dependent on it ... Watching a child makes it obvious that the development of the mind comes about through his movements ... Mind and movement are parts of the same entity.”

Mainstream Western education is in thrall to the mind-body dualism which perpetuates the idea of automated thought and the metaphor of the brain as a computer. Sight, sound, touch, smell, and taste are progressively downplayed as children move through education, despite the fact that that they comprehend the world with these senses.

The implicit snobbery of academic over practical knowledge has long been a feature of Western education systems. As Stephen Cave of the Leverhulme Center for the Future of Intelligence points out, over many years the British

education system assessed children at the age of eleven, with a view to deciding whether or not they were cut out for an intellectual career. As Cave sees it, this is a stark illustration of the way in which the education system explicitly rewards the mind at the expense of the body.



The lives of the explorer and scientist Humboldt and the mathematician Gauss put a period of intense intellectual and geographical discovery under the spotlight. Humboldt died defeated by his efforts to map large swathes of the natural world and before the fifth and final part of his *Kosmos*, intended to be a natural history of the universe, was published in 1862. He was the epitome of the Enlightenment desire to measure the world but stands out not just because of his appetite for knowledge but for his willingness to put up with “bumps and scratches” in achieving his goals. He endured wild animals, flies, mosquitos, the advances of prostitutes, and natural hazards in the pursuit of knowledge. On his return from South America, he was fêted by the US president Thomas Jefferson, while the citizens of Paris wanted to hear about his experiences.

While Humboldt wanted knowledge and was prepared to venture beyond the library to find it, Gauss spent his life thinking his way into complex mathematical realms and made his mark with acts of intellectual imagination. Unlike Humboldt he was a stay-at-home explorer, choosing to advance knowledge in a more cerebral way. He was a man of the mind, not the body. Yet despite the obvious differences in their approach, they shared the desire to map, understand, and model the world around them.

The urge to generate data and to analyze it has resulted in technologies such as GPS that have a profound impact on how we understand the world around us. These technologies

that produce maps of the world around us also mediate our experience of it. Screen in hand, we can go somewhere without having any real sense of where we are. Following our satnav, we can arrive somewhere without having experienced much on the way. We can efficiently chart our course through a city, but in following the directions of unseen algorithms we miss the experiences and serendipity that lies at the heart of urban life. These technologies allow us to understand things from a detached distance and to know things by description rather than by acquaintance.

They are technologies that embody efficiency and control but not experience, engagement, or real understanding. These technologies encourage us to avoid messy and uncontrollable things, like emotions, relationships, feeling, atmosphere, and mood. Instead we've been asked to focus on numbers, patterns, outliers, and correlations, and detail and color get washed out. The mind-first perspective is often a reductionist one that, while sometimes useful, can be, as the theologian Rowan Williams puts it,

A search for the least adorned, the most fundamental pattern or structure we can come up with ... When we have said that everything can be reduced to this or that equation, we have actually said nothing of any great substance; we have simply said there is a mathematical process without which this would not be what it is.

The marginalization of more practical skills arose primarily as a result of this bias toward a "mind-first" view of intelligence. What is revealing about this view of intelligence and education is how it distances itself from more practical forms of knowledge. Yet now is a good time to reassess the situation, and the theory of embodied knowledge is a good way to do that. At a time when many intellectual or analytical tasks are being done faster (and sometimes more

accurately) through the use of artificial intelligence, it is important to recognize that much of what makes our human intelligence distinctive and hard to replicate emerges from our bodies.

In the next chapter we will learn how the body can help us experience and understand the world. The mind-first approach is so familiar that we can be forgiven for assuming that there might be no other way of knowing the world. However, the best model of the world is not a map but the world itself, and our bodies are instrumental in how we acquire knowledge of it.

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Chapter 3

EXPERIENCING THE WORLD

“The fact that we are flesh and blood creatures equipped with beating hearts rather than brains in vats, explains in part why we have the experiences we do.”

SHAUN GALLAGHER

THE OCTOPUS

As divers approach an octopus they might encounter a surprising behavior: the octopus occasionally extends an arm as if to greet them and offer to show them around. Despite their physical appearance, which many early writers found utterly terrifying—the Swedish zoologist Carl Linnaeus described the octopus as a ‘unique monster’—they exhibit distinct personalities, characterized by what the Roman writer Claudius Aelianus considered “mischief and craft.” Octopuses are gentle and inquisitive, and display considerable intelligence. They are known to respond to different humans in different ways, apparently able to

distinguish between them. In research environments they are known for their ability to pick on individuals by squirting them with water or mimicking their actions, though in the wild they live solitary and short lives.

Octopuses are molluscs that at some point in their evolutionary history shed their shells and ended up with a more vulnerable, but flexible, soft body. They are a boneless mass of soft tissue, with a mucus-like skin that allows even the largest to fit through an opening an inch wide, which given that the giant Pacific octopus has a span of six meters, is contortion on a remarkable scale. As every child knows, they have eight arms covered with suckers that they use to pass food along the length of the arm, from sucker to sucker, to the waiting mouth. Their bodies contain pigment-filled sacs that give them the remarkable ability to change color, either to hide from or threaten predators or to communicate their state of “mind”—after mating or being stroked by humans, some octopuses turn a creamy shade of white. As the philosopher Amia Srinivasan puts it, the “megapixel screen of an octopus’ body ... has expressive bandwidth.”

The intelligence of the octopus is an evolutionary anomaly. The closest common ancestor between octopuses and other intelligent animals, such as humans, monkeys, dogs, crows, and dolphins, was a blind worm-like amoeba that lived over six hundred million years ago. An octopus brain contains about half a billion neurons, the same number as that of a dog, which compares to around one hundred billion in humans. The brain-to-body ratio of the octopus suggests that, from an evolutionary perspective, they have invested heavily in their brains, yet what’s most distinctive about the crafty octopus is that it defies the normal arrangement of body and brain as being distinct anatomical entities.

The neurons of an octopus are dispersed throughout its body, with over two thirds of them located in their arms—

each of the suckers on their eight arms has over ten thousand alone. The esophagus, through which food passes, runs right through the middle of the neurons located in its head. Divers report that this anatomical design can cause trouble when it eats sharp objects, with it literally impaling a significant area of its brain. So, like humans and chimpanzees, our closest intelligent relatives in the animal kingdom, octopuses have a central nervous system but are quite different in that their neurons are not confined to the head but distributed throughout their bodies. In that sense, they don't illustrate the clear distinction that we like to make between brain and body. Their arms, a series of experiments have shown, are able to act independently and intelligently on their own, without the need for coordination from their brain—as Srinivasan writes, “even a surgically detached arm can reach and grasp ... the octopus' body is ... not a thing controlled by the animal's thinking part but itself is a thinking part.” Further defying anatomical assumptions, research also suggests that their skin can not only taste and smell but can also “see,” the explanation being either that their skin becomes an eye or the body can see independently of the brain.

If the octopus encourages us to reconsider basic assumptions we make about the role of different anatomical parts, it also shows how obdurate the philosophical distinctions between brain and body have become. How do we write about an arm that can see or act independently, when everything we've been taught makes us believe that eyes do the seeing and that minds control bodies, which can't act independently of the “control tower” that is the brain? Octopuses are fascinating creatures, which as philosopher and diver Peter Godfrey-Smith notes, urge us to rethink what we mean by consciousness and intelligence. Yet they also invite us to consider the limits of the Cartesian dualism that pervades Western thinking. How octopuses use their remarkable bodies to experience their world

encourages us to consider these bodies as intelligent in their own right, which illustrates how it might be the case that the body is as important as the brain in contributing to our own intelligence.

In that sense the octopus is the poster child for the concept of the embodied mind, the idea that the mind is not only connected to the body but influenced by it. In order to understand how this counterintuitive idea might relate to humans, we need to start by exploring the concept of embodiment and the thinking of one of the twentieth century's most significant philosophers, Maurice Merleau-Ponty.

THE BODY AND PERCEPTION

If for Descartes the essence of our humanity was our mind and our mechanical body was animated and instructed by it, for Merleau-Ponty it was the other way around—the body was central to how we perceive and make sense of the world. He made many of the claims that thinkers before him had made of the brain about the body, and in so doing changed how we understand perception and the acquisition of knowledge forever.

Merleau-Ponty was born in Rochefort-sur-Mer in southwest France in 1908 and according to Taylor Carman, a leading interpreter of his ideas, “led a life not especially relevant to the inner logic and development of his ideas.” He lived in the intellectual milieu of Paris, having been schooled at the prestigious École Normale Supérieure alongside Simone de Beauvoir, anthropologist Claude Lévi-Strauss and the writer Jean-Paul Sartre, with whom he later collaborated before they fell out over strongly differing political views.

Merleau-Ponty was a leading light in one of the most important schools of thought of the twentieth century. Phenomenology began with the work of Edmund Husserl, with Martin Heidegger, Sartre, and Merleau-Ponty all contributing to its development. At its heart, their project was devoted to tearing down the edifice of much earlier philosophy, which they regarded as intellectualist in nature. Instead of seeing our relationship with the world as defined by our cognitive efforts, phenomenologists argued that it is our body which defines our fundamental relationship to the world. Merleau-Ponty suggested that “all forms of human experience and understanding are grounded in and shaped by our ... bodily orientation in the world.” For him, our perception of the world begins with the body rather than with the mind. Whereas rationalists like Descartes saw thought preceding perception, for Merleau-Ponty our perception of the world begins with the body.

The phenomenologists were interested in describing human experience from a first-person perspective. They wanted to understand how people experienced everyday life, which made their philosophy different from the more distant third-person perspective that characterizes the idea of objective, scientific knowledge that is the product of the mind. This was a point of view that echoed through many aspects of modern life that the phenomenologists wanted to challenge.

Phenomenology engaged in conversation with the long-since-departed Descartes, and his idea that the body's involvement in the world was irrelevant to the act of processing it. Merleau-Ponty was not content with the view that the mind allowed us to be detached observers of the world and instead felt that the body is our “anchorage” and what gives us our point of view of the world. Everything we know and understand about the world, he believed, comes from our body's relationship to it. While Descartes's famous dictum “I think, therefore I am” puts the mind first, had

Merleau-Ponty put it so concisely, he might have said, “I have a body, therefore I can know.” The body was at the heart of his theory of perception and knowledge. Instead of following the previously dominant idea of a higher form of logical intelligence located in the mind, he argued that our thinking is dependent on, and guided by, the body.

There are two ideas about the body that an account of Merleau-Ponty’s theory of embodiment needs to cover—perception and schema. To lighten the philosophy, let’s start by spiriting ourselves away to a crowded music concert.

Picture yourself in the thick of the crowd at a music festival. The band you came to see is finally on stage and playing a barnstorming set. It’s been a glorious mid-summer day, you’re with friends, you’ve had a drink and life couldn’t be much better. You’re right at the heart of things as the crowd around you sways to the music, whooping and cheering. Suddenly it no longer feels like you’re in control of yourself and you are lost in the orgy of a delirious moment. The crowd’s movements have become yours, as their swaying bodies shift with yours and in sync with the sound and lights on stage.

You are having what you and the phenomenologists would call “an experience,” and your body is at the heart of it. Occasionally you might take a pause from dancing, and an inner voice might think “Woah!,” but on the whole this is a sensory rather than a cerebral experience. You don’t stop to break down and process all the individual inputs—the sounds, the smells and sights—but you experience (and later remember) them as a whole. You are experiencing what Merleau-Ponty would call a *world* as a whole, and your perception of it is very much a bodily one—it is hard to imagine feeling this way without being in it. “You just had to be there,” you later tell your friends as you recall the evening but struggle to put it into words that adequately capture the experience you had and how it felt.

This experience at a concert demonstrates the bodily nature of perception—the idea that it is not a mental exercise that takes place in your head but rather something that begins with the body. Perception is an age-old philosophical mystery that concerned the ancient Greek philosophers, and it is the enduring concern of Merleau-Ponty's life's work. He saw it not as a state of mind but something that arises from our body's relation to the world, which meant that for him, the body forms the basis of all human understanding. Bodily perception is what discloses or reveals the world; we experience and make sense of the concert because we are in it and it inhabits us.

The idea that we cannot experience the world without a body, and that perception is not a mental act but one of bodily engagement, seems obvious and perhaps even banal, yet it was a profound break with previous philosophical thinking. If we accept that everything we experience at that concert, and in our everyday lives, such as “thinking, judging, remembering, imagining, expecting ... [is] anchored in the body,” as Taylor Carmen puts it, we can come to realize that our bodies are at the heart of things. Perception then is a *bodily* phenomenon, in that we experience our own sensory states not merely as states of mind but as states of our bodies.

Merleau-Ponty also suggested that it is our bodies that mediate between the world and our inner states. His concept of “body schema” explains how we make sense of our own body, understand its movements and its position in relation to itself, to others and to the world, and how that sense of itself shapes our awareness of what is happening around us. This idea of body schema is also used to explain how we act on everyday tools and objects around us. At the concert you take out your phone to send a friend a message. You know how to do it, but you don't have to think about it. As you sway with the bodies around you, you're more than able to take a picture and tap out a text to go

with it. Merleau-Ponty described just such a process with the keyboards prevalent at the time he was writing—a typewriter:

One can know how to type without knowing how to indicate where on the keyboard the letters that compose the words are located. Knowing how to type, then, is not the same as knowing the location of each letter on the keyboard, nor even having acquired a conditioned reflex for each letter that is triggered upon seeing it ... It is a question of a knowledge in our hands ... The subject knows where the letters are on the keyboard, just as we know where one of our limbs is—a knowledge of familiarity.

The body schema is Merleau-Ponty's explanation for how we are able to respond—often unthinkingly—to what's happening around us and how we are able to perform actions without much conscious thought. The idea of “knowledge in our hands” is one way he describes knowledge learned through repeated practice. Many accounts of how we do things imagine a list of procedures stored in the brain, which we retrieve as and when we need them. Merleau-Ponty called this “I know” knowledge, but he was more convinced by practical “I can” knowledge. Tapping out a text message is not explicit or even conscious—it's a skill that is embodied and arises from a familiarity so deep that no thought is required for the successful completion of the task. In everyday life we have much such knowledge in our hands. It emerges from the repeated practice of a “skill,” a prime example of what I am calling “embodied knowledge.”

EMBODIED KNOWLEDGE

We perform a range of actions that involve embodied knowledge in our everyday lives. Think back to the concert. When you're standing, jumping, swaying, dancing, or trying to hold a certain posture, you are performing any number of bodily movements. You're using tools: a phone to take photographs, matches to light a cigarette, or a bottle and straw to take a drink. You're also responding to the material and social environment as you orient yourself to the ground under your feet and in relation to the people surrounding you. Finally, you're engaged in a wide range of nonverbal behaviors: you're reading other people's expressions and using your own body to express yourself, and you're trying to maintain what feels like the appropriate distance from those standing around you. Your body is doing many different things and all of them require knowledge, which comes from your body.

When you're doing these things, it doesn't often feel like you're drawing on knowledge. That's partly because you no longer have to think about what you are doing—they are actions you are performing without much conscious instruction from the mind. The idea that we can act without thinking is a challenge to the received wisdom of what knowledge is and how it works. We tend to assume that it takes a certain form—things that are written down or given some other form and then communicated to our brains. It is interesting to reflect on the thrust in human life to put everything we can into language, as if that's the key to unlocking understanding. Yet embodied knowledge is lived rather than documented and does not lend itself to easy articulation. A familiar example from everyday life can illustrate the difference between knowledge that is explicit and articulated and embodied knowledge.

When we first cook a new recipe, we often work from a cookbook and follow the instructions closely, since this combination of specific quantities of ingredients is new to us. We trust that the author has committed to paper the

right sequence of steps we must obey in order to get the right outcome. Onions cooked until they are translucent, in a pan that is not so hot that the butter burns, with a teaspoon of sugar to counteract the acidity of our tomato sauce. Yet once we've cooked the recipe for ourselves, we feel less dependent on the book and have more trust in our ability to interpret its instructions. We might know that we can probably get away with a little less sugar. Our performance of the task and what we learned along the way has resulted in that knowledge becoming embodied, and we can cook that tomato sauce without giving it too much thought.

Sometimes it is hard to know what embodied knowledge you have until the circumstances change and your body doesn't know what to do. Drop an avid festival goer into the calm of London's Wigmore Hall for a performance of a string quartet by Beethoven and she'll have no choice but to respond with the actions and bodily deportment that fit that very different environment: sit straight and still in your seat, offer polite applause, and use facial gestures that signal your appreciation of the composer and the musicians' interpretation of his work. This feeling of being out of place, something we experience when we find ourselves in a strange cultural setting, arise from the fact our body is not accustomed to the environment and doesn't have the relevant knowledge.

It can take time and experience to acquire embodied knowledge but because it is gained through immersion in different worlds and through doing rather than being taught, it is easier to acquire than we might imagine. In fact, as we shall discover, our bodies can't help but acquire the skills they need to fit into new environments.

BODY OVER MIND

Merleau-Ponty's writing on the bodily nature of perception, experience and knowledge represent a fork in the road of Western philosophy, providing a counterpoint to the perspective that had prevailed since Descartes. Centuries of focus on the mind as the key to perception started to splinter and a new picture of knowledge began to take shape. This knowledge is different in how it is acquired and where it resides, and also in its qualities and character. However, the Cartesian distinction between mind and body stubbornly persists and is reflected in how we organize education, how businesses gather information, and in the world of computer science. The idea that the computer is a model of the mind, and that thinking is like data processing, has led in recent years to a series of extravagant claims about the potential of artificial intelligence.

Thinking, understood as the processing of abstract representations of the world around us, is clearly central to human life and achievements. For example, describing and understanding features of the world through such representations as mathematical symbols has enabled humans to measure the height of mountains, create steam engines, build stable bridges, and develop powerful communications technologies. Yet at the same time, because the mind-first view has predominated, we've sidelined understanding that arises from the body through experience. Until Merleau-Ponty, we ignored the fact that our minds are part of bodies that exist in and experience the world.

Merleau-Ponty's insistence on raising body over mind gave rise to a very different perspective of the nature of experience and knowledge. One way to understand the move from the Cartesian view to an embodied perspective that emphasizes the role of the body, is to focus on the relationship between thinking and doing. Philosophy has tended to emphasize the thinking; practical, bodily action figures little in that idea, and yet our lives involve both

thinking and doing. Embodied knowledge sits in the middle of this continuum—it's a form of knowledge that allows us to act as if we are not thinking, because with knowledge imprinted on our bodies we can act without consciously reflecting upon what we know. We develop embodied knowledge without having to be taught it because we acquire it through the experiences our bodies encounter and the actions they perform.

In the second part of the book we'll learn more about embodied knowledge. We will discover how we learn through **Observation** before exploring how our bodies acquire knowledge and skills through **Practice**. In **Improvisation** we will see how embodied knowledge allows humans to respond to the unfamiliar. Our bodies are central to how we understand other people's intentions and feelings, an element of embodied knowledge we will explore in **Empathy**. In **Retention** we will see how our body's way of remembering what it has experienced and knows makes it a powerful complement to our minds.

In this next part we will see how many of the claims that phenomenologists have made about the body's central role in our experience have been borne out by scientific discovery and will learn that embodied knowledge is at the heart of every aspect of our daily lives.

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Part 2

THE FIVE FEATURES OF EMBODIED KNOWLEDGE

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Chapter 4

OBSERVATION

“The body is man’s first and most natural instrument.”

MARCEL MAUSS

There’s a long tradition in Western cultures of ranking vision over the other senses. We often note that “seeing is believing” and when we understand something, we say “I see.” Both Plato and Aristotle associated sight with reason and certainty. In his famous *Playboy* interview, the Canadian philosopher Marshall McLuhan, “the high priest of popcult and metaphysician of media,” explained how the emergence of literacy and the printed word led us to believe in the superiority of the “cool and neutral eye” over the other senses. He attributed fundamental changes in how we perceive space and time to this “rise of the eye.” “The man of the tribal world,” McLuhan suggested, “led a complex, kaleidoscopic life precisely because the ear, unlike the eye,

cannot be focused and is synaesthetic, rather than analytical and rational.” Literacy, he said, gave man “an eye for an ear,” which led to a diminishment not just of hearing, but of touch, taste, and smell too.

Yet the body, on the other hand, is often thought of as something that can mislead us and as the domain of wishy-washy “feeling” and deceiving emotions. We’re often encouraged to take our emotions out of things and think only about the facts of the matter, but it is hard to take ourselves out of the picture when the world we are trying to understand is the world that we are standing in. Merleau-Ponty’s idea that our bodies are the things through which the world reveals itself to us is a call to think with all our senses. Observation is about more than mere “looking” but rather observing with all the sensory equipment with which our bodies come fitted. Much that we perceive we don’t see with our eyes: we make sense of objects by touching, smelling or manipulating them, and we can perceive events going on around us and make sense of how they are connected to us without consciously seeing them. We take on information with our bodies, both consciously and unconsciously.

THE SAND STATES AND THE VIEW FROM SOMEWHERE

It wasn’t until Steve Eisman and his colleagues had spent a few days in Las Vegas that they realized they were onto something and should double down on their financial position. It was a decision that would make them a fortune and give them lead roles in the dismantling of a financial pyramid scheme that had developed in the early 2000s,

leading to a meltdown of the global financial system and the Great Recession between 2007 and 2010.

Eisman ran the FrontPoint hedge fund with Vincent Daniel, Porter Collins, and Danny Moses. “Brazen, grandiose and focused,” he was a natural contrarian who had already spotted, and profited from, the sub-prime loan crisis of 1997. This crisis had involved issuing loans to people with a poor or nonexistent credit history and the subsequent “securitization” of these loans with a high risk of default, the bundling together of them into apparently safer financial products that investment banks could sell on for large profits.

The root of the global financial crisis lay in the securitization of mortgage loans. As house prices rose during the early years of the twenty-first century, ill-disciplined lending gave bankers the opportunity to repackage these loans for others to buy. People on low incomes were offered tempting loans and people with a mortgage on one house were encouraged to secure another on an additional property. Often this was repeated many times over, with each loan providing more raw material for the lucrative business of securitization. By 2005, \$625 billion of sub-prime mortgage loans had been issued in the United States alone. After these loans were “originated” they were sold to Wall Street banks to be packaged up into bonds and, in turn, sold to investors. By the end of 2005, the market for these so-called “sub-prime mortgage-backed bonds” was worth half a trillion dollars.

The bonds had esoteric names, which obscured what was really going on—the terminology deployed by the financiers made what they were doing sound safe, secure, and above board. “Collateralised debt obligations” was the name given to packages of debt on loans granted against items that themselves had been christened with obscure names, with mobile homes rebranded as “manufactured housing.”

These linguistic sleights of hand made it hard to disclose the details of these murky worlds.

The bundles of loans were designed to protect lenders from the risk of individual loans going bad, or at least that was the theory. However, beyond the clever-sounding jargon, loans that people couldn't repay were being resold in packages to other investors, who were told they were as safe as government bonds. Eisman sensed what was going on but knew that he had to take a fresh look at this market if he was prove his hunch correct. He and his team set out to "disclose" the deliberately obscure world of sub-prime securitization.

Eisman had a good ground-up view of Wall Street, having worked in and around it for over a decade, and a natural distrust of its people and their methods. He knew the individuals and companies making the loans to ordinary people and was familiar with the sharp-suited salesmen at investment banks who were selling on the packages of debt. He also had a small but trusted team at FrontPoint. Vinny Daniel, his eyes and ears on the market, was "careful and wary and interested in details" and had cut his teeth analyzing the bad apples in the 1990s sub-prime market, when he had taken over six months to pore over forensically a mass of loan data to understand what was happening. That data was able to yield what the philosopher Thomas Nagel described as "the view from nowhere": an objective and detached perspective.

Yet the team from FrontPoint knew that something in the market smelled funny: confronted with the mixed messages of gung-ho confidence and obscure terminology, they sensed that something didn't quite add up. From "the very first day we said there's going to come a time when we're going to make a fortune shorting this stuff. It's going to blow up," Eisman recalled, "we just don't know how or when." But the team had the humility—and the foresight—to know that they needed to supplement their data analysis and

modeling with other points of views. They set about building that perspective with a “view from somewhere”—the so-called “sand states” of California, Florida, Arizona, and Nevada, where the housing market was running especially hot, and the glitzy hotels of Las Vegas.

In early 2007 they attended a conference for bond dealers and salesmen put on at the Venetian in Vegas, a hotel which Michael Lewis, whose book *The Big Short* chronicles Eisman’s story, describes as “Palazzo Ducale on the outside, Divine Comedy on the inside.” It was here that they encountered men in suits earning a living from selling highly combustible and esoteric securities products. Away from the sales pitches in the conference hall, they found bond dealers playing craps—a game that, like the products they sold, had a superficial complexity that masked the fact that the dice were always stacked in favor of the banker. While they were gambling with other people’s money, conference attendees were served drinks and entertained by low-paid working Americans who had loans they could barely afford on properties that couldn’t rise in value indefinitely, as the bankers’ models had assumed they would. A colleague of Vinny’s returned from an evening out and regaled him with the story of a stripper he’d met who had five separate home equity loans. On an earlier field trip the team had taken to Florida, they had met a man renting a house from a man who had registered the property in the name of his dog.

CHEAP SUITS, STRONG SIGNALS

The view from Las Vegas that January contained arresting stories and many smaller details that added up to an unsettling picture. Eisman was particularly struck by the suits being worn by one caste of financiers—it said

something about the topsy-turvy nature of what he was seeing.

The products that the salesmen in the hotel were frantically pitching were all blessed by rating agencies like Moody's or Fitch, and the anointing of these toxic products with good credit ratings gave them legitimacy. Jobs at the rating agencies should, Eisman reasoned, have been the most coveted and highly paid since they required the most exacting analysis of complex products, but he noticed that people who worked there were wearing "blue suits from J. C. Penney, with ties that matched too well and shirts that were starched too stiffly." Their suits suggested to Eisman that they weren't the main actors in the unfolding drama at a time when they should have been sitting at the pinnacle of the market, casting a critical eye over the products being sold.

Daniel, Collins, Moses, and Eisman left Las Vegas—a city that by 2009 would lead the nation in home foreclosure—with a collection of experiences that cemented their view of the market. The numbers of people present (seven thousand compared to the five hundred that might attend a regular equities conference), as well as their flamboyant antics, breathless pitches, and attire told them what they needed to know and they drew their own conclusions. The market, they figured, had lost its mind. They had arrived in the city believing that the sub-prime market was destined to decline and had already taken a \$300 million short position to profit from this. Leaving Vegas they quickly upped this bet to \$550 million. And then, for good measure, they shorted the stock of Moody's and its cheap-suited analysts.

Eisman and his team were smart, analytical, and big on detail. They had pored over the market data looking for signals to help them understand what was happening, which had led them in the right direction. But in a rarefied market that was deliberately shrouded in jargon, they needed something else to inform their convictions. The picture of

the market emerging from the data, “the view from nowhere,” was suggestive but inconclusive. By contrast, observations made in strip joints, on housing schemes and at the gaming tables of the sand states gave them a rich, highly situated view that disclosed the world of sub-prime and gave FrontPoint the confidence to bet against the market long before others were able to see it for the giant Ponzi scheme it was.

Before they went to Las Vegas, the team had only a theoretical picture of the sub-prime world. Exquisitely crafted spreadsheets built from abstract data were the best available models, but they were internally consistent according to the beliefs of the market participants, namely that house prices would continue to rise, mortgages would be repaid and that loans to the low-paid or unwaged were safe when packaged up into bonds. That objective view of the sub-prime world didn’t survive Eisman’s first contact with it in Nevada.

In a 1935 essay on the body, the French sociologist Marcel Mauss claimed that “the body is man’s first and most natural instrument,” by which he meant that it is at the center of how we learn, perceive, and express our knowledge of the world. By using his body to observe the market up-close, Eisman was able to create a more rounded perspective on a highly complex, large-scale phenomenon. This “view from somewhere” was partial and first-person, but it was also concrete. While the models of the market appeared to make sense, FrontPoint could quickly see the inconsistencies and contradictions. House prices might not always rise, people on low wages with five properties was not a good thing, and a huge over-supply in the market could only mean one thing for house prices.

While these observations might have been available if you knew where to look, Eisman created a perspective that was based on experience rather than intellect. He would never have developed that picture without going to Vegas,

and once there he used all his faculties to make sense of what was going on. The clues he could pick up around him, such as the suspiciously cheap suits, confirmed and amplified the analysis his team had already conducted. Who could possibly know that such a small detail might be a clue to solving a financial mystery?

Merleau-Ponty's insight that perception is enabled by the body—and that it is the body where different sensations, inputs from our interactions with the world, are unified—helps us understand how Eisman and team were able to make so much of their trip to Vegas. The objective view of the market contained many data points, but Eisman's immersion in the world of sub-prime exposed him to a myriad of signals, cues, and clues that the data missed. While some clues were stronger than others, it was the experience of Vegas as whole that helped Eisman and his team understand the gulf between the official and objective view of the market and what was really going on.

We live in a world in which data is regarded as the oracle, a provider of truth and insight. It is held to give us the objective, third-person view, and nowhere is that more the case than in the world of finance, a realm dominated by numbers. How FrontPoint set out to understand the market was idiosyncratic, but their engaged approach to understanding it meant they had the last laugh. Their shorting of the market resulted in the doubling of their fund, from \$700 million to \$1.5 billion. The key to this was the clues and cues their bodies experienced, but Eisman is not alone in using the power of observation to understand other people's—or species'—worlds.

THE ANIMAL MEN

You don't expect to find a barrister sleeping in the alleyway beside a pizza shop in east London, nor in a hole dug out of a Welsh hillside, and you might also be a little surprised to catch a glimpse of one naked in the fast-running waters of a Devon river or sniffing otter droppings on its banks. Man is usually the hunter, but what would it feel like to be hunted across open moorland like a stag? What's it like to spend the night sleeping among foxes in an alleyway in London's East End? Charles Foster's fascination with the lives of animals has led him to do some unusual things in pursuit of answers to questions like these.

Foster says that his fascination with the animal kingdom started when he avidly read every relevant book in the local library at an early age. But he wanted to go further. He's not just a trained lawyer with a doctorate in medical law and ethics—he is also a vet. He knows his animals but always thought there was something unsatisfactory about human knowledge of them—to him, it felt top-down and superimposed. Despite advances in neuroscience, which can show us which bits of a badger's brain light up when it puts its sensitive nose to inspect something in the woodland, we don't really know how the world smells to it. How might we understand how the world looks to a badger? And what might that tell us about how can we see the world as it appears to others?

Foster's answer was pretty simple: if he wanted to know what it's like to be a badger, he needed to become one. That meant asking a friend with a JCB digger to make a set on a Welsh hillside and for him to make it his home, along with his very game son. Without any of the histrionics of a TV game show, they munched on worms and bugs, and got on all fours to inspect the surrounding habitat like their badger companions. Badgers are creatures that see with their nose and Foster had prepared for this by getting his wife to hide a strong-smelling Stilton cheese in the house before he tried to hunt it down while blindfolded.

Foster's wider ambition was to avoid the trap of thinking that how we see the world is how others, especially animals, see it. To achieve this he attempted full immersion in the habitats of animals and a faithful imitation of their behaviors. "When I'm being a badger," he says, "I live in a hole and eat earthworms. When I'm an otter, I try to catch fish with my teeth."

Foster's antics are a continuation of a very human and ancient fascination with animals. Stone Age paintings of animals attest to a millennia-long interest in their world. Modern science can provide insight into a bird's eye view of the world or how their aural universe sounds, but can we know what it is like to *be* another animal? A famous essay by the philosopher Thomas Nagel asked the question: "What is it like to be a bat?" It's a classic piece of academic rumination and very different to Foster's efforts. Nagel chose bats because, like badgers, how they see the world is different from humans—they use echolocation to navigate and perceive objects. Nagel concluded that if humans could turn themselves into bats and acquire the ability to echolocate, they would be able to experience the life and behaviors of a bat, but he argued that we could never adopt the mindset of a bat because our brains do not have the same "wiring" as theirs. His conclusion, though reached through different means, is in sympathy with Foster's: behaving like another animal can bring us closer to its experience of the world.

Trying to explain the purpose of his escapades, Foster talked about his adventures with a Greek poet friend and explained that it was all about trying to understand the world of others. "But," the poet objected, "I can't have the first idea what it's like to live in the world of a Southern Baptist from Alabama," picking a culturally distant group of people for effect. Foster was minded to agree because his poet friend had not been to Alabama, but then realized that because of his time with the foxes he had got close to them.

“I share much more with a fox than with a fundamentalist,” he said. “I’ve lived with the fox in an embodied, sensual world of wood and earth and bone and semen and cold.” Foster had established that it is the specific sensory capacities of animals that shape their perceptions of the worlds in which they live. He might not be able to mirror all their capabilities but by observing their worlds much as they do, body first, he had got closer to understanding what it is like to be one of them.



Foster is not the only slightly eccentric Englishman to have tried to cross the species barrier, but while he took an unmediated approach without much in the way of props, designer Thomas Thwaites tried something a bit different. His story began one morning when he was under-employed and feeling slightly down about his prospects in life. Walking his dog Noggin against the stream of London commuters striding purposefully to work, he wondered what it would be like to be a dog, with no worries about bills or bosses, income inequality, climate change or terrorism. “Wouldn’t it be nice to just switch off that particularly human ability for a couple of weeks?” he asked. “To live totally in the moment, with no worries about what you’ve done, what you’re doing, or what you should do? To holiday from being human—wouldn’t it be nice to be an animal just for a bit?”

Initially Thwaites set his sights on becoming an elephant by building an exoskeleton and walking across the Alps, and he even received funding from the Wellcome Trust to support that goal. However, he soon realized that transforming himself into an animal of this size and strength would be hard. He discussed the situation with a Danish shaman—someone experienced in the ways of crossing between worlds, be they human or animal—and she advised him to try becoming a goat.

His adventure saw him explore three distinct approaches: he used books, explored the brain of a goat, and inhabited its body as much as possible. First he read up on goat culture, he learned about their social lives and strict hierarchies of the herds. He figured that his language skills might be an obstacle to the world of goats, so he visited an academic who specialized in transcranial magnetic stimulation, a procedure that uses magnetic fields to stimulate nerve cells in the brain to improve symptoms of depression—his hope was that if this expert could switch off the area of his brain responsible for speech, he'd be one step further along his journey. After learning that this would be rather dangerous, he began to focus on transforming his body into that of a goat. It was all very well trying to think like a goat, he realized, but “without embodiment I’m never going to feel like a goat—I need to turn my arms into legs and hands into feet, aka hooves.”

A prosthetics expert designed a set of legs so that he could attempt to walk on all fours in something like the style of a goat. He even attempted to reproduce the 320-degree field of vision that goats enjoy, but learned that wouldn't be possible without sophisticated video goggles or technology made for tank periscopes. When he felt as ready as he could be, he traveled to the Swiss Alps to meet a herd.

Thwaites enjoyed his time living among goats. His shepherd host thought his herd took quite well to the man-goat, and Thwaites's suit meant he was seeing goats eye-to-eye and breathing their smelly breath. He was able to “see the world through somebody else's mouth” and doing as goats do, which he quickly realized mainly involves walking to a patch of grass, eating a bit and then moving on to another patch a few minutes later. Physically it was hard being a quadruped in the mountains, “like doing one-armed press ups down the side of a mountain,” and he was soon sweating profusely and suffering from searing pain in his exhausted arms. He realized it was easier for him to walk up

the mountains in his prosthetic suit than it was to descend, but then it struck him that he had committed a goat *faux pas*—being higher up a hill than the rest of the herd can be a demonstration of dominance in the hierarchical world of goats and another goat quickly moved to dislodge him from the top of the pecking order. At the end of a week spent ranging across grassy meadows and snow fields, Thwaites felt like his efforts had affected not just an obvious physical change but an internal one too; he had got close to the world of goats, through very intimate observation of them.

Thwaites's focus on the finer details of the goat body mirror Foster's efforts to experience the world of the animals he set out to understand. Both men realized that however hard you try, it is not easy to think yourself into the world of other species even though you can put yourself physically into their worlds and observe the world as they do. For Thwaites that required being on all fours, while Foster lay on his front in a churchyard, staring at foxes.

Yet what these animal men demonstrated is that observation involves more than just eyes. It extends to the entire body and if you want truly to understand the world of others, whether humans or animals, you need to embody their world. The human body is plastered with chemical, mechanical, visual, and thermal sensors that allow us to feel the world around us, and we also have proprioceptive capacities—the ability to sense the position and movement of our bodies. Since most of the human brain is tasked with processing all this information, it seems reasonable that we should use the full range of these resources to comprehend the world.

While Nagel was concerned to explore if we could *think* ourselves into the world of a bat, Foster and Thwaites realized that with such a powerful amount of equipment designed to sense the world around us at our disposal, it makes little practical or philosophical sense to split mind from body and depend on the former rather than the latter.

Why do anything to even impair these senses, Foster reasoned as he took a naked dip with otters on Exmoor, having concluded that “wetsuits are condoms that prevent your imagination from being fertilised by mountain rivers.”

When you’re trying to understand the perspective of an animal, the “view from somewhere” is at their level, but it should not depend on sight alone. Foster wants to be able to read the “legible smells” the way a badger can and complains that humans “have acutely sensitive hands, but we handle the world with thick gloves and then, bored, blame it for lacking shape.” What the adventures of Foster and Thwaites show is that we have bodies that, if pushed, are suited to observing the world in a multisensory way.

Although there might be some natural limits to our bodies—Thwaites encountered the limits of human joints in trying to become a mountain goat and Foster longed to become a swift—the biggest limitation is our insistence on using the mind to acquire knowledge rather than the body. That acquisition of knowledge through observation rather than instruction is something that can be witnessed in a variety of settings, and there’s an intriguing body of science to explain how this happens.

STEALING KNOWLEDGE WITH YOUR EYES

It’s the mid-1990s and anthropologist Trevor Marchand’s plane is coming into land in Sana’a, the capital of Yemen, decades before the start of the bloody civil war that has since pulverised the country. The sky is punctured by graceful minarets, from which the muezzin calls the faithful to prayer. Marchand had planned to learn more about the practice of craftsmen by working on a house-building or restoration project, but he soon finds himself drawn to a

minaret rising from a half-built mosque at the end of his road.

Like any anthropologist trying to find a “way in” to spend time with local people, he sat opposite the building site each morning, observing the comings and goings and hoping to get noticed. It worked—a curious-looking Canadian was an unusual sight on the streets of Sana’a—and the master mason from the new mosque came over to ask what he was doing. Marchand replied that he was hoping to work with some builders in the city, adding that he was “trying to understand the building process as well as the apprentice system here.” Suitably intrigued, the mason invited him to observe their work.

Within minutes Marchand was making his way up the minaret’s debris-strewn staircase, occasionally bumping into nonplussed builders at different levels of the tower, before emerging into sunlight at the top of the structure. Standing on top of a wall overlooking a vertiginous drop, he chatted with the craftsmen for a while before taking his leave. A few weeks later he paid another visit and was asked in more detail about his purpose. He explained that he was an architect who was in the city “to work with traditional builders,” and quickly added, “I’d be very interested in working for you.” The craftsmen grinned reassuringly, and he started work the following day.

Marchand is a trained architect with a long-held fascination with how the ability to build things gets acquired. A visit to a photography exhibition of Yemeni architecture in a London gallery led to him using his anthropological training to explore apprenticeship and the practice of various crafts. He has since studied traditional builders in Mali, trained with fine furniture makers in London, and spent more than a year with the minaret builders in Yemen. In all three settings, Marchand has been intrigued by how people learn what are intricate skills with surprisingly little explicit instruction at times. How,

Marchand wants to know, do people learn without being taught?

At the mosque Marchand began at the bottom, just like his fellow apprentices. Juniors are not formally employed and have very little job security. These apprentices are on the first rung of the ladder both literally and figuratively and start out their ascent of the minaret and the craftsmen's pecking order with simple tasks. Their jobs include ensuring more accomplished colleagues have the right tools and that the site is well stocked with supplies. They listen in to their master's conversations with clients about budgets, schedules, and the practical matters that building a mosque involves.

The early stages of their apprenticeship is almost entirely devoted to menial tasks but affords them plenty of opportunities to see how things are done. In time, apprentices graduate to laying bricks on the outside of the minaret and to working on the infill between the outer and inner structure, before they are eventually ready to tackle the more intricate jobs. As they progress through these different tasks—something that can take years—they learn to think and act in complex three-dimensional geometric space and acquire a sophisticated understanding of the spatial relationships between the materials and the building.

During an apprenticeship, Marchand found, there is almost no formal instruction. The building site is not a place of conversation and the verticality of the minaret does not lend itself to dialogue. Apprentices are learning their craft with barely any official tuition and not much more in the way of informal conversation. Marchand observed that even when they get things wrong they are rarely told why and instead get an earful of verbal abuse. More remarkably still, not only is formal teaching largely absent but the minaret is built without architectural plans. Marchand found that these builders inverted the Western model: "It was totally opposite from my training as an architect," he said, "where we would

start off from year one producing these plans. It was only toward the end of our architectural studies that we started to learn about the way things were actually assembled and the properties of the materials.”

The story of the minaret craftsmen demonstrates a world that is different from what we might expect from the building of a complex, tall and intricate structure. Practical knowledge is emphasized at the expenses of theoretical understanding, yet is not taught so much as enabled through a process of observation without instruction, and the asking of questions by students is discouraged. In such a setting how might it be, Marchand puzzled, that apprentices can learn the subtle and elaborate arts of minaret masonry? He saw that when working on a new task, apprentices approximated based on what they already knew. More significantly, he noticed they had a very keen eye for the gestures, movements and techniques that their seniors used—they observed, then mimicked, and eventually mastered the actions they had repeatedly witnessed. Knowledge, it seemed, was conveyed from one body to another without words.

The story of the minaret craftsmen is one of many examples of skill acquisition that has been observed to occur without explicit instruction. Basket weavers, lacemakers, Capoeira dancers, and yoga adherents all master their craft through observation and imitation. The anthropologist Michael Herzfeld talks of the apprentices he studied in the Middle East “stealing knowledge with their eyes.” That’s one explanation, but how else might we account for the transmission of knowledge through observation—and what does it tell us about the role of the body in the acquisition of knowledge?

LEARNING THROUGH OBSERVATION

How many times today has someone finished a sentence for you? This is a very common occurrence, and probably took place in the last conversation you had. When this happens, what is surprising is that the word the other person uses is often the one you had in mind, leaving you wondering how it is that they were able to intuit what it was you planned to say. Equally, even when people don't say the word you were intending to use, they still often accurately capture the intended meaning of your sentence.

Consider this exchange between a couple: "I think today would be a good day to spend some time in the garden, I might—" to which the following interjection emerges, "cut the grass. Yes, it would be good to get that done now in case it rains." Linguists call this "shared utterance," the phenomenon where one person "interrupts the verbal utterance of another in order to complete a statement or, more saliently, an idea ... that both speaker and hearer are incrementally constructing in the real time of dialogue." Shared utterances highlight the idea that speech is a collective rather than an individual act. Speech interactions create a shared understanding and demonstrate that knowledge is not some static object that can be passed like between people but rather that it gets created through interactions.

These sorts of verbal exchanges litter our everyday lives and also closely match people's physical interactions—in other words, the shared utterances of speech which result in us co-creating meaning through conversation have physical analogues. Take simple everyday occurrences, such as realizing that your partner is struggling to strain vegetables through a colander with one hand so putting out one of yours to help, or navigating the intricate ballet of people in a crowded railway station without bumping into the person walking toward you. All these actions involve shared activity, the act of one person beginning something and

another finishing it, and some form of intended or unintended coordination.

Both conversational and physical interaction involve a sense of shared anticipation of each other's actions and intentions. Although the craftsman working in the minaret don't do much talking, Marchand thinks that as an apprentice watches his colleague, he feels the urge to complete the task that he is seeing the other craftsman perform. There's an emerging body of evidence that suggests that this urge that can be identified in how we converse is also present when we observe the actions of others.

Have you ever had that almost irresistible feeling as someone demonstrated something to you or you watched them perform an action that you had to copy whatever they were doing? Have you ever felt that *your* body was going through *their* motions, like a dog straining at the leash? Perhaps that person was showing you how to hit a tennis forehand or was chopping some herbs vigorously as you watched, or maybe you were the passenger in a car as the driver moved through the gears as they accelerated down the motorway. Even if you resist the urge to follow their actions, your body is experiencing the feeling of performing their actions without actually realizing them physically. This visceral sense that you are either almost doing the thing that you are watching someone do, or the faint sense that your body is priming itself to perform this action, can be explained by motor simulation theory.

Motor simulation theory emerged at the turn of the century from the field inhabited by cognitive scientists, neuroscientists, and psychologists. Although these disciplines are focused on understanding the brain and the mind, over recent decades many within these fields have come to understand that how we think, what we know, and sensorimotor experience are intimately connected. Sensorimotor refers to the combination of both sensory and

motor functions and is often contrasted with cognitive capacities. However, researchers have shown how certain action-related cognitive states relate to the performance of the action; more precisely, they have shown that imagining an action without executing it activates the same neural pathways. Simply put, thinking of performing an action shows up in the brain as if the action had actually been performed.

Think back to the apprentices who could learn without being explicitly taught. They were observing the master craftsman and developing skills as they did so, and the science of motor simulation explains how this learning by observation works: it activates motor systems in the brain that are similar to those triggered during the action itself. What's fascinating about motor simulation theory is that it describes not just what is happening in the brain but what is happening in the body, too. As the body is preparing itself for performing this task, minute innervations (nerve activity) take place in the muscles of relevant parts of our anatomy. We may or may not be able to feel this, but either way, after thinking about or observing an action our bodies are improving the strength, velocity, and control of the relevant muscles. On the building site this happened constantly as craftsmen watched others perform skilled actions or thought about it. As Marchand puts it, the body's "motor system produces 'understanding' from the body." Motor simulation is the mechanism at the heart of imitation and, in this context, the learning of new skills.

Take an apparently simple act like a somersault and put yourself back into your school years, when your gymnastics teacher instructed you how to do one. He might well have described what to do, but he more than likely demonstrated it, too. Even for an adult with good language skills, describing how to do a forward roll is pretty hard. It is much easier to demonstrate this—and better too, because those spectating are able to use their bodies to learn. As the

theory of motor simulation shows, the act of watching an action alone primes the body to do the action. The idea of a somersault is taking place in your brain, and your body is able to understand what it will need to do when it steps onto the gym mat.

Motor simulation theory helps explain why observation is at the heart of the body's acquisition of knowledge; through observing the activities of others, our bodies and brains work together to prepare the ground for us to perform the action, laying down the neural pathways and preparing our bodies for what we have just seen. This is why motor simulation helps explain how we acquire complex skills and offers an explanation that is less tied to the idea of instruction or the memorization of rules but rather to something that occurs when the knowledge is developed with our bodies.

However, most skills are not things we can acquire through observation alone—that's just the first step on the road to acquiring embodied knowledge. Building on what can be learned through observation takes time, and embodied knowledge is honed through practice and repetition.

Chapter 5

PRACTICE

“For the things we have to learn before we can do them, we learn by doing them, men become builders by building and lyre players by playing the lyre; so too we become just by doing just acts, temperate by doing temperate acts, brave by doing brave acts.”

ARISTOTLE, NICOMACHEAN ETHICS

HOW TO RIDE A BIKE

I bet you can ride a bicycle—we like to think that few things are easier. It’s not a difficult thing to do and once you have learned, you’ll never forget how to do it. But if I was to ask you to explain *how* you ride a bike, things would start to get a bit more difficult. You might tell me that you need a certain amount of speed in order to balance or that if you keep on pedaling, the bike will stay upright. But beyond these simple explanations, I suspect you’ll struggle to provide much more detail.

It turns out that since the first bike-like device, a velocipede, appeared in 1817 scientists have been trying to work out how it is we ride them. As Mont Hubbard, a mechanical engineer from the University of California, Davis puts it, “Everybody knows how to ride a bike, but nobody knows how we ride bikes.” It wasn’t until recently that scientists worked out what it is that allows a rider to balance while pedaling. The pioneering work of Jim Papadopoulos, a “failed” but brilliant mechanical engineer, is at the heart of this story. In the 1980s, Papadopoulos studied over thirty previously published scientific papers that had attempted to connect the geometry of a bicycle and the laws of physics to the art of bike riding. It didn’t take him long to reject much of what he was reading, filing under “bad science” many of the papers in which he discovered fundamental mistakes. It was another year before he had what he believed to be the definitive set of bike riding equations, by which point the research team he was part of, the Cornell Bicycle Research Group, had run out of funding. Papadopoulos was forced to turn to a series of dissatisfying teaching jobs after having only published one paper on his work. The public revelation of the mystery of bike riding would have to wait.

It wasn’t until the late 1990s, when his old collaborator from Cornell, Andy Ruina, started working with a researcher from Delft in the Netherlands, that Papadopoulos’s work was revisited. Within a year the three had collectively turned out what are now regarded the conclusive equations, which they published at a conference in South Korea in 2007. Finally, there existed the mathematics to explain what people had been doing for nearly two hundred years, on an estimated two billion bicycles worldwide.

With the math in hand, the team of scientists started to run a series of more practical experiments and discovered that bikes had gained by trial and error a series of design features that make bike riding possible. One such features is “trail”—the ability of the front wheel to operate like a castor

on a shopping trolley that turns into the direction it is being pushed. They also learned that steering and body movement contribute to balance, though body movement has a smaller impact on balance than steering, which is critical. The basic strategy for balancing a bike, they showed, is steering into the undesired fall.

You may know that you steer into the direction you are tipping toward, though when you're riding a bike you do it without knowing that this is what you are doing. The idea of steering into your fall feels counterintuitive. It is doubtful that it would have been part of your explanation and it is unlikely to have been one of your instructions if you have ever taught someone to ride a bike. All I can recall when getting my children on two wheels was imploring them to "keep pedaling!"

In 1869, the Scottish engineer William Rankine commented on the phenomenon of counter-steering—where a rider can steer to the right by briefly moving the handlebars to the left. Thirty years later, the Cambridge mathematician Francis Whipple produced a mathematical model of a bike that he used to explore self-stability, the ability of a bike to automatically recover from a sideways disturbance and balance itself.

However, the ability to ride a bike is not dependent on knowledge of the complex physics of balance, gravity and momentum. As the struggle of mathematicians and experts in physics to make sense of bike riding shows, it's possible that we can do something without a formal explanation of how it is possible. Conversely, as David Jones demonstrated in an article for *Physics Today* in the 1970s, and in a neat illustration of the nature of bodily skill, it's also possible to ride bikes that are theoretically unrideable. Through trial and error, most of us can master the art of riding a bike. Cycling is a practical experience and our ability to do it is not dependent on us understanding how we do it—we learn how to ride by doing it.

We discover that when we go too slowly, we start to tip, and that rapid and violent movements make the bike fall away from under us. We form a physical sense of the relationship between the movement of our body, its relationship to the bicycle, the speed we are traveling at and the ground we are cycling on. Initially, we think about one of those elements more than the other, and overcompensate, overreact and crash. Soon we learn to turn more gently and pick up speed when we wobble, and we fall off less. In a short space of time, the bicycle is no longer a mechanical object that's distinct from us but an extension of our bodies.

The papers published by the team from Delft contain a mass of equations and diagrams explaining the geometry of a bike and the combination of forces and rider behaviors that keep it upright. With this knowledge explained for the first time, in 2011 the roboticist Masahiko Yamaguchi was able to demonstrate a small robot called Primer-V2 that was capable of riding a miniature bicycle. Using the insights from the analysis of humans and bike riding, Yamaguchi designed the robot to use steering to keep itself upright. He designed the robot to explore the potential for technology to mimic simple human skills, and his efforts show how complex even the simplest actions can be. For example, his robot stops by putting its feet on the ground, which is something humans do instinctively, but this was one of the toughest problems he faced when designing the robot.

Yamaguchi's work in creating a robot that can ride a bike does not make our human skill any less impressive. In fact, part of his motivation for building Primer-V2 was to explore the connection between knowledge and practical skills—the coexistence of the inability to give a formal explanation of an action with the ability to perform it is something that bike riding illustrates. On the one hand, the effort to understand how we ride bicycles shows that humans can perform skills

without having any knowledge of the underlying principles that make them possible.

On the other hand, bike riding neatly illustrates that we can possess knowledge that eludes articulation. Most of us know how to ride a bike, but we can't begin to put into words *how* you do it. The scientist Michael Polanyi, who was fascinated by this relationship between explicit knowledge and the knowledge we find hard to articulate, which he termed "implicit," noted that "we can know more than we can tell." Knowledge that has become embodied, like the ability to ride a bike, is hard to put into words.

Whatever the length of time it took scientists to figure out how we do it, we find learning to ride a bike reasonably easy—it takes little more than a weekend in the park to get children up on two wheels and while they will improve over time, the basic skill is not one that we forget. But not all skills are as easy to develop and some require vastly more practice and repetition.

ENVIRONMENTS OF SKILL

When Aristotle talked about "builders building" and "lyre players playing," he was suggesting that what we do shapes who we are, and that the more we do things, the more intimately our being is connected to them. An accountant's facility with Excel, the barista's mastery of the coffee maker or the farmer's ability to know if the crops are ripe are all central to their identities. And nowhere is this more evident than among craftsmen and women.

Erin O'Connor is a sociologist who comes from a family of makers. Her interests as a graduate student lay in understanding how people become proficient in practical knowledge and how skills are transmitted and developed, and she was fascinated by the relationship between

instruction and learning by doing. In 2003 she enrolled at the New School in Manhattan, one of the few American universities that puts European philosophy at the heart of its teaching. Its students are encouraged to immerse themselves in the dense theory of early and mid-twentieth-century continental thinkers. At the outset, her supervisors encouraged her to read as much of this work as possible. She remembers the initial plan for her studies as “theory, theory, theory,” but soon realized that what she was reading would not help her comprehend the experience of makers and the way the environments in which they learn affect their acquisition of skills. Her head was full of the ideas of philosophers, but the world of craft remained distant, a striking realization that made the idea of becoming an apprentice craftswoman herself feel like an important step in understanding skill.

Determined that she needed to do more than read theory, Erin contacted New York Glass, a not-for-profit glassblowing studio. The educational director there suggested that if she wanted to learn about glassblowing, she could come and watch, but she explained that she didn’t feel that observing was enough and that she wanted to learn about glassblowing through participation. “I’d like to actually learn myself,” she told him. Though the courses were full, it was agreed that she could observe the lessons and, where possible, roll up her sleeves and get involved. In earlier research with furniture makers in the Catskill Mountains in upstate New York, watching what makers were doing from the outside she’d felt like a voyeur and it had been a rather disembodied experience; this time she hoped it was going to be different.

“When the doors open, you get the scent of charcoal, grime and sweat. There is a special scent of hot metal in the air— you’re filled with it.” The sounds of the “hot shop,” the term used for glassblowing workshops, are central to the synesthetic, multisensory experience that O’Connor

describes. “The sound isn’t only the furnaces. It’s of people talking,” she recalls. “Glass-blowing is a collaborative practice and so you hear just chatter, non-stop chatter, the sound of metal on metal.” The glowing molten glass, the sight that she had expected to be most dominant in her experience, was almost the last thing she remembers of that initial encounter.

Entering New York Glass, O’Connor was immediately hit by the rich atmosphere of the place. She resists the idea that she was *struck* by the sights and sensations of the hot shop but rather invokes the words of the supergroup USA for Africa’s “We Are the World,” explaining that it felt less like a world that she had entered into and more that the hot shop was a world that was now inside her.

Initially, O’Connor just watched, but there was usually a student missing so she was able to participate. Soon she wasn’t just learning about how people learn to blow glass, but how to blow glass herself. She discovered that although instruction was given, knowledge of how to blow glass was gained through an immersive and highly sensory experience in a very unique environment. Glassblowers are created in the heat, smell, and noise of the workshop. Just as glassblowers shape glass, so glass studios shape the body of glassblowers as they learn the difficult skill of transforming molten glass into beautiful objects.

Glassblowing, as O’Connor tells it, is hard. She recalls learning the skill of the “gather,” using a broom-handle-length hollow pipe to take liquid glass from the furnace. Glassblowers do this in a similar way to how we might take honey from a pot, twirling our spoon to create a body of gloopy liquid. At first this is not easy and the blow pipe can go too deep into the glass or at the wrong angle, but through repetition she gained a decent level of competency. Over time, her body seemed to know what to do. Six months into her apprenticeship, her “gather” hadn’t quite become second nature but she could do it well enough and it was

time to move on to the quintessential initiation test in the glass-blowing world: blowing a goblet.

Shaping the glass once you've removed it from the furnace is harder to master. Having gathered her glass, she was blowing out what would become a vessel but it was hot, gloopy, and hard to control. O'Connor remembers her instructor Alan telling her to "ride the bubble," but she didn't really understand what he meant. She recounts "marvering" the glass: using glass-blower's jacks—a pair of tongs—to rotate the bubble and give it shape while trying to stop the bulb of glass from sagging. She was struggling until Alan came over and slightly adjusted the angle of her hand on the jacks; suddenly the idea of riding it made sense. The minute flick of the wrist that Alan had performed with his hands over hers had given the instruction meaning, and the action was now working.

O'Connor recounts her journey, from struggling to do even the simplest of glassblowing tasks to attempting her first goblet, during which she discovered herself thinking less about what she's doing and found that her body increasingly took over. She still remembers the first time she realized that her arms were continuing to rotate the blow pipe as she walked over to the steel table to work on her gathered glass. Her body knew what to do and she was becoming a glassblower: someone practiced in the skill of glassblowing.

O'Connor is modest about the skills she acquired, and she remains in awe of the skill of the people she worked with. They helped her go from being a novice to a level of competence through some instruction, but as much as anything through letting her be part of an environment in which skill was being performed. Yet she also realized that developing a skill is something that happens through doing things repeatedly—the journey from unskilled apprentice to master is one that unfolds over time.

THE PATH TO MASTERY

The death of Hubert Dreyfus in April 2017 robbed philosophy of one of its great characters. An American disciple of the work of Heidegger and Merleau-Ponty, he was one of the earliest and most articulate skeptics of artificial intelligence. His suspicion of the claims that computers could be intelligent sprang from the influence of the European thinkers he studied alongside in Paris in the 1950s. Humans learn quite differently from computers, Dreyfus argued; while computers learn by gathering pieces of information and rearranging them in ways that follow predictable rules, humans acquire knowledge through our interactions with our surroundings and repeatedly performing actions.

The body is not just how we experience the world; it's also at the heart of Dreyfus's account of how humans develop skills. He believed that we use our bodies to make sense of the situations we are in and that our bodies learn through acting. Bodies are responsive to the result of their actions: they absorb feedback and begin to know what to do as a result. Dreyfus built a theory about how skills are acquired, in which the diminishing role of instruction or conscious thought is a central idea. It has found wide acceptance in many fields and has influenced disciplines as varied as AI, robotics, social work and nursing.

Dreyfus' time in France began a love affair with European cars, and a mint-condition, convertible VW Karmann Ghia was his pride and joy. Driving became a favorite example in his account of skill acquisition, but any sort of practical skill, whether glass-blowing, cooking, sailing, or more obviously cognitive skills like chess all conform to his model, which charted the progression of the novice starting out through to the acquisition of expertise.

Novices. When teaching a beginner, a sailing instructor breaks things down into their simplest parts. For example, they might point out how to identify from which direction the wind is coming or explain that a sailing boat can only “point” so far into the wind before grinding to a halt. These are necessary things to learn, but they won’t by themselves make a great or even competent sailor—they are pieces of information without context, which a sailor will need to make sense of them.

A more advanced beginner shifts from implementing basic rules to thinking about what she has learned through experience or from her teacher. The sailor might follow a maxim such as, “when the area of the sail close to the mast starts to flap, steer the boat away from the direction of the wind.” Instruction at this stage is focused on helping the pupil learn to recognize situations and arming them with rules of thumb that allow them to respond appropriately.

Competents. Increasing skill is marked by the ability to recognize what can initially feel like an overwhelming number of things in a single situation. At this stage of their apprenticeship, a learner will start to recognize which features of a situation to focus on and attend to. However, given the vast number of different situations they are likely to face, it is unlikely that specific guidance can be given about each one. For example, a sailor needs to learn how to respond to sudden gusts of wind, which might mean easing off the rope that controls the sail or shifting their body weight—there can be no single rule for how to respond and they need to learn what might work best through experience. Dreyfus suggests that it is at this stage in the learning process where caring about our performance starts to kick in. Both teacher and apprentice start to dwell on what works best and why, experience that feeds into subsequent responses to similar situations.

Proficients. That sense of being engaged in the task is key to the development of a skill. Also critical at this stage

of skill acquisition is what Dreyfus terms the replacement of “reasoned response with intuitive reactions,” as experiences in different situations, our responses and their results, become assimilated. A virtuous feedback loop is created, as we start to understand what works.

It is at this stage that the shift from following rules to knowing what to do begins to become more obvious. The ability to identify situations that have been encountered in the past and realize what works becomes evident. For instance, a sailor will be told that when she is sailing downwind, she should shift her weight toward the front of the boat to avoid the stern dragging in the water. From experience she will begin to sense the difference in the performance of the boat that this action produces, and will learn to feel how her body position changes how the boat sails.

Someone who is proficient can see the problem that needs to be solved but still needs to figure out what the answer is. They don’t break down the situation into its individual elements, as beginners do, but confront or engage with it as a whole—this boat, on this stretch of water, in these wind conditions, traveling in this direction relative to the tide. With proficiency, an understanding based on experience that occurs without conscious effort starts to emerge. The skill they have acquired is the ability to conduct pattern recognition on a range of different factors.

Experts. The expert not only knows what needs to be done but how to perform that action correctly—they’ve had enough experience in a variety of situations to know what will work. Immediate and intuitive responses are the characteristic of the expert. The expert sailor knows when their boat is being overpowered by the wind and that they need to let the sail out to regain control, and they do this without thinking. Of course, multiple solutions sometimes present themselves and so an instinctive response is not

always appropriate, but an expert knows when to slow down and think through their options using their ability to read the situation they are in.

As we move through these various levels of skill and attain expertise, something else happens: we think less about what we are doing and start to feel not that we are “doing something” but rather that we are “in” what we are doing. We are not sailing a boat—we are sailing. We’re thinking not about all the individual tasks—shifting weight, steering, controlling the sail—as separate components of the activity, but rather performing them in a composite way. They all come together and we’ve progressed from solving independent problems and making decisions to doing what needs to be done in a fluid, natural way. Only when people are not really thinking about what they are doing, suggests Dreyfus, can we truly call them experts.

When we start to learn a skill, we need to learn the rules or theory that underpin an activity, but as we develop mastery of a skill we don’t need to think about them and are able intuitively to match new situations with the right responses, based on past experiences. Dreyfus saw our lack of reliance on rules and our ability to recognize what’s happening and respond accordingly as a mark of what makes human intelligence so special. He saw that mastering an activity requires us to learn some propositions or rules that guide us in the beginning but that, over time, we can file them away until as experts we no longer need to rely on them. When our bodies just know what to do, we can say we have acquired expertise.

THINKING AND CHOKING

Achieving expertise is not the end of the story, since the maintenance of expertise requires the development of a

specific relationship between the mind and body. In his famous essay “Roger Federer as Religious Experience,” David Foster Wallace reflects on the beauty of the tennis world champion’s game. It is a meditation on what is known as the “kinesthetic sense,” the ability to control the body and its artificial extension—the racket—through an extremely quick series of tasks. It is this that allows Federer to return a serve from his opponent in less time than it takes to quickly blink twice. Professional tennis players hone this skill through hitting thousands of strokes, developing the ability to do by “feel” what cannot be done by conscious thought. The fact that Federer doesn’t consciously think about what to do is mirrored in our own performance of complex skills. In fact, it’s useful to be able to do things without thinking because thinking can impede our performance.

An admission: I’m a pretty lousy skier. I never really skied as a child, and it shows. I display all the awkward signs of someone who started the sport as an adult and has certainly not mastered it—my body doesn’t “just know what to do.” On the occasions when I go skiing, the first few days are spent getting back in the groove and I have to tell myself what to do: “lean down the mountain,” “put your weight on the downhill ski.” A few days in, my running commentary of instructions can be muted and my body starts to take over, yet when I’m faced with something that scares me or looks difficult, the commentary restarts. When I’m faced with these situations, the more I think about it and the harder things seem to be.

There’s abundant evidence from cognitive psychology and neuroscience to demonstrate that overthinking leads to a decline in performance. Standing at the top of a particularly frightening black run, I experience what the science shows—“reflecting consciously on what one knows about a skill often undermines its proper performance.” In

cases like this, there's a negative relationship between conscious reflection and skilled action.

Let's think back to Dreyfus's model of skill acquisition and two important observations he makes. One is about the decomposition of the components of the skill in the early days of learning it—breaking it down into its constituent pieces, so we can focus on each piece in isolation. We stop doing this as we become experts; the knowledge of what actions to take does not require constant cognitive control, and there's evidence to suggest that attending to the components of a well-learned skill can impair our performance of it.

The second important observation from Dreyfus's model concerns the role of language in skill acquisition. In the early stages of learning, we are either given verbal instructions or issue them to ourselves: "lean down the mountain." This is helpful initially but as we become good at things it is no longer necessary—indeed, the evidence suggests that what is known as "verbal overshadowing" actually becomes counterproductive. In an experiment reported in 1990, participants were asked to verbalize what they could recall of a difficult-to-verbalize stimulus, in this case the face of a bank robber and were less able to recognize the face than those who had not been asked to put their descriptions into words. Verbalization created a language-based representation that overshadowed difficult-to-verbalize aspects of perceptual memory. This concept has since been shown to apply to activity, too.

Studies show that when we think about what we are doing, we break a skill down into steps, each of which must be run by our brain separately. This slows things down and the transition between each component of the skill—"lean down the mountain," "weight on the downhill ski"—creates more room for error between each step. At the outset of learning something, we need to focus on what we are doing and break it down into discrete steps, but as we become

better at something we are able to perform the task “as a whole.” Verbalizing what we’re doing breaks down an activity into its constituent parts, which is counterproductive for the performance of the task. Let’s explore what’s going on here in more detail through golf, which is the sport that experimental researchers in this area favor.



In research conducted by the cognitive scientist Sian Beilock and her colleagues, experienced golfers (those with a handicap below eight) were asked to perform a putting task under two different conditions. In the first, they were asked to pay close attention to their swing and at the moment when their club head stopped its follow through, they were told to say “stop” out loud. The researchers called this the “skill-focused condition.” In the second, golfers were asked to putt balls while listening to a series of recorded tones. When they heard a buzzing sound, they had to say “tone.” The experimenters referred to this as the “dual-task condition.”

The golfers were given twenty attempts to putt the ball from locations at different distances from a hole, and each of them tried the skill-focused and dual-task conditions. The results were clear: the experienced golfers performed significantly better when listening for the tone than when they were focusing on when their swing was finished. The experiment showed that skilled golfers could accurately putt balls when performing another task, but when they were asked to focus on what they are doing, their putting became less accurate.

The experiment showed that a well-learned skill may actually be impeded when you are asked to think about what you’re doing. This tallies with similar research that refers to the idea of “choking,” where pressure to perform

can cause people to start breaking down a task back into its individual components, introducing error, disruption, and a degradation of their performance. These experiments all show that where someone has developed expertise, overthinking things can hinder performance. But what about novices who are still working their way up the skill ladder?

In a follow-up study, the same researchers who conducted the experiment with golfers explored the performance of novice and skilled footballers dribbling a ball through a slalom course. Like the golfers, the footballers were asked to dribble under two conditions: while paying close attention to what they were doing and when focusing on another task—listening out for a tone. The experiment showed that the less proficient footballers were better at dribbling when they were focused on what they were doing, but asking them to focus on something else impacted their performance negatively. By contrast, the performance of skilled footballers was not inhibited by being asked to focus on something else—having mastered the skill of dribbling a ball, they had attention to spare. We all benefit from this sort of surplus of attention in our everyday lives that allows us to perform two tasks at once; we might speculate that the body that “just knows what to do” might at earlier points in our species’ development have possessed an evolutionary advantage.

There’s plenty of research to support these findings but some people claim that the idea of experts who can perform their skills without thinking is neither helpful nor accurate. As the ballet-dancer-turned-philosopher Barbara Montero notes, “Ballet is not effortless: those ethereal nymphs in *Les Sylphides* who seem to simply levitate are actually jumping their wings off.” Her point is that while the performance of dancers and sport stars might have the appearance of unthinking automaticity, it is actually one of grit, focus, and ruthless self-analysis. It is, she suggests, a mistake to assume that an apparent lack of effort means things are

easy. Montero has a point, and we should certainly recognize the time, effort, and practice that goes into the mastery and maintenance of skills, especially where performance really matters. The journey from novice to expert is a long one, but world champions and top-flight performers always feel that there is room for improvement.

The findings from the researchers' rigorous experiment into sporting performance are categorically not suggesting that once you've mastered a skill you can switch to a magical form of autopilot. While their work shows that paying attention to each step during a performance might help the novice but hinder the proficient, this doesn't extend to the other types of attention that skilled performers display—their concentration must take other forms if they are to be truly successful. For example, a sportsman might focus on evaluating a move or stroke they've just made, pay particular attention to what her opponent is doing, or make sure they stay focused.

In his autobiography, the Australian cricketer Ricky Ponting recalled how before every ball he received he would say "Watch the ball" to himself three times in order to stay focused. "The only way I could keep a clear mind was to give myself one thought for every ball, which was to just watch the ball," he said. "I used to say it three times ... Once when he started his run, once when he was halfway through and once when he was into his delivery stride." Ponting is one of only four players in history to have scored thirteen thousand Test runs. Renowned for his masterful hook and pull shots, although his body clearly knew how to respond when faced with a ball traveling at 90 miles an hour that reached him in about 0.6 seconds, he still needed to focus and "watch the ball." This mantra had the effect of maintaining performance in circumstances that were complex or challenging.



When we think about how we learn the skills that we use every day, we often assume that instruction—whether from other people or through books or manuals—is at the heart of things. Instructions certainly have a role to play, but they have a particular character. They are linguistic, discrete and often sequential—“do this, then do that”—and yet, as we have already seen, when we have mastered a skill we don’t perform it in this broken-down way but in a sequence of fluid, integrated actions. Moreover, the process of becoming an expert involves the transformation of these commands from those who are teaching us into knowledge that is fundamentally non-linguistic. These instructions become things we just *do*, rather than rules that we follow.

As knowledge becomes embodied in this way, it becomes increasingly hard for us to verbalize. As we saw with the example of riding a bike, we can possess a skill without the ability to put what we are doing into words. To some extent, we can call ourselves an expert in something when we don’t think about what we’re doing in words—and when we have reached this level of skill, we know more than we could put into words anyway. When instruction is difficult because it is not easy to articulate what needs to be done, other means are required; this is one reason why skills like glassblowing are taught less by instruction than by bodily demonstration.

However, we have also seen that the phenomenon of embodied knowledge can depend on letting the body do what it has learned to do without allowing our minds to get in the way. Our bodies are more than capable of doing things without instruction from the brain, and overthinking things can impede our performance.

THE CULTURAL APPRENTICE

So far, we have explored largely practical skills like driving, glass-blowing, and golf. However, learning how a culture works, or at least how to fit into one without standing out like a sore thumb, is a process of knowledge acquisition and follows a very similar pattern, in which the body is central. It takes place when we inhabit environments and requires us to understand, and absorb, before moving beyond the idea of “rules.”

The physical environment is as critical to the acquisition of cultural knowledge as it is to the development of practical skills. Just as being in the “hot shop” is important to becoming an expert glassblower, exposure to a culture is key if we are to learn how it works. Cultural understanding is to a large degree about practical knowledge, such as how to act appropriately in different situations. But learning to get by in a different cultural setting also involves getting to grips with codes that are only rarely written down or made explicit—and if they are, it usually doesn’t take someone long to provide examples of exceptions, or for others to dispute the existence of the “rules.” In other words, cultural knowledge, like much of the practical knowledge we’ve been exploring, is fuzzy at the best of times. It is no less hard to explain how to blow a goblet to a novice glassblower than it is to explain the intricacies of the British class system to an outsider; knowledge of both are best acquired through experience.

The acquisition of embodied knowledge is reflected in how children are socialized. The journey from childhood to adulthood is about gaining the practical and cultural skills required to survive and thrive in a particular world—in that sense, children are apprenticed to their parents, who exhibit a mastery of their particular world. But we might also think of ourselves as apprentices when we take a job in a new organization, find ourselves in a new environment or travel somewhere unfamiliar. All these worlds have their own styles and the people who inhabit them have particular

habits and ways of talking. As Dreyfus puts it, “cultural style is so embodied and pervasive that it is generally invisible to us ... cultural style is too embodied to be captured in a theory and passed on by talking heads. It is simply passed on silently from body to body.” These are skills that are not taught so much as acquired through practice and through exposure to them.”

Learning how a culture works, and how to act in it, is like learning to ride a bike. Once you’ve mastered it, you no longer need to think about it, you feel “at home” in it, and you’re able to adapt to changing circumstances instinctively. The human ability to operate without reliance on rules and with the ability to improvise is one thing that makes our intelligence so special, and the body is central to this. In the next chapter we will discover how embodied knowledge is at the heart of coping with uncertainty or unfamiliar situations and how that skill of improvisation is hard to replicate.

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Chapter 6

IMPROVISATION

“Improvisation embodies the power to create value freely from an instantaneous encounter.”

DAISUKU IKEDA

THE MIDDLE GAME OF LIFE

We live life in the present tense, and much of what we contend with every day is unanticipated. That sense of unpredictability is at the root of the word “improvisation,” which derives from the Latin “*improvisus*,” meaning unforeseen. Life involves much that we cannot plan for but to which we need to respond, and chess represents a good metaphor for this aspect of life and how we deal with it.

Garry Kasparov has spent much of his life hunched over a chess board, his chin supported on clenched hands, so it’s

perhaps unsurprising that he once called chess “life in miniature.” While he is skeptical that being good at chess equates with being intelligent, he is not alone in using chess to think through ideas about intelligence, as well as how humans respond to unfamiliar situations.

One of the attractions of the life-as-chess analogy is the sheer complexity of the game. Arranging thirty-two pieces on a board of sixty-four squares looks simple enough, yet after the first few moves, things spiral into complexity. When both players have moved once, 400 possible board set-ups exist. After the second pair of moves, there are 197,742 possible set-ups, and after three sets of moves there are 121 million. The Shannon number—calculated by Claude Shannon, the inventor of information theory—contends that the total possible number of possible chess games is 10^{120} , which is 10 followed by 120 zeros. In conclusion, chess is a complex game with plenty of options, which makes it a good way to explore how we improvise and the sort of knowledge that we bring to bear when we do so.

Listen to the commentary of a game of chess and you will hear references to the sequence of moves being made, like the “King’s Indian Defence” or the “Budapest Gambit.” These are examples of chess openings or defences against them and *The Oxford Companion to Chess* lists over 1,300 such variants. The moves considered best for both sides in such openings have been worked out to a depth of twenty to twenty-five moves, and good chess players memorize them all. They are quickly able to recognize what so-called “lines”—or sequences of moves—are being played and can respond accordingly.

In the early stage of a game, when the moves conform to a line, the players are in what is called “book” and can draw on their knowledge of what is known to be the best next move. Nearer the finale, or endgame, when there are fewer pieces left on the board, they are often playing through move sequences that have been documented in an

endgame tablebase, a computerized database that contains a precalculated and exhaustive analysis of chess endgame positions. The beginning and end of chess games conform to shared and agreed scripts that can be followed, if not to rules.

The arrival of the “middle game” is signaled by a “novelty,” a deviation from the book, and it is here where the players must perform without a script, since middle game positions are unique from match to match and it is not possible to memorize all the variations. Given the huge number of options, this middle game territory is vast, but chess computers are able to crunch through them by following a simple logic: the best move to make is the one where following your opponent’s best countermove, you are left in the strongest position. How do you know what your opponent’s best countermove is? It’s the one that after you make your best reply leaves her in the best shape. Which of course begs the question, ‘What’s my best reply?’ It’s the one where, after she’s made her best countermove, you are left in the strongest position. These questions go round in a circle, which mathematicians term “recursion.”

When Kasparov was beaten by IBM’s Deep Blue computer in 1997, he was playing an immensely powerful machine. Using custom-designed microprocessors, it worked by analyzing two hundred million positions per second. However, even the ability to explore so many possible moves is not enough when faced with the immovable mathematical reality of recursion. Claude Shannon calculated that it would take 10^{90} years to explore all possible moves, considerably longer than the lifetime of the universe to date. This problem of search depth means that chess computers are not designed to analyze every possibility—their designers prune the move options the machines consider, focusing computing power on where it is most likely to produce a useful response.

Pruning is what human chess players are doing too. A good chess player uses their ability at pattern recognition to identify the situation they are in and focus their attention where it is required. Professionals like Kasparov can analyze three moves per second, far fewer than computers, so it is vital that they target their attention at the right part of the board and on the right problem. They might not have the computational firepower of chess computers, but they do have the ability to understand a situation, identify a pattern and explore the options that it presents. In their 1973 exploration of chess masters, *Perception in Chess*, William Chase and Herbert Simon described the performance of chess experts as a perceptual skill in which they could recognize and recall board patterns. They estimated that chess masters acquire a repertoire of between fifty thousand and a hundred thousand patterns that enable them to identify a good move without having to run through all the possible options.

The defeat of Kasparov by Deep Blue was a landmark event. Kasparov had started the match bullish about his chances, but ended it feeling that he had let humanity down. Chess had for many decades been at the center of efforts by computer scientists to replicate human intelligence and finally a machine had succeeded—it was an important moment. The emergence of chess engines has changed a game where the intuitive intelligence of humans is no longer a match for the brute strength of computers. Yet humans still play other humans and display an ability to improvise in the middle game when they are confronted by novel board positions.

Kasparov has given up front-line chess and new stars have emerged, notably the Swedish player Magnus Carlsen. Carlsen showed prodigious talent from an early age and the captivating film *Magnus* charts his journey from a precocious but occasionally erratic player to the poised champion he is today. What is striking about him is how

intuitive a player he seems to be, something he recognized in a recent article when he noted that “you cannot second-guess your intuition before every move.” In the 2018 World Chess Championships in London, he gave a virtuosic performance against the American Fabiano Caruana, winning in a time-limited tie-breaker. When playing not just against a great player but also a ticking clock, Carlsen seemed to be able to understand rapidly the positions he was confronted by and respond accordingly.

It can be instructive to draw parallels between life and chess. For example, in life, as in chess, openings can be well known and formulaic. Think how different types of social interactions—from meeting friends in a pub to formal meeting with clients or family gatherings—are opened through a series of standardized moves, both verbal and physical. However, once the openings are over, the interactions can take manifold unexpected directions and we respond appropriately without even pausing for thought. Yet life and chess are also very different: chess is a controlled environment with a few simple and unbending rules, while life is not. In the middle game of life there is no recourse to a simple set of operating procedures, and most of what we do is not subjected to rigorous analysis before we do it.

Chess computers beat humans because they can compute deeper and faster than any human, but the way they were developed is instructive when we compare them to the new artificial intelligence systems that can play even more complex games, like Go. Chess computers were originally, and largely still are, built on a rule-based approach: they process their way through all the available options and the optimal responses to opening lines. The principal difference between the computer that defeated Kasparov two decades ago and modern-day chess computers is that while the IBM creation was large, custom built, and lovingly prepared by chess experts and computer

scientists for the game against Kasparov, a chess engine of greater power today features on the pocket-sized device you use to check your email and social media.

However, when the Google-owned artificial intelligence company DeepMind's AlphaGo system beat eighteen-time world champion Go player Lee Sedol in 2016, the approach it took was not one of brute force. Go is a strategy board game for two players played with black and white stones, the aim being to capture more territory than the opposing player. Despite the simplicity of the rules, there are many more moves to consider than with chess. On a 19x19-square board there are 10^{360} possible board configurations in Go, compared to 10^{120} in chess, which is one million trillion trillion trillion more. To build a system that can beat a human at Go required DeepMind to take an approach that was very different from that used in a typical chess computer, since in a game of this complexity evaluating all the possible moves would take longer than the anticipated lifespan of the universe.

AlphaGo used what is known as a "Monte Carlo tree search algorithm" to find its moves, based on knowledge acquired by machine learning, using an artificial neural network that had been trained by expert human players and through play with other computers. Once it had reached a level of proficiency, the DeepMind team improved the system through reinforcement learning; moves made by the AlphaGo were "rewarded" or "punished" depending on the results they produced, before the computer used this feedback to create strategies that would achieve the maximum amount of reward. Reinforcement learning of this type is seen in most species, and if you've ever rewarded a small child for eating their dinner or withheld their spoon when they've used it to cover the kitchen with food, you've adopted a reinforcement learning strategy.

This approach worked, and the reaction to AlphaGo's victory over Lee Sedol was similar to that which followed

Kasparov's defeat nineteen years earlier. However, the victory by DeepMind's creation was rather different; it hadn't muscled its way to victory by crunching more possible moves quicker than its opponent, but rather had learned to play the game and made moves that had the appearance of being wrong but turned out to be inspired. Match commentators and engineers alike gasped when, at move 102 in the first game, AlphaGo made a shockingly unexpected move that a human would likely never have made. Subsequent analysis show it revealed a truly novel "understanding" of the game's strategy. The move was described by commentators as "superhuman," and one unseen in the two thousand-year history of Go.



Having conquered Lee Sedol, DeepMind put AlphaGo into retirement and started work on a system that would come to be known as AlphaGo Zero, a version of AlphaGo that learned the game without the support of human input in the early stages of its learning. It started with zero knowledge of the game, except the rules. "At its core was an algorithm so powerful," wrote James Somers in the *New Yorker*, "that you could give it the rules of humanity's richest and most studied games and, later that day, it would become the best player there has ever been."

Chess and Go are complex games and although the speed of progress in building computers that could beat the world's best players didn't live up to the early predictions, computers have now triumphed in both. However, before we call time on the power of human intelligence in the machine age, it is worth reflecting on the fact that the best chess computers don't play chess like humans do but rather win by knowing the rules and crunching through all the possible moves to find the best one. Their victories are ones of search power and speed more than what one might call

“intelligence.” While AlphaGo and AlphaGo Zero appear to possess more intelligence, their victories are possible because they take a fundamentally different approach to computing that is much closer to how humans operate.

Humans learn by trial and error as we engage with the world. We are punished for our mistakes and rewarded when we get things right, so we learn through reinforcement and by responding to our interactions with the world. In other words, it is possible to say that the AI exhibited by DeepMind’s creations has progressed most when it has followed approaches that resemble a more embodied view of intelligence.

Moreover, it is worth remembering that these game-playing systems like AlphaGo are operating in conditions that are quite different from our daily lives. Chess and Go are fixed environments that may be highly complex but have boards with defined numbers of squares and simple rules. They are environments of perfect information, where both players are informed of the events that have previously occurred and share the same set of possible next moves. While chess computers rely on rule-based programming, the successes of AlphaGo and AlphaGo Zero have been possible because they take a learning approach that mirrors what humans do—learn by experience. By playing hundreds of millions of times, they learn to identify what works.

Our lives are more free-flowing, unpredictable and unfold in constantly changing environments. We don’t possess the same perfect information that opponents in a game of chess have—even if we use “rule-like” descriptions to explain how our lives work—“I take the six forty-five train in the morning” or “We always eat as a family at the weekends”—life doesn’t conform to rules. We improvise more than we follow a script, whether we’re talking, eating, playing sports, cooking, or driving. No drive to the shops is the same as the last—the traffic and weather conditions are always unique, and drivers don’t possess perfect information about the

other road users. When we are driving there are many variables in play, which makes building computer systems that can deal with complex real-world environments like roads, with a huge range of diverse signals and stimuli, much harder.

WHY IS MAKING AN AUTONOMOUS VEHICLE SO HARD?

When John Krafcik took to the stage at the South by Southwest technology gathering in Austin, Texas in November 2018, he dropped a bombshell. The CEO of Waymo, Google's self-driving car unit, announced that autonomous vehicles were not going to be hitting the streets in large numbers any time soon. Waymo was not the first company developing AVs to make this admission, but it was certainly the most high-profile. Google have been publicly working on autonomous vehicles for longer than many other companies and Krafcik's comment that "it's really, really hard" was a very human acknowledgement from the technology company.

Of course, skeptics are keen to point out that we were promised we would have flying cars by now and those are also yet to materialize (though Larry Page, one of Google's founders, is a large shareholder in several companies developing them, one of which is aptly named "Kitty Hawk"). Honda executives had promised they would have their car ready in time for the 2020 Olympics and Ford Motor Company had predicted fully autonomous vehicles would arrive by 2021, but Jim Hackett, Ford's CEO, admits that "the industry overestimated the arrival of AVs." All the major car companies are now rowing back from their promises, and only the idiosyncratic and outspoken Elon

Musk remains convinced that fully autonomous vehicles are possible in the near future.

The investments being made by these car companies is huge and they have hired some of the world's best computer scientists, roboticists and engineers, yet their destination is still a long way off. As Krafcik admitted in his speech, it might not even be possible to produce a car that exhibits level five autonomy, that is, a vehicle which can drive itself on any road, at any time of year, in any weather and under all conditions. If you ask a room of people working in this space, it will be divided roughly evenly between those who say level five autonomy may happen in their lifetime and those who say it might never happen at all. The one thing they will agree on is that it is a remarkably tough problem.

So, what makes developing a self-driving car so hard? To start with, as Krafcik notes, there's the weather. It's not just because California is the tech capital of the world that much of the activity around autonomous car development is happening there—it's also because it reliably delivers blue skies. Heavy rain, sleet, snow, and fog disrupt the sensors on AVs. Snow obscures the road markings, which a self-driving car requires to know where it is on the road. Secondly, there's the roads themselves: while a road might not appear to be something that changes much, in reality they do. Researchers at Oxford University studied a six-mile stretch of road in England for a year and concluded that it is highly viable. One of the mini roundabouts moved three times and the roadside vegetation changed across the seasons, casting different light and shade on the road. Cars were parked at different places and in different ways. The road, they concluded, is a highly variable environment.

Many car companies, most notably Google's Waymo, are adopting an approach that relies on both a car's ability to "see" and on extremely detailed, three-dimensional maps of the road that mark features like intersections, driveways,

slip roads, and street furniture. However, mapping the world in sufficient detail is costly and must be completed for every stretch of road that an AV is going to use, which will take a considerable time.

The principal reason that developing autonomous cars is hard is because roads contain other cars with human drivers, as well as pedestrians and cyclists, which makes them infinitely complex and unpredictable environments. The primary issue is learning how to identify, understand and predict their current and likely future actions—only a car that is able to respond to this variability and uncertainty will be safe and successful.

If you drive, you probably rarely consider how intricate even the most simple of interactions involving other cars really is. When you pull up to a junction and encounter another car that looks like it is going to turn, how do you use the movements of the car or its driver to form a judgment about what it is going to do next, and how do you communicate your intention back to the other driver? There is lots going on here: perhaps some eye contact or body language, whether overt hand signals or a subtle head movement indicating that you should proceed. Both drivers are reading the situation and anticipating each other's actions. Lucy Yu, policy director at FiveAI, a company working on a fully autonomous shared transport service, calls this, “game theorising.” It's the sort of interaction that takes barely more than a second or two and drivers barely think about it, yet it is an everyday marvel of human intelligence and behavior that is difficult to explain.

Driving is a reasonably safe activity; by one estimation, in the United States there is a single fatality for every hundred million miles driven. That's likely a statistic that most of the AV car makers would be willing to accept, but they are a long way off achieving that level of safety. Reproducing the sort of skills that are on display when we are behind the wheel of a car is spectacularly difficult. Most

significantly, it requires cars that are able to transfer the abilities they have in one highly specific road environment to another. It's one thing being able to safely navigate on the wide, gridded, sunlit streets of Phoenix, Arizona, and quite another to be able to perform as well on the crowded, less ordered streets of Rome.

Every mile that we drive presents us with thousands of options and possible scenarios. Imagine you're hurtling down a fast road and a large piece of litter comes into view. Is it the remnant of a cardboard box, or something heavier and more dangerous? If it's the former, it might be okay to keep going but if it's not, action is required. How are you going to respond? That question is difficult to answer because there are many other things that you will take into account in the milliseconds it takes you to respond, from the weather conditions and the feel of the car on the road to what's behind you or how much room there is in the other lanes.

There is no neural pathway in our brain that prepares us for that piece of cardboard box, on that piece of road, at that time, in those road and weather conditions, but we know what to do, and do it. Beyond experience acquired in the time we've driven, there is little that can ready us for that event and yet we are able to respond to it, fluidly and quickly. As we drive, we take these unforeseen events in our stride because we are able to improvise.

It is reproducing that ability to improvise that is the hardest problem faced by AV designers. It is impossible for the makers of autonomous vehicles to write algorithms that can tell a car what to do in every situation because there are infinite situations. Even if the number were finite but very large and it were possible to prepare a car for all of them, you could safely assume that some novel scenario would present itself and cause a problem. As Mark Woods, a roboticist who is currently working on a device to explore the surface of Mars, puts it, designing a robot for an

environment that doesn't change much is hard, but designing one that works reliably in a dynamic environment is another matter entirely. The "variability of the world is the problem," he notes. "You can't fully model it." Steve Wozniak, the cofounder of Apple, agrees: "What we've done is we've misled the public into thinking this car is going to be like a human brain to be able to really figure out new things and say, 'Here's something I hadn't seen before, but I know what's going on here, and here's how I should handle it,'" Wozniak said. "A human can do that."

Autonomous vehicle designers have solved most of the hardware challenges, and the sensors they use like lidar and radar can be bought off the shelf. The big challenge is writing the software that allows the car to do three things that humans are very good at. First, there's perception—what does the world around the car look like, where is it on the road and relative to other objects, and how are those changing across time? Second, there's prediction—what are these other objects going to do next, and what are the signals that makes their likely behaviors predictable? Third, there's planning—given what can be understood of the world around the car, and the possible future behaviors of these other actors, what should its next move or action be?

This trinity of skills that human drivers exhibit—perception, prediction, and planning—need to be mastered by software systems that can perform them in environments that are never the same twice. Since it is not possible to foresee every eventuality and hardwire the behavior of a car, designers are taking a different approach: they are seeking to create AV systems that display the same capability to improvise that humans exhibit. The same sort of embodied knowledge we acquire through experience and practice will need to be exhibited by any car that hopes to achieve level five autonomy, but where do we get this trinity of skills from?

Jamie Cruickshank, a software engineer at FiveAI, sees the abilities that we will use developing even before we start to learn to drive. Although his explanation references the brain, he's actually talking to the wider set of abilities that are intimately linked to our bodies, like perception and spatial awareness.

As humans, before we get behind the wheel, we in the UK have had seventeen years of learning about spatial understanding, interpreting objects in the world around us, and the behavior of others, not to mention millennia of evolution. What we are doing in creating self-driving vehicles is trying to unpick that and teach it from the ground up to a machine with zero prior knowledge. In the unpicking, we find many things that the human brain does that we take for granted but are in fact extremely hard problems to solve in an efficient and robust way.

Cruikshank's observation puts his finger on a significant challenge. As has been recognized since we began to develop artificial intelligence, the pattern recognition skills that humans exhibit are tough to replicate. Pattern recognition refers to how we identify and make sense of objects and is closely related to perception, which is how the sensory inputs humans receive are made meaningful. Pattern recognition lies at the heart of the AI agenda because it is central to human intelligence—any useful AI has to possess it. Pattern recognition ability is critical for the development of safe self-driving cars, where situational awareness is vital.

Take a typical street scene, where there are objects and information everywhere in a multitude of forms—animals, humans, street signs, traffic lights, and road markings. A computer system needs to understand both what and where the objects are, before it can predict what they might do

next and start planning how to respond. The perceptual and spatial awareness capabilities of humans are difficult to replicate; in order to try to make sense of the world around it as a human does, AV engineers have developed camera and sensor systems and have sought to integrate them to form a unified view of the surrounding road.

According to psychologists following the Gestalt tradition, a major influence on Merleau-Ponty's view of perception, humans do things a little differently: our perception, they suggest, is not about the accumulation of piecemeal bits of sensory input but emerges as a coherent whole, which cannot be easily disaggregated into its component pieces for further analysis. We perceive a street scene in its entirety rather than analyzing each isolated piece of it. It is like a piece of music: the notes get their meaning from being part of a whole, rather than the melody being built up of recognizable individual notes. It is the fact that we perceive the world as a meaningful whole that makes our powers of pattern recognition both powerful and hard to replicate.

When the roboticist Rodney Brooks once suggested that the "best model of the world *is* the world," he was pointing out that even with the most sophisticated autonomous vehicle, the model of the world would still be limited—and this is the problem for driverless cars. The incomplete and imperfect representation of reality and of the actors within it, human and nonhuman, holds machines back. This is what gives humans and their embodied minds the advantage, and it looks set to do so for many years to come.

DECISIONS, DECISIONS

Gary Klein has made a career from studying decision making. His famous study is of American fire commanders

and how they act in the face of the complex and dangerous events. In this research, Klein and his colleagues were interested to understand how firefighters make decisions under conditions of extreme uncertainty and with time pressure that do not enable them to evaluate their options. Standard theories of decision making asserted that we compare alternative options before we make a decision, but Klein and his team suspected that this might not be the case.

Their research showed that firefighters make decisions instinctively rather than through following “decision trees” and comparing options. Faced with decisions such as whether to evacuate their teams from a building, initiate search and rescue missions, or go on the attack against a fire, firefighters use pattern recognition capabilities to understand a situation and make a judgment call. Firefighters, he suggested, “could draw on repertoires of patterns that they had compiled during more than a decade of real and virtual experience to identify a plausible option.” What Klein and his research team found remarkable was the ability of a fire commander to know instinctively when a building was going to collapse. They could, he suggested, “read” the signs, take fine perceptual clues, and respond accordingly: “The fireground commanders were able to draw on their repertoires to anticipate how flames were likely to spread through a building, to notice signs that a house was likely to collapse, to judge when to call for additional support and to make many other critical decisions.” Klein termed this alternative to the analytical approach to decision making “recognition-primed.” Experience is central to how it works, but it is more accurately described as the ability to run pattern recognition quickly and effectively as a result of experience. If the plan of action they generated was appropriate, Klein showed, they would go with it, but if it appeared to have weaknesses they would modify it or move to the next option.

Firefighting is, of course, an unusual example of a high-pressured environment where rapid decision making is required, yet Klein and his team extended their research beyond firefighters to other contexts like critical care nursing, the military, and chess, environments where decision making can take anything from a couple of minutes to a few days and involves different numbers of people to coordinate. In all these contexts they discovered the same recognition-based strategies, but they found that experience was a big influence on the decision making approach taken. Decision makers with less experience exhibited a more analytical approach because they didn't have the experience of exposure to a range of different circumstance and so lacked the ability to recognize and read patterns. Klein's research also showed that analytical strategies were employed when the available data was abstract and alpha-numeric rather than perceptual and when decision makers knew that they may need to justify the decisions they made, for example in public policy or business settings.

Klein is at pains to point out that recognition-primed decision-making is not always the best strategy to pursue; analytical approaches have their place, and he often found both being used alongside each other. However, he claims that recognitional approaches are valuable when there are time pressures and conditions are more fluid. His conclusion was that the acquisition of experience gives people the ability to read a situation, assess the options available, and intuitively generate a good response. Our powers of perception, in which the body is central, are at the heart of such decision making.

The perceptual powers that give us our situational awareness are in evidence when we're driving. However, just as a quick, intuitive decision can turn out to be the right one, it is worth remembering that humans are fallible and make snap decisions without engaging our analytical

capabilities, which can result in bad decisions. Likewise, when we're behind the wheel of a car we are putting our powers of perception, situational awareness, and decision making on display, but we are far from infallible.

We have an extraordinary ability to improvise throughout our daily lives—even when the demand on our skills seems familiar, we have to make decisions about what to do or say. As we do so, we are figuring out which aspects of our embodied knowledge to deploy and drawing on repertoires of possible moves, responses, and actions. We display this ability especially well under pressure and in the moment, and this is improvisation. We try out a response to see if it fits or works for a particular situation, and if it doesn't we adjust and remember so that next time we're better able to respond to a similar situation.

It's easy to think that improvisation is the privileged skill of the chess grand master, a jazz musician, or a brain surgeon who is able to respond intuitively to a new situation. And it's also easy to fetishize these specialists and see them as uniquely talented—it's true that within their respective fields they are, but in our often humdrum lives improvisation is also at play, even if it is not always visible.

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Chapter 7

EMPATHY

“Man differs from other animals in that he is the one most given to mimicry and learns his first lessons through mimesis.”

ARISTOTLE, *POETICS*

FEELING OLD

It was when I was halfway along the track we were taking through the forest that I first realized what was happening. I was on a mountain bike trailing far behind my eleven-year-old son, when I suddenly had a realization: I felt more fearful of falling than I had ever done in the past. To prevent a fall that might hurt my pride as well as my body, I was unconsciously slowing down on the banked, downhill turns, even as my son disappeared out of sight. At the same time, I made another connection: I was getting old and that

sense of fear, and my response to it, were intimately connected. The fact that I was wearing a recently acquired pair of varifocal spectacles topped off this feeling of senescence.

I may be old to my son, but relative to the rapidly ageing world I am not. Forty-seven may be middle-aged but it's certainly not old, and I'm fortunate to be pretty healthy. However, my epiphany in the forest drove home another realization. Having worked in a research and innovation lab focused on technology for ageing populations earlier in my career, I'd spent the best part of five years exploring people's ageing experience. By the end of that time I'd felt like I had a good understanding of what getting old feels like and how people in different cultures experience the later years of their lives. It suddenly dawned on me that this might not have been the case and it was only now, over a decade later, that I was able to understand the ageing experience because my own body was declining. My feeling of bodily change had given me the ability to get a handle on the physical and emotional aspects of ageing.

In 2008, the American architect David Dillard had a similar realization. Faced with a slowdown in economic activity after the global financial crisis, Dillard, the founder of Dallas-based D2 Architecture, needed to find meaningful activities for seventy-five young, able-bodied architects. He had an idea: he gave many of his staff health conditions that were typical of old age. He "diagnosed" one with early-onset dementia and "gave" another a full knee replacement. A third was told she was recovering from a stroke and confined to a wheelchair. He then took steps to ensure that they, and he, could appreciate the limitations of sight or dexterity that come with age. "The taping of fingers together was first thing," he recalls. "It gives me an idea of the limitations of arthritis." With their conditions ascribed, Dillard and his staff spent a day and a night in a senior living facility. The Sleepover Project had been born.

There are 45 million people over the age of sixty-five in the United States, with many millions living in specially designed communities, homes, or nursing facilities. Some of these feel more like hotels or cruise liners than nursing homes, but many of them cater for the much older and frailer. Dillard's firm now specializes in the design of such communities, but back in 2008 that wasn't the case. At that point his staff worked across a range of building projects, yet when it came to senior living projects, few of them had any direct experience of the lives of the people for whom they were designing such spaces. Dillard wanted to fix that gap in understanding, and as the recession began to bite, he arranged for forty of his staff to visit a nursing home for twenty-four hours. They took with them their newly discovered condition, a blank notebook, and a willingness to experience the world from someone else's perspective.

The architects made some big discoveries. One of them was confined to a wheelchair after a total knee replacement. In the precise terms of an engineer, he reported that he had "only 50 percent load-bearing capacity on one knee," yet what that meant in practice stunned him. He became aware of things that had never crossed his mind before: "I became much more aware of thresholds between material changes, going through doors and maneuvering. I noticed how people were using any piece of heavy furniture as a grab rail—if the furniture is not there, they have to use the walls to lean." This architect learned that this sort of "furniture surfing" was what people did when the building did not provide the support that older people needed.

The Sleepover Project transformed the architects. All of them speak of the assumptions they had previously made about older people before being confronted by their day-to-day bodily experiences. However, it was in the washing and bathing facilities that they were faced with the indignity of life in a senior living facility in the most obvious and direct way. One speaks of being wheeled through the facility under

everyone's gaze toward the "bathing station," a clinical washroom. This architect reflected on the fact that even his climbing experience hadn't prepared him for the fear-inducing experience of being hoisted over a bath in the washroom. For those with real mobility impairments who were frail in mind and body, he now realized, this experience must be truly terrifying: "When you begin learning first-hand what it's like to be a resident of that age, you look around and suddenly you can empathise with the emotional rises and falls that the community and residents go through."

Dillard realized that his young team of designers and architects could never hope to understand the older people who ended up living in the spaces they design unless they had some experience of it themselves. The feeling of being old, he showed through the Sleepover, comes from the experience of being old. Dillard understood that empathy for the lives of others comes not from reading about their lives or even talking to them, but by attempting to experience their worlds through the body. It is the relationship between the body and empathy that this chapter explores.

WHAT IS EMPATHY?

The idea of empathy has risen up the agenda in recent years. On the campaign trail in 2008, US presidential hopeful Barack Obama frequently cited the empathy deficit as a cause of the country's challenges, yet he wasn't the first politician to do so—both Bill and Hillary Clinton had cited the absence of empathy over a decade earlier. In a piece for *The Atlantic* in 2013, the journalist Robert Wright went so far as to say that "the world's biggest single problem is the failure of people or groups to look at things from the point of view of other people or groups, i.e. to put

themselves in the shoes of ‘the other.’ I’m not talking about empathy in the sense of literally sharing people’s emotions, feeling their pain. I’m just talking about the ability to comprehend and appreciate the perspective of the other.”

Wright may have been correct in his diagnosis of the problem, but he presented few solutions for how to address it and assumes that we can comprehend other people’s perspectives without really *feeling* something for their lives. To a great extent that’s because empathy has often been treated as something emerging in people’s minds rather than emerging from their body and its experiences. It is understood first and foremost as a problem of psychology rather than one of physiology.

The idea of empathy is traced back to the economist Adam Smith and his 1759 book *The Theory of Moral Sentiments*, in which he argued that humans have an innate ability to step into other people’s shoes or “changing places in fancy with the sufferer.” The word empathy didn’t exist in the English language until 1909, when the American psychologist Edward Titchener created the word based on the Greek *empathēia*, meaning “in” and “suffering.”

Scholars typically talk about two types of empathy—cognitive and affective—and the distinction is significant. Cognitive empathy is the ability to take another person’s perspective, seeing the world from their viewpoint or understanding “where they are coming from.” However, when you have affective empathy you display an ability to recognize and share others’ emotional responses to a situation or environment. You would want a funeral director or parish priest to evince cognitive empathy and understand your grief, but you’d probably find they were less help in your time of need if they displayed affective empathy. While Adam Smith called what we would now empathy “sympathy,” it is worth noting that you can be sympathetic to someone’s situation or emotional state, grief for example, without actually sharing it. Empathy, as the author Roman

Krznaric suggests, can be thought of as the “act of stepping imaginatively into the shoes of another person, understanding their feeling and perspectives and using that to guide your actions.”

Studies have shown declines in empathy at a society-wide level, especially in the United States and Western Europe. For example, one study of American students published in *Personality and Social Psychology Review* revealed that levels of empathy in this demographic fell by 48 percent between 1979 and 2009. As with any complex social phenomenon, there are multiple causes, but three are worth calling out: individualism, distance, and filter bubbles. Firstly, as Krznaric points out, the Western world is increasingly individualistic. We are encouraged to look within ourselves and focus on ourselves and our feelings and emotions. Not only is this another example of mind trumping body, it is also what lies behind a culture of self-help and narcissism, in which the self is what matters and the experiences, needs or realities of others recede from view.

In her 1997 book *The Death of Distance*, the economist and journalist Frances Cairncross argued that the spread of the internet, mass communication, and electronic media would render geography, time zones, and borders increasingly irrelevant. Her provocative idea has turned out to be both wrong and right; the world is indeed vastly more interconnected, but borders and geography still matter, to which any refugee or populist politician will attest. Despite the growth of the web, cheap connectivity, and a proliferation of ways to connect with each other, distance is still one of the biggest barriers to understanding and empathizing with other people's lives. That distance is both spatial and social; however cheap and easy communications might be, they don't physically bring us into contact with other people, and scholars like Sherry Turkle, the author of *Alone Together*, have suggested that they might make us

feel more connected while at the same time separating us from others. And we also suffer from temporal distance: consider our inability to empathize with the plight of future generations battling with climate change. As Krznaric argued in a paper for Friends of the Earth, we are unable to adequately understand the impact of our current actions on the future of our own children, let alone the offspring of those we've never met in worlds we've never encountered.

Despite living in worlds that are increasingly rich informationally, so-called informational “filter bubbles”—where the news, views, or information we see emerges from a set of sources that reinforce our preexisting views—ensure that we can never be certain that the information we receive is not just a specific slice of reality, curated according to who we are and how we see the world. As social media networks and news sites use algorithms to display news and views that are in line with our own, the risk grows that we live in a world of parochial information. A character in Don DeLillo's 1985 novel *White Noise* quipped that “for most people there are only two places in the world—where they live and their television set,” yet nowadays it seems that the same is true with smartphones rather than televisions. The net result of these three related phenomena is an inability to see things from other people's perspective.

The concept of empathy as we know it today emerged from the world of psychology and many explanations of what it is are psychological in orientation, but there's also a strong case for suggesting that the body is at the heart of how we can experience, and so understand, the lives of others.

WHAT IS A FEELING?

What was happening as I careered down the forest path on my bike? The obvious answer is that I was experiencing fear. As I picked up speed, I shifted from feeling like a good dad doing something fun with his son to experiencing a sense of panic. I felt my hands grip tighter on the handlebars and a bead of sweat collecting on my forehead. This response suggested that I felt an emotion, to which my body gave a physical expression.

This way of looking at things, another artifact of the Cartesian idea that mind and body are distinct, began to be challenged in the 1870s when, as William Davies writes, “various studies began to examine human and animal bodies on the basis that they could reveal mental activity.” This challenge was given its fullest and most influential expression in a paper written by William James, an American philosopher and psychologist, that was published in *Mind* in 1884. In “What Is an Emotion?” James asked whether we run from a bear because we are afraid or whether we are afraid because we run. The obvious answer, he said, that we are afraid so we run, is wrong. We are afraid, he suggested, *because* we run.

Conventional wisdom suggests that an emotion—be it fear, anger, or sorrow—gives rise to its bodily expression. We run because we are scared, shake because we are angry, or cry because we feel sorrow; the physical follows the emotional. James, however, disputed this. He proposed that when we perceive something, be that a scary animal or a mountain bike going too fast, our body’s response to that is that we get goose pimples or break out in sweat—and the experience of that bodily change is the emotion we feel. Emotional states, James was arguing, don’t come from our minds but originate in our bodies. Without a bodily expression in response to something we see or perceive, James asked, what would an emotion be?

What kind of an emotion of fear would be left, if the feelings neither of quickened heart-beats nor of shallow breathing, neither of trembling lips nor of weakened limbs, neither of goose-flesh nor of visceral stirrings, were present, it is quite impossible to think. Can one fancy the state of rage and picture no flushing of the face, no dilatation of the nostrils, no clenching of the teeth, no impulse to vigorous action, but in their stead limp muscles, calm breathing and a placid face?

Without these physical changes, he answered, the feeling would be merely cognitive, something “confined entirely to the intellectual realm.” The more he looked at it, the more convinced he became that what we normally think of as the expression or consequence of an emotion was, in fact, central to any sense of emotion or feeling. He concluded that the idea of disembodied human emotion was a nonstarter and that were a body in any way unable to express physical responses, that person would be confined to emotionless life lived purely in the cognitive or intellectual realm. James’s analysis on the embodied nature of emotions has a profound conclusion—that it is erroneous to differentiate between feelings of an emotional nature and those that emanate from our other senses, like smell or taste.

The feelings I had on the bike in the forest are easy for me to recall, though I wouldn’t be able to feel them again without putting myself into that sort of situation again, or without reproducing those same sorts of bodily responses to uncontrolled speed. The implications of this link between body and emotions are significant. Firstly, it suggests that it’s not possible to conjure up emotional responses to things without some form of bodily involvement. Secondly, it suggests that we can’t feel things without some form of bodily commitment or involvement.

However, James's theory of emotions and the primacy of the body has another, more intriguing implication, namely that the body does shape the mind. "Whistling to keep up courage is no mere figure of speech," he wrote. "On the other hand, sit all day in a moping posture, sigh, and reply to everything with a dismal voice, and your melancholy lingers." Recent work in the cognitive and neurosciences has demonstrated this in a way that late-nineteenth-century philosophers were unable. The body really does influence how we think and feel. When we see someone moping glumly and say "Chin up!" we may be being more helpful than we think.

In her book *How the Body Knows Its Mind*, cognitive scientist Sian Beilock discusses research that has shown that when James said "refuse to express a passion, and it will die," he was right. Botox is a treatment typically used to remove lines or wrinkles from people's faces, and in a European study, people with major ongoing depressive disorders were recruited to receive injections above and below their eyebrows. Some of them received placebos and some received Botox, and it was a double-blind study, so the doctors administering the injections didn't know who was getting which. Within six weeks, signs of depression had decreased by an average of 47 percent for those who had received the Botox, while those who had received the placebo showed no such improvements and reported no change in their depression. Without meaning to diminish the complexity of mental health by putting it so simply, it does seem that frowning can make you sad and the inability to frown improves how you feel. Other studies have reported similar findings: Botox helps you smile, and smiling makes you happier.

Our body, these studies show, sends signals to the brain about how we feel, and the extent to which we allow ourselves to express our emotions informs how we feel, a point made by Charles Darwin in his book *The Expression of*

the Emotions in Man and Animals, before James had written his influential essay:

The free expression by outward signs of an emotion intensifies it. On the other hand, the repression, as far as this is possible, of all outward signs softens our emotions. He who gives way to violent gestures will increase his rage; he who does not control the signs of fear will experience fear in a greater degree.

If it is the case that the body has a central role in the emotions that we experience, as Darwin and James argued and the cognitive and neurosciences have recently demonstrated, how might we know how others are feeling? And what role, if any, do our bodies play in understanding the actions, motivations and inner lives of those around us?

MIRRORING OTHERS

During the early 1990s, a new way of understanding these questions emerged from a lab in Parma in Italy, where a team of researchers were running neurophysiological experiments on the brains of rhesus monkeys. The discoveries of these scientists have intriguing parallels with the theories of James and the work of phenomenologists like Merleau-Ponty and are a good example of the hard and soft sciences converging on a similar view of how our bodies shape how we think. More importantly, these discoveries have profound implications for our understanding of how we comprehend what others are thinking and feeling.

Like many major scientific discoveries, a folklore has emerged around how it happened. A research assistant is said to have been enjoying an after-lunch gelato in the lab where the experiments were taking place; as he licked his

ice cream, one of the monkeys was watching him and the electrodes emerging from the area of the animal's brain known to choreograph movement suggested that these neurons were firing. Before lunch, the team under Giacomo Rizzolatti had been running experiments to explore a monkey's brain activity as it grabbed peanuts and put them in its mouth. What surprised the team as they watched the display was that the same area of the monkey's brain was lighting up as it watched the assistant eat his gelato.

The observation suggested that the same neurons in the monkey's brain were firing when it *performed* an action as when it *watched* someone else performing a similar action, as if the actions it was observing were being played out in its own brain. Because the pattern of neuron activity associated with the observed action was a representation of the performance of the action itself, Rizzolatti and his team called their discovery "mirror neurons."

The monkey was mirroring in its own brain the action of someone reaching for a piece of food: the brain activity was the same as if it were grabbing some fruit itself. Critics asked whether that meant the monkey understood the action of others or whether it just recognized the act of reaching for a banana. The team ran further tests to see what would happen in the monkeys' brains if they comprehended the meaning of an action without seeing it take place. "If mirror neurons truly mediate understanding," they reasoned, "their [brain] activity should reflect the meaning of the action rather than its visual features," and to establish this they ran two tests.

First, they ripped a piece a paper in front of the monkey and then played back the sound without performing the action. Similar neuron activity occurred when a monkey could see and hear the paper being ripped and when it could only hear a ripping sound, which led them to conclude the monkey could understand what it was hearing. With that established, they conducted another experiment. This time

they showed the monkey a researcher picking up a piece of food and then erected a screen so the monkey could only guess at what was happening. The same neurons fired when it was only able to imagine that behind the screen the researcher was picking up some food.

The next step was to demonstrate the existence of mirror neurons in humans, which they did with a series of experiments using electrophysiological monitoring to record electrical activity of the brain. Having concluded that mirror neurons allow for the observed action to be understood, the team wanted to know if the mirror system allows us to understand not just what others are doing, but what they are feeling too.

Imagine seeing someone curl their lip in an apparent display of disgust at an unpleasant smell. Prior accounts of how we experience what other people are experiencing suggested that we perform some cognitive “elaboration” of what we see and we reach a reasoned conclusion as to what they are feeling. Within our brains, a process of logical deduction takes place that requires no emotional involvement on our part.

The existence of a mirroring mechanism presents an additional and complementary explanation: when we see someone feeling disgust, that sensory information is mapped onto the parts of our brain that would initiate that physical expression if we were experiencing the same thing for ourselves. In that way there’s a direct mapping: thanks to mirror neurons, we are actually experiencing the same emotional state of disgust, or as Rizzolatti puts it the “observer and the observed share a neural mechanism that enables a form of direct experiential understanding.” This was quite different from the cold, deductive logic offered by the traditional explanation of how we understand what others are feeling—it essentially proposed that we perceive emotions in others by activating the same emotional state in ourselves. Mirror neurons that fire both when we

experience something and also when we see someone else going through the same experience suggest there might be more truth than we realize in the expression “I feel your pain.”

What this Italian research team had discovered was heralded as the key to unlocking age-old questions about how and why we empathize with other people. The prominent neuroscientist Vilayanur Ramachandran christened them “empathy neurons” because, as he put it, “it’s as if this neuron is adopting the other person’s point of view.” While some have called these cells “Dalai Lama neurons,” being of Indian descent, Ramachandran has opted to label them ‘Gandhi cells’, after the Indian independence leader who advocated for the dissolution of barriers between people with different beliefs. These neurons, Ramachandran believes, break down our barriers to other people by providing the mechanism by which we can feel what they are feeling. He and Rizzolatti both believe that mirror neurons explain how we empathize with what others are thinking and feeling.

However, the theory of mirror neurons presupposes that we can only create that emotional bridge when we have experienced similar actions for ourselves, and it has been mapped onto the relevant area of our brain. If we haven’t, we can recognize what they are experiencing but because it is not in our brain’s motor system, we won’t experience it for ourselves and won’t be able to fully empathize with them. When we talk of the importance of empathy in a healthy, functioning society and the perils of its absence, mirroring helps us understand why experiencing the lives or environments of others is so important in generating an understanding of how they feel. If empathy depends on shared experience, it does so because we can only truly sense what things feel like for others when we have experienced what they have.

The concept of mirroring does not offer an all-encompassing theory of how people process, store and apply information about other people and social situations. Some have expressed doubt about how far the theory can represent an explanation of our understanding of others, since the functioning of mirror neurons is most closely observed in terms of actions and motor-related activity in the brain. Other researchers have questioned whether these neurons can be considered a distinct class of cells. However, mirror neurons are considered as vital to a range of human characteristics and the concept has been picked up in a range of disciplines as a possible explanation for the mysteries of the human condition.

One of these mysteries is how we learn. For example, Ramachandran has claimed that mirror neurons lie behind the “great leap” in human creativity that occurred around forty thousand years ago. At this time, language, tool use and artistic creation exploded, even though the human brain had developed to its present size 250,000 years earlier. Ramachandran proposes that mirror neurons, which allow us to understand another’s intentions and develop a sophisticated theory of other minds, are what lies behind the growth of cultural endeavor that emerged at this time. Equally, because these neurons give us the ability to mime others’ vocalizations, he proposes that they set the evolution of language in motion. In this way, Ramachandran puts reading other people’s minds and imitation learning—both enabled by mirror neurons—at the heart of his explanation for the development and spread of human civilization.

Aristotle observed in his *Poetics* that “Man differs from other animals in that he is the one most given to mimicry and learns his first lessons through mimesis,” and mirror neurons suggest his observations have a good basis in science. When we copy others we talk of “aping” them, but it appears that Aristotle was right in only applying his

observation to humans. Nonhuman primates don't have the same ability for imitation—it is rare in monkeys and limited in the great apes like chimpanzees and gorillas. However, imitation is a mechanism through which humans learn and share not only skills, but also language and culture. In short, communication of feelings but also knowledge rely on imitation, for which mirror neurons offer a compelling explanation.

BODY-TO-BODY COMMUNICATION

Mirror neurons allow us to connect with other people without words and on multiple levels, so it is no surprise that the theory of mirroring has been taken up in many fields, not least by those exploring how humans communicate—and not just one-to-one, but also in groups.

There's a tendency to see communication as primarily verbal. Just as the dominance of the mind in theories of intelligence led us to think of the brain as a computer that processes abstract information, so classic theories of communication saw language abilities as an artifact of the same form of processing, but of sounds and words. However, over recent decades the body has taken a more central role in research regarding language, speech, and communication.

While some researchers suggest the quantification of what proportion of our communication is verbal or nonverbal makes little sense, others have put numbers to it. The psychologist Michael Argyle estimated that more than 65 percent of information exchanged in face-to-face interaction is expressed through nonverbal means and Shuichi Nobe claims that as much as 90 percent of speech is accompanied by gestures. The psychologist Geoffrey Beattie argues that hand gestures are at the heart of

communication and emerge from the same part of our brain as the semantic information (i.e., related to meaning) we're trying to express with words. If this sounds implausible, consider the fact that even when you're speaking on your mobile phone you're probably using a wide array of hand gestures as you walk around the room—even when the other caller can't see our hand movements, we are using them to express ourselves. People who are blind from birth also use hand gestures when they speak. Whatever percentage we're willing to allocate to each mode of communication, it's clear that we don't use just words but also gestures, movements, and expressions to communicate with others.

The conductor Sir Simon Rattle is a maestro at using his body to communicate. Hands are key for any conductor but Rattle is legendary for seeming able to use his orchestra as if it was an instrument he was playing himself. How does he control this group of eighty or so musicians who are playing about twenty different instruments? During rehearsals a conductor uses words to communicate with the orchestra, but during a performance he is limited to nonverbal communication; he can only communicate through his body and baton and must draw out features and feeling from the score without uttering a word.

Conductors sometimes mimic the music they are conducting through bodily motions. For example, they might march when the music is a march or swing when it is a swing. On other occasions they might indicate to their orchestra that they should play softly by bending their knees, dropping down slightly, and hunching their shoulders. Guides to conducting recommend that conductors use the fact that their facial muscles can create about ten thousand different expressions. With gestures and facial expressions, a conductor can draw out subtleties and emotion for which there might not even be an obvious word to express his intent were he able to speak. Witness Rattle's

face as he takes his orchestra through a piece of music and you will see that the baton almost seems irrelevant in his performance. As one music critic wrote, there's a correlation between his body language and the sound of the orchestra: "Ease is also key to Rattle's musical language, and his body language reflects this. Rarely without a smile on the podium, he has an unmistakable enthusiasm to communicate his love for the music in the making, and thereby creates a sound that is plush, confident and certain in human warmth."

Crowds don't have conductors, yet they often behave as if there were someone in their midst directing what is happening and how people are feeling. Audiences tend to start their applause together, and often end their clapping in synchrony. Responding to the intensity of those around us, we might increase the volume of our applause, and as if by instruction from a conductor, an audience ceases clapping almost simultaneously. There are three interconnected ways of thinking about this. One borrows from the natural world, one relates to the concept of mirroring and the third from the findings of psychologists exploring the idea of social cognition. All lead back to the idea that understanding others, and being able to empathize with them, have a crucial bodily component.

BODIES THAT RESONATE

In 1656, Christiaan Huygens, a Dutch physicist, mathematician and astronomer, invented the pendulum clock. Huygens had been involved in the seventeenth-century race to build an accurate clock that would enable sailors to precisely locate their longitude. Success in this endeavor was seen as vital to world trade and he was quickly granted a patent for his creation. Writing to his

father in 1665, he mentioned an observation that intrigued him. He reported that he was in bed sick, from where he watched two clocks hanging on the wall. What he observed was that the pendulums on them started to swing “in sympathy” with each other and, he added, if this synchronization was somehow disturbed, they quickly reestablished their harmonious movement. This observation of synchronization was subsequently reported in the late nineteenth century in organ pipes that sound in unison when located close together. The phenomenon of the spontaneous synchronization of oscillating systems has been known to exist in living systems for centuries and is often called “entrainment.” Fireflies will entrain with each other when illuminating and the human heart starts to beat in sympathy with another in proximity to it. One of the most spectacular examples of entrainment occurs when flocks of starlings murmur in awesome aerial displays of synchronized flight.

Entrainment is of particular interest in relation to music. Older theories proposed that musical rhythms were computed by the listener’s brain, which extracted information from sound before turning that into an action, like a tapping foot. Psychologists have more recently begun to view rhythmic musical movement as a process of entrainment, in which ‘oscillations inside the listener become synchronised with rhythmic cues in the environment.’ The commonplace idea that we are ‘moved by music’ is illuminated by this more bodily explanation of the effect that music has on listeners.

Entrainment is a physical phenomenon and depends on a connection or resonance between people—or other creatures—while the concept of mirroring also depends on a physical element, as we observe others and enact their actions ourselves. As Vittorio Gallese, a member of the Italian research team behind the mirror neuron discovery remarks, “when we observe actions performed by other

individuals, our motor system ‘resonates’ along with that of the observed agent.” This resonance of our body with other people allows us to sense their moods, and it is this process that connects the conductor, his orchestra, and the audience.

If Sir Simon Rattle’s actions and expressions are being communicated to his audience through the mirroring mechanism, how do individual members of the audience develop an understanding of how the music is affecting others around them and how does the audience’s collective response shape the emotional state of an individual listener? The theory of embodied cognition, for which there is a large and growing body of evidence, explains this by challenging traditional theories that claimed that when one audience member sees another smiling and looking like they are enjoying Rattle’s performance, they have a sensory experience of that audience member. They might even act in response, perhaps by smiling at them, feeling warmth toward that person and undergoing a change in their so-called “introspective state.” However, the traditional theories assumed that knowledge of such an experience resided in abstract, symbolic forms in the mind rather than consisting of the sensory inputs or motor responses that constituted it.

In contrast, the theory of embodied cognition suggests that knowledge exists not just as these abstract forms but also involves the sensory, motor, or introspective state being partially stored in the body. In other words, sensory stimulus don’t just result in a cognitive state but in bodily states too and, through the mirroring mechanism, perceiving these states in others produces them in the self. The audience’s emotional response is given physical form, which other members of the audience can pick up on.

The everyday phenomenon of yawning is a good illustration of this idea. If we see someone yawn, the undeniable urge to yawn overcomes us and we start to feel

tired. Laughter is another form of social contagion—as any child knows, once a classroom has started giggling about something it’s almost impossible not to join in. Yawning and laughing are not just bodily states: they are infectious because they *are* bodily states.



The science shows that understanding others is enabled by our bodies and is not merely a mental process. However, since entrainment and body-to-body communication both depend on physical copresence, it is worth reflecting on where this leaves us, given that much of our lives are now spent in a digitally mediated world. As teaching moves online, meetings increasingly take place through video conferencing systems and virtual reality hangouts become more popular, we are increasingly removing our bodies from our interactions with each other. If both reading other people’s state of mind and reading the mood of a room depends on physical copresence, what are we missing out on when we inhabit digital environments?

Designers of new communications systems are investing heavily in improving the fidelity of the audio and video in their systems, and often they include additional communication channels like chat functions. Designers of virtual reality systems focus on making the avatars on their systems as lifelike as possible and work particularly hard on improving the expressiveness of their facial characteristics. However, there are plenty of technologists who realized that face-to-face human interaction depends on a subtle combination of eye movements, head motion, gesture, and posture. Communication between people depends on this holistic sense of embodied interaction, and merely improving the video quality or adding features won’t give virtual interaction anything like the richness of social information that face-to-face encounters involve. An emoji

might be a useful way to signal a response but it doesn't have quite the same contagious quality. As we have discovered, mood and feelings have a distinctly embodied dimension and there will always be limits on what virtual communication systems can achieve in their efforts to give geographically separated people the sense that they are in the physical presence of others.



The idea that understanding what other people are feeling depends on the body is a departure from the once-dominant psychological or cognitive explanations. This new explanation hinges on the idea that our emotional states do not just come from our minds but originate in our bodies because of the intimate connections between our motor, sensory, and cognitive functions. The idea that feelings are embodied rather than inner psychological phenomena explains why they are so easily shared with others. If we think of mood as something that is embodied and on the outside, it becomes clearer why we are so able to divine the mood of a room.

The emotions that we associate with an experience are intimately connected to those felt by the people around us. In that sense, they are created and shared between people when they are together and their feelings resonate with each other. Being with other people allows us to feel what they feel.

Mirroring enables us to appreciate how we understand what others are feeling, while the idea that our bodies physically resonate with each other helps us better comprehend how feelings can be shared by people who are in each other's presence. The contagion of mood and feeling between people is an artifact of the embodied nature of experience, as our bodies first, and then our minds, fall into synchrony with those of others.

The mystery of how we understand other people or feel empathy for them is typically explained in terms of our minds, as in when we are urged to *think* about others' feelings, but our bodies play a significant role in how we see things from an alternative perspective. And not only are our bodies critical to how we understand the world—they are also at the heart of how we remember it.

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Chapter 8

RETENTION

“What has my body become? A memory in a landscape?”
KNIGHT AND MCFADYEN

If the body is at the heart of experience and feelings, it is also central to how we retain and recall knowledge. Even people who haven't read Marcel Proust's *In Search of Lost Time* will likely have heard references to the author's journey of remembrance, which is precipitated when he dips a small madeleine cake into his cup of tea:

No sooner had the warm liquid mixed with the crumbs touched my palate than a shudder ran through me and I stopped, intent upon the extraordinary thing that was happening to me. An exquisite pleasure had invaded my senses, something isolated, detached, with no suggestion of its origin ... And suddenly the

memory revealed itself. The taste was that of the little piece of madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before Mass), when I went to say good morning to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of tea or tisane. The sight of the little madeleine had recalled nothing to my mind before I tasted it.

The expression “Proustian moment” is used to refer to those occasions when a sensory cue—a familiar smell or taste—triggers a memory. There are plenty of similar events in all seven volumes, and they each describe in detail what Proust is perceiving at the time and what he’s remembering. Each reflects the repeated and enduring link between perception and memory. Proust recognizes that memory is as much located in the body as in the brain.

The idea that knowledge is stored in the body runs counter to the received wisdom that the brain is like a filing cabinet or a hard drive of memories and knowledge. As Robert Epstein, the eminent psychologist, puts it, “No matter how hard they try, brain scientists and cognitive psychologists will never find a copy of Beethoven’s *Fifth Symphony* in the brain—or copies of words, pictures, grammatical rules or any other kinds of environmental stimuli. The human brain is not really empty, of course. But it does not contain most of the things people think it does—not even simple things such as ‘memories.’”

So if the brain is not where things get “stored” in the straightforward way we tend to imagine, how might the body provide an alternative explanation for how we remember things? And how might we distinguish between the different types of memory the body has?

The idea that memory isn’t just a cognitive phenomenon is neither new nor confined to the academic world. The concept of “muscle memory” is widely used to convey the

fact that the body is able to retain knowledge and to act without the conscious or active control of our mind. When we use muscle memory, our bodies just seem to know what to do.

References to muscle memory in everyday conversation describe our ability to act spontaneously without thinking and recall the sort of movements, which are often very precise, that work in a specific situation. In academic contexts this sort of memory is typically referred to as “procedural memory” because it allows us to perform procedures or skills automatically, without having to consider how we proceed from one step to the next.

This ability to act unconsciously but with precision is found in a bewildering array of contexts in our everyday lives. Rather than being the preserve of the gifted and experienced craftswoman or racing driver, it is in evidence when we do up our shoelaces, go for a walk, play the piano, or type on a keyboard. All these skills are called “sensorimotor” because they rely on the coordination of sensory perception with movement. As we discovered in *Practice*, we learn through doing, and one way to think about muscle memory is as an acquired product of what Richard Shusterman calls “sedimented habit.” The more we do something, the more proficient we become and the more our body becomes attuned to the tools we’re using or the environment we’re in. Layer after layer of experience is laid down in our body. A more scientific explanation would suggest that as we perform these skills, patterns of movement become embedded in our central nervous system—what we think of as muscle memory is a powerful combination of habituated muscles and the brain’s neural networks.

Getting dressed, tying your shoelaces and brushing your teeth are all examples of such procedural memory, but much of life involves more complex activities that rely on the same form of memory—we should be thankful for it

because it creates efficiency and is an aid to performance. A writer sitting at their keyboard is able to devote their attention to the words that they are typing rather than on controlling the movement of their fingers across the keys in front of them. In that sense, a body that knows what to do requires less of our conscious attention to focus on what it is doing, leaving us able to focus on the aspects of our performance that might benefit more from our full attention.

The efficiency that arises from the combination of a body that knows what to do and our brains can have both useful and harmful consequences. While it allows people to focus on a task in hand when they find themselves in a changeable or unfamiliar environment, studies of train drivers have shown that familiarity with a task can lead to a lack of focus, with dangerous consequences.

Yet there are other dimensions to the idea of muscle memory that extend beyond these practical skills. In fact, it is about far more than the ability to perform actions without thinking—it is also about the body's ability to remember where it is, what happened there previously, and what it felt like.

TOTAL BODILY RECALL

The memories of Proust's childhood that tumbled out when he tasted a small cake were not just of a time, but also of the place in which his early years were spent. The cake has specific aromas and tastes, sensory perception that triggers memories, and our broader perception of the world similarly results from us inhabiting it with our body. What we see and perceive of the world is from our body's point of view, and the body gives us what Shusterman calls the "primordial point"—our bearing in the world. Experimental studies have shown that we are able to form maps of environments with

our unconscious attention as we navigate through them—when we focus on remembering an environment our mental maps of it may be stronger.

Consider what happens when you visit an unfamiliar supermarket. It is often an unsettling experience to be in an environment that is laid out differently from what you expect. The fruit and vegetables may be by the entrance, but otherwise the layout of the store might be quite different from what you are used to. Normally you are able to wander from aisle to aisle, knowing where things are located and able to pick things from the shelves without much thought. As a result of numerous visits to your regular shop, it has become known to you; you note things that are out of place without needing to consciously engage with the shop's environment. You have a remembered feel for the space you are in.

The body's perceptual abilities are at the heart of this act of remembering, and it is not just with our eyes that we engage with the supermarket but with all our senses. The rice and pasta section is close enough to the refrigerated aisles to feel cool, but as we move toward the bakery at the far end of the store, the air temperature becomes more comfortable and the smells get more enticing. All our senses are at work in building a multidimensional map of the space and each time we visit, it becomes more detailed and stable. It's not just our familiar five senses that help us build that life-sized model of the world but our sixth sense, proprioception, too. Our perception of the position of our body relative to the world gives us a deep and embodied sense of where we are and what's around us, which is helpful when we are in the supermarket. It helps us swiftly complete what can be a dull or unwanted chore and affords us the luxury of not having to expend a great deal of mental energy as we do so.

However, there's also a more meaningful and experiential dimension to the role the body plays in what we

remember: it also reflects and shapes our relationships with others. Do you always sleep on the same side of the bed and find yourself feeling that something is not quite right when, while staying away from home, you find yourself on the wrong side of your partner? Do you adopt the same positions when walking with them and derive a comforting sense of familiarity that gives you a feeling of well-being? It's because emotions are grounded in the body that these bodily positions have this affective dimension. There is an alignment between how we feel in the context of other people and the positions we adopt, and this connection between our bodies and feelings builds over time.

Whether it's the memory of the taste of a certain food or the odor of a certain place, our body's sensory abilities result in memories that emerge without much effort but seem to contain the essence of the person, place or moment in question. The way in which such an essence can be triggered by a sensory perception is mirrored in the way that cultural knowledge can also possess a bodily dimension.

EMBODYING AN IDENTITY

Although the uniforms worn by priests, judges, police officers, and nurses are an important component of their identities, they are not the only way in which these people communicate who they are. The training to become a police officer or priest takes time and requires a great deal of specialist knowledge, but being a police officer requires a lot more than knowledge and the uniform—before one can be seen to be a “real” police officer or priest, it's necessary to really embody that role.

A trained police officer may know the law and the guidelines she must follow, but it is important that she uses

her body to assert her authority in a public order situation. Her training is not limited to what is legal and the procedures she must follow, but also includes how she should impose herself in situations of risk and danger. Likewise, in order to become a priest a novice must not only master the scriptures and learn to take services and run a parish, but he must also learn how to embody values of humility, devotion and love. While his training might not be as formal as a police officer's, he must still learn what bodily position to adopt at a moment when sympathy needs to be extended to a grieving family—how a combination of open arms, proximity, and facial expression can transmit care and concern. In a famous essay on the body, the French sociologist Marcel Mauss wrote about a revelation that came to him in hospital:

I was ill in New York. I wondered where previously I had seen girls walking as my nurses walked. I had the time to think about it. At last I realized that it was at the cinema. Returning to France, I noticed how common this gait was, especially in Paris; the girls were French and they too were walking in this way. In fact, American walking fashions had begun to arrive over here, thanks to the cinema. This was an idea I could generalise. The positions of the arms and hands while walking form a social idiosyncrasy, they are not simply a product of some purely individual, almost completely psychical arrangements and mechanisms.

Mauss's insight emerged from an observation about walking, and elsewhere in the essay he reflects on the different marching styles of the British and French. Of course, marching is a skill that is drilled into soldiers through hours of practice on the parade ground, but walking is something we learn in the early stages of our development. Could it be, Mauss was asking his readers,

that the way we walk is more than just a matter of personal style but something that has a larger cultural dimension? He was suggesting that how we hold our body, its posture and demeanour, comes to embody our cultural or, as we see in the case of the police officer or priest, professional values.

The body, as Mauss saw it, was not just a neutral bundle of flesh and bone but a repository of cultural knowledge, as well as something that expresses that knowledge. Acquiring the status of a professional requires not only learning a craft or trade but the development of a certain body or bodily disposition. Police officers are not simply walking encyclopedias of what's lawful—their uniformed, trained bodies are the embodiment of law and order, and their training is designed to create bodies that embody the values of the police force. The ex-marine Mark A. Burchell, an anthropologist who completed the thirty-two-week Royal Marine training process—and has participated in it again as a researcher—remarks on how it is designed to essentially break down a young man's body and remake it as a soldier's. The process of making elite soldiers is physical for a reason, and not simply because of the physicality of soldiering; the body is central to their identity as a marine. As Burchell puts it “their repetitive bodily engagement with the military's material culture such as assault courses and other physical training environments, will transform their mind and physical postures from one of being tested to one of triumph,” and this continues throughout the training program “enabling their gradual progress toward embodiment of their new identities as Royal Marine Commandos. At this point the body is weaponised and ready to deploy.’

Beyond these sorts of professions, it is worth remembering that humans have always made cultural decisions about how bodies should be augmented with paint, adorned by decoration, or physically altered for religious or other cultural purposes. Many rites of passage,

such as those documented by anthropologists like Victor Turner, involve bodily alterations such as circumcision. As he saw it, the body of a teenage Ndembu boy becomes that of an adult through this ritual of socialization. Bodies are very much a product of a place, time, and culture, and both contain and communicate cultural messages.

LEARNING LINES

When we watch talented actors perform, it can be easy to overlook the vast number of lines they need to learn in order to play their part. Many actors brush aside this skill and don't regard it as a skill at all. The British actor Michael Caine once said, "You must be able to stand there not thinking of that line. You take it off the other actor's face." His comment acknowledges how important it is to be spontaneous, but it does little to reveal how he remembers a script. Yet given that many of us spend a lot of time trying to memorize things, it is easy to be jealous of the apparent ease with which actors can commit such a large amount of information to memory. At school we have to cram facts for our exams, and in our adult lives we might struggle to remember people's names or what it is we want to say in a work presentation. So how do actors do it?

Recent studies of how actors learn their lines have showed the degree to which their success is due to how they link action to dialogue. One research study by Helga and Tony Noice into information retrieval in the context of acting, showed that lines that are delivered while an actor is moving are easier to remember than those that are delivered without an accompanying action. Many months after the study, the actors involved could recall their lines much more successfully when they were performing the action compared to when they were sitting down. In another

of their studies, the Noices showed how the lines and props used in a scene work together to help actors retain their lines. In an example they give, an actor walks over to a bottle, picks it up and declares, “This is how I solve my problems.” Knowing what their character means by these lines, the actor’s movement and actions reflect this meaning: “the bottle represents the meaning of the situation, and the meaning of the situation constrains what actions he will perform.” He might take a large swig from the bottle or swing it in the direction of another character. The meaning, lines and action are closely linked, and so when the actor needs to recall the lines, they can remember the dialogue and the action—the memory is grounded in the body and its action. Rather than just sitting down and trying to memorize large quantities of dialogue, actors can learn their lines by performing them; the evidence from studies, including those by the Noices, suggests that this could work in any non-acting context too.

Cognitive scientists distinguish between the procedural memory we’ve already encountered—a form of memory that can be recalled without conscious effort—and declarative memory. This sort of memory refers to those things that are consciously recalled (or “declared”)—the dates of kings and queens, French vocabulary, and the elements of the periodic table are all facts that we might have had to commit to memory. Recalling them tends to involve conscious effort, but as we have already seen, the process is easier when they are associated with actions. It’s also the case that we often remember things better when we are in the environments where we acquired the knowledge in the first place, or when we reenact the situations that led to its acquisition.

A famous study of Scottish scuba divers, undertaken in the 1970s, demonstrated the relationship between environment and memory. The divers who participated in the study were on a holiday near Oban on the Scottish west

coast when they were asked to learn lists of two- and three-syllable words on dry land or underwater before they were tested on their recall of the word lists. Having tried to memorize a list on dry land, they were asked to dive to twenty feet and recall the words while sitting on the bottom of the sea. The divers recalled words better when the recall conditions matched the original learning environment: the researchers had shown that memory is highly context-dependent. Another more everyday example of context-dependent memory is illustrated by how we respond to losing something at home, such as our spectacles. We often search by retracing our steps to determine where we might have put them; given the role that context plays in recall, it's unsurprising that we quite often remember where we left them the moment we return to the right part of the house. Our recall of information depends not just on mind and body—the study suggested that our brain and bodies can use our environment to help us recall and process information.

THE EXTENDED MIND

The idea of embodied knowledge is a challenge to the presumption that the brain, independently of the body, is responsible for how we remember things and where cognition takes place; rather, it is the combination of mind and body that is responsible for memory. Yet as we've seen in this chapter, it is also the case that our environment affects how we think and remember.

Does that mean that objects and environments are part of our mind? The cognitive scientist Andy Clark, who is something of a rock star in the world of cognitive science, thinks so. An article he wrote with David Chalmers in 1997 titled “The Extended Mind” is one of the most cited in the

discipline and made a revolutionary contribution to human thinking about thinking. Their argument, in simple terms, was that mental states and processes are spread across physical, social, and cultural environments, as well as bodies. Thought, they suggested, is “scaffolded” by the things outside our heads—not just physical objects, but the environment.

In the 1990s, when the article was written, the Filofax personal organizer was popular, and they used this as an example of how objects can help us organize our thoughts and remember things—the paper diary, address book, and to-do list was a demonstration of the human ability to incorporate objects and tools into our thinking. If someone asks you to multiply 457 by 397, it’s quite likely you won’t be able to do this in your head (unless you are prodigiously talented at math), so you will quickly reach for a paper and pen. In the same way that a Filofax acts as an extension of our memory, so pen and paper are an inseparable part of our cognitive ability to perform difficult sums. When we’re playing Scrabble, we tend to think that the moving of tiles is an action rather than a thought process, but the action of rearranging is in fact, Clark and Chalmers would contend, as much cognitive as physical. We’re thinking with our arms, hands, and eyes. Our mind does not just extend into our bodies, they were arguing, but also into our physical environment. They proposed a thought experiment to argue their point:

Imagine there is a man named Otto, who suffers from some memory impairment. At all times, Otto carries with him a notebook. This notebook contains all the information Otto needs to remember on any given day. Suppose one day he wants to go to an exhibition at the Museum of Modern Art in New York, but he can’t remember the address. Fortunately, he can simply look up the address in his notebook. This he duly

does, sees that the address is on 53rd Street and attends the exhibition. Now compare Otto to Inga. She also wants to go to the exhibition, but has no memory problems and is able to recall the location using the traditional, brain-based recollection system.

By comparing Otto with Inga, Clark and Chalmers were suggesting that there was no significant difference between the two of them. Both of them “look up” the information—Inga in her brain and Otto in his notebook, which acts as a sort of “outboard brain.” As the authors saw it, if a part of the world functioned in a way that would be accepted as part of the cognitive process were it going on in the head, then it was, to all intents and purposes, a *feature* of the cognitive process. When this provocative paper was first published there were many skeptics of this position, including some who regarded Clark and Chalmers’s definition of what sort of objects could be seen to play a cognitive role as a bit too liberal.

Yet as smartphones dislodged the Filofax and become central to our everyday lives, the early critics of their position started to come on board. I moved house two years ago and have still not committed my home phone number to memory, and I suspect I can recall only a small fraction of the hundreds of numbers that are stored on my phone. I use note-taking software to jot things down, as well as an electronic to-do list. I have “outsourced” much of my memory to my phone. In this way, the physical objects in my personal environment have come to play a major role in my cognitive processes—my mind and the environment are, in this sense, “coupled.”

Although it took the personal technology revolution for many skeptics to come onboard with Clark and Chalmers’s theory of extended mind, it’s not hard to argue that since humans began making artifacts and creating art between fifty thousand and one hundred thousand years ago, they

have been using the physical world not just to assist their thinking but also to store ideas. One sign of how influential Clark's thinking has been is that some archaeologists now refer to what they do when they dig up ancient civilizations not as the reconstruction of objects but of "minds."

The idea of the extended mind brings brain, body, and environment together in a theory of how and where cognition takes place. All three work together to help us retain and recall information, but also the ability to perform tasks that are both simple and complex.



The knowledge we retain in our bodies is not just procedural knowledge, like how to flip a pancake or drive a car, but also relates to our sense, and memory, of places, people, and experiences. How we find our way in the world, how we remember occasions, and how we relate to other people is all grounded in our bodies. This is not to say that our bodies are like vaults from which knowledge never escapes—it's certainly the case that practical skills can go blunt through lack of practice and need sharpening—but the sort of knowledge that we are able to retain in our bodies has an ease of recall that is distinctly different from the sort of factual or "declarative" knowledge around which many aspects of life are built, not least education.

Muscle memory is a wider idea than is suggested by its use in everyday contexts, and is about more than the ability of the body to perform tasks without conscious thought. Beyond the procedural knowledge we often refer to as muscle memory, the body also shapes how we experience life: how we navigate and recall places, as well as the events that happen in them.

The French thinker Gaston Bachelard talked about "muscular consciousness," which is a nice way of summarizing how the body is involved not just in how we

experience but also how we remember. That phrase puts a heavy emphasis on the idea of movement and awareness, giving a physical expression to the nature of memory and leaving you in no doubt that he regarded memory as more than a cognitive phenomenon.

Not for the first time, we have seen how science is starting to explain the ways in which the body plays a role in how we think that others have previously speculated about in philosophical ways. Yet there are still many gaps in our scientific understanding of how, for example, procedural knowledge gets laid down in our bodies and can be unconsciously recalled when required. However, what is clear is that our bodies are equal partners with our brains as we attempt to make sense of, and remember, the world.

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Chapter 9

WHY EMBODIED KNOWLEDGE MATTERS

“I shall reconsider human knowledge by starting from the fact that we can know more than we can tell.”

MICHAEL POLANYI

We’ve now explored how embodied knowledge is acquired and five characteristics of it that make it an indispensable feature of human intelligence.

In **Observation** we saw how taking advantage of the body’s perceptual and sensory resources reveals the world to us and learned that the body is at the heart of skill acquisition. But mastering skills requires more than just observing them, and in **Practice** we discovered how the body acquires knowledge by doing and why, when our body has acquired knowledge, it is sometimes best to let it perform without too much conscious direction.

In **Improvisation** we saw how the body is at the heart of how we perceive, predict, and plan. The body underpins our ability to improvise in unfamiliar situations and to escape an over-reliance on rules. In **Empathy** we learned about the discovery of mirror neurons that provide a new view of the relationship between mind, body, and our feeling for, understanding of, and communication with other people. **Retention** showed that memory is not just a capability of minds but also of bodies and their environments. The idea of muscle memory extends to how we experience and remember people, places and experiences.

Over the course of this part, we have looked at these five characteristics individually, but they should be considered together—the body is a single entity and the processes in each of these features are intimately related. Taken together, they show what is distinctive about the skills, understanding, and capabilities that embodied knowledge enables.

Although explaining what embodied knowledge is and how it is acquired requires some theory, it is a very practical form of knowledge. It lies behind the performance of all skills, be they simple ones we perform every day such as walking or cooking or more complex ones like playing the piano or performing surgery. Perhaps more urgently, it's important that in a world where automation threatens to replace humans in certain parts of the economy, we remind ourselves of our body's ability to perform complex tasks. The observation that it is hard to reproduce in a robot the fine motor skills of even a young child serves as a reminder of the abilities that bodies display.

If embodied knowledge is practical in nature, it is also transferable. Being developed through repetition and practice in different environments, it lends itself well to being used in unforeseen situations. Free of strict “rules” that govern its operation, it is what lies behind our ability to improvise.

Embodied knowledge is a highly accessible form of knowledge that can be acquired through immersion, observation, and action and as a result doesn't require teachers or complex or expensive resources. It can be acquired through experience of the world rather than formal instruction about it.

This accessibility lends embodied knowledge an efficiency, and not merely in how it is acquired. When knowledge becomes embodied it means we can do things without giving them significant conscious thought; having a body that knows what it is doing allows us to focus on our performance of a skill. The artist doesn't think about how she's holding her brush but on the expression of her idea. Embodied knowledge allows her to focus on *what* she's trying to deliver not on *how* she's delivering it.

At the most basic level, our experience of the world can't be anything but embodied, since we exist in and perceive the world with our bodies, and unthinkingly use them every moment of our lives. Our bodies help us to understand the mood of those around us, as well as their emotions and what they are thinking. We use our bodies to communicate with others and read from other people's bodies what they are feeling.

Over many centuries, the Western world has tended to obscure the potential of our bodies for making sense of the world and their role in what makes us intelligent; at worst, it has dismissed the body as a source of misleading or merely subjective information. The push for a disembodied approach to make sense of the world has marginalized the body by relying on abstract representations. Yet because of this, what comes with the body, not least feeling and emotion, has also been lost; instead we've opted for dry and factual representations of the world, which provide a partial account of how it is and how it feels. Bringing the body back into play is an antidote to the reductionist view that attempts to boil everything down to its most fundamental

pattern, structure, or essence. It helps reassert the importance of experiences.

This reductionist tendency is evident in how countries and businesses are run. Digital technology, big data, artificial intelligence, and machine learning are all part of this attempt to reduce things to their most basic level. As the management thinker Peter Drucker wrote, “The computer is in one way the ultimate expression of the analytic, the conceptual world view of a mechanical universe.” Making the case for embodied knowledge is one way of challenging this view. At the heart of trying to understand the experience of others is the attempt to see it from their perspective and get a sense of what they know or take for granted; the body is at the heart of that effort, too.

In the following part of the book we will explore how embodied knowledge is being used in **Business, Politics and Policymaking, Creativity and Design** and **Robotics and AI**. In all of these we’ll learn how the five dimensions of embodied knowledge we have already learned about have gained expression in these walks of life, and we’ll discover how these fields are enhanced and outcomes improved when the potential of embodied knowledge is unleashed.

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Part 3

EMBODIED KNOWLEDGE IN ACTION

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Chapter 10

EMBODIED BUSINESS

“Research has become a proxy for customers. Good inventors and designers deeply understand their customer. A remarkable customer experience starts with heart, intuition, curiosity. You won’t find any of it in a survey.”

JEFF BEZOS

In early 2018, Brian Roberts, chairman and CEO of Comcast, a multi-billion dollar US media company, began a takeover attempt of the Sky satellite television business. In such a large transaction, lots of advisers are involved because there is a lot of analysis to be done to understand the right price and the pay-off of such a deal.

Visiting the UK in the run-up to the acquisition attempt while his advisers looked at the numbers, Roberts decided to take some time out. Instead of spending the weekend huddled with his bankers and consultants, he jumped in a black cab and headed off to a shopping center to spend time talking to Sky salesmen. On the way to the shopping center, a talkative taxi driver regaled him with the

differences between the services offered by Virgin Media and Sky. “The cab driver was incredibly knowledgeable about the difference between Virgin and Sky in every feature,” he said. Spending time with the salesmen, he saw their immense pride in and passion for their product as they demoed some of the latest features of the Sky platform and he got a real sense of why it is the dominant force in pay TV in the UK. Roberts is a media industry veteran—his father had set Comcast up so he was born into the business—but what had been missing for him was a real sense of what made the Sky product different.

Roberts decided to go for the deal that weekend and made an offer for the business. The mild-mannered businessman is clear that his first-hand research was not the deciding factor in the deal, but it did serve as “another reminder for me how impressive Sky is.” By July 2018 he had claimed his prize.

This is not how business normally operates. Typically, an army of investment bankers, corporate advisers, and a body of research is the order of the day during a £22bn takeover. In this context, the market is typically viewed by outsiders as an abstraction with little attention to the product or the customers who use it. However, markets are not abstractions; they consist of diverse human beings with emotions, sentiments, complexities, and contradictions, and treating them as homogeneous is dangerous. Roberts realized that you sometimes need an “on-the-ground” perspective and a more instinctive feel for the market before you act.

He is not alone; many other businesses and executives like him are turning to their bodies to understand the markets they operate in, capitalizing on the advantages of embodied knowledge.

DISTANCE, DATA, DISEMBODIMENT

Markets are complex systems, in which parties engage in forms of exchange for goods and services that take many different forms. Whether the word conjures up images of stalls in a town square or a frantic exchange with traders signaling with their hands, markets are increasingly hidden from view. The design, production, distribution and sale of many goods is highly globalized and even where physical goods are being bought and sold, markets are increasingly electronic and only visible to most people as a “Buy It Now” button on a website followed by a white delivery van a few days later. Markets are abstract and highly complex entities, yet it is vital that we comprehend them.

Economics and management science provide tools that aim to help business leaders make sense of markets, but they have their weaknesses. Firstly, markets don’t conform to immutable laws in the same way as the physical world does, and secondly models and frameworks—such as Michael Porter’s “five forces model” or Boston Consulting Group’s “growth share matrix”—though they may act as powerful interpretive tools, are often themselves based on abstractions or assumptions.

The economist John Maynard Keynes coined the term “animal spirits” to describe the way in which emotions can move markets, and argued that economic behavior is often far from rational. Emotions have a strong presence in our decision making—commentators routinely refer to “investor sentiment” or “consumer confidence” in recognition of the fact that rational considerations are not the only factors that affect how people act. Market bubbles are a good example of how people get carried away by optimistic sentiment detached from economic fundamentals. Markets are made up of unpredictable humans and when buffeted by waves of disruptive forces like technological innovation are much

more dynamic and unstable than economists can reliably model or than most business thinkers like to imagine. There are plenty of examples of businesses finding themselves out of step with the market—ask executives from Nokia or Blockbuster how it feels when the reality of a fundamentally changed market upends your business.

Organizations do what they can to stay one step ahead of their markets by investing in intelligence and research. Large businesses have entire departments responsible for collecting, processing, and communicating information about the world beyond their organization. Indeed, as the organizational theorist Ikujiro Nonaka observed in *Harvard Business Review*, it is “deeply ingrained in the traditions of Western management to view the organization as a machine for ‘information processing.’” It’s a particular type of knowledge that such organizations are designed and predisposed to regard as useful—that which is “formal and systematic—hard (read: quantifiable) data, codified procedures, universal principles.”

Businesses are faced with the need to develop an understanding that can help them predict changes in the direction of a market and in their customers’ preferences, but neither of these conform to mechanistic, predictable rules. Unfortunately, large organizations are for the most part, as Nonaka observed, largely geared to generate, process, and communicate quantifiable, disembodied information about their markets and as a result either ignore or discriminate against more subjective insights, intuitions, or hunches about their markets. They strive to be “data driven” and let the numbers do the talking.

Most businesses are Cartesian in their outlook. Firstly, they see the world as something that can be understood as an objective reality. The approaches and technologies they use to create this objective view—surveys, segmentations, and big data—reflect the idea that it is possible to develop

an objective view of the world in the first place, and that the development of this should be a priority.

Secondly, those businesses are in thrall to the idea that the answers are in people's heads. A cartoon often pops up on the professional social network LinkedIn that shows executives viewing a presentation titled "Inside the Mind of the Consumer." They are looking at an image of the brain divided up into segments including "work," "travel," and "my kids," but nowhere to be seen is the brand of pickle they are responsible for marketing. "Inconceivable," one of them declares, surprised that there isn't a place for his product in the mind of this consumer. "This consumer is a brand loyalist." While this is a comic take, it reveals a common line of thought.

Further evidence of the loyalty of business to Descartes's mind-body distinction shows up in its excitement for neuroscience, the advent of which has led to a flurry of attempts to identify which bits of the brain lights up when people see brand logos and imagery. This became known as "neuromarketing" and reveals the hope of business and marketing people that they might be able to activate the regions of consumers' brains that are connected with a particular emotion if they get their advertising right.

However, the traditional mind-first ideas about how people or markets might be understood are being challenged and a new perspective on what market knowledge could look like is emerging. To find out more, let's join some executives pitching their tents in a national park in southern Californian.

THE CAMPING TRIP

The team flying into California from New York in November 2014 didn't exactly look ready for the camping trip. Most of

them had wheelee suitcases—perfect for a business trip involving a series of meetings and a night or two in a hotel, but not ideal for what my business partners and I had planned for them. Although it was warm in San Diego, their clothing looked a little thin too. These business travelers, a senior team from the North American headquarters of battery maker Duracell, looked ill-prepared for what was to come.

We went straight to an outdoor equipment store on the outskirts of the city, where we met three groups of local outdoor enthusiasts who had agreed to join us on the camping trip. The first job was to ensure that the new arrivals were prepared for the night ahead. One of the locals told them it would be cold in the mountains once the sun had gone down and recommended jackets and sleeping bags. He explained to the novices as we walked around the store that these items' tog ratings—a measure of their thermal insulating properties—could be used to determine how warm the items would be. We also examined the large range of flashlights on offer and were given guidance on the technical specifications of the devices, their brightness being measured in lumens. The shop's display racks showcased the theoretical measures of a product's specifications, but we would soon find out what those might mean in practical terms.

It was a two-hour drive to Lake Morena County Park, a few miles from the Mexican border, but a stop at a Walmart to obtain fishing licenses severely dented the schedule. By the time we arrived, the heat of the day was fading fast and we had to get settled quickly before darkness descended. As infrequent campers our inexperience was revealed by the way we pitched our tents in places that were at risk from water runoff. It was the small, unremarkable details that revealed the seasoned outdoor enthusiasts: one dug a small hole beneath a portable water tank to collect the excess water when dishes were being rinsed and prevent a muddy

puddle from forming. Another camper showed us his insulated cup that doubled as a kettle and could bring water safely to the boil in a fraction of the time it took using a mess tin perched precariously on a stove.

Elsewhere on the campsite, the other campers were getting settled in, though we were in awe of the way the experienced campers handled their environment and kit. As newcomers, we learned more by the mistakes we made than by direct instruction, and we were scolded by the park ranger for collecting firewood from the surrounding scrubland rather than buying a bundle from him. Later, as we sat around the fire, we started to learn why there had been such a large selection of flashlights in the outdoor shop: lighting was not a minor matter in the darkness of the park.

One camper pointed to a set of cheap LED lights he had clipped to the low-hanging branches of the tree. This was his hack, he pointed out, to provide pleasant, low-level lighting that didn't compete with the warm glow of the campfire. We learned, in quite practical ways, about the differing role of headlamps and lanterns. The piercing light of a powerful headlamps is perfect for a task like cooking or searching the back of a tent for kit, but in a campfire conversation transforms its wearer into an interrogator. The idea of having multiple flashlights had previously felt like an extravagance, but it no longer seemed like such a bad idea.

After an evening of socializing with the other campers, the novice campers headed to bed, their wheelee suitcases left conspicuously outside their tent entrance. Despite some mild discomfort that is the bedfellow of the infrequent camper, most of us slept well. In the morning the regular campers made light work of cooking and making coffee on their stoves, while our attempts only served to show our lack of the sort of camp craft that we were keen to learn more about.

As the sun appeared from behind a peak, we returned to our conversation in the outdoor store; what had felt like mere details about over-engineered products was starting to make sense. The previous evening the temperature had plummeted, and we had retreated to our tents to find extra layers. The tog ratings of our coats and sleeping bags suddenly seemed less of a theoretical discussion but one of practical importance. It is only when you are shivering in a tent at 3am as the temperature slips below zero that the difference between various tog ratings becomes apparent, while a visit to the bushes in the middle of the night reminds one of the worth of a good headlamp. Describing flashlights in terms of the tasks or roles they might play and discriminating between them in terms of their brightness or design now seemed sensible. By being exposed to these products in the context in which they are used, and by understanding how the theoretical descriptions of them translate into practical benefits, we had developed an understanding of how an experienced camper can love their kit.

After breakfast some of us went walking and others went fishing. The walking group pored over the equipment they take on hikes when they are properly off-grid. Accidents happen, they reminded us, and you can't always rely on a phone to call for help—a proper GPS device is needed if you're serious about going off the beaten track. Although our camping trip—at a public campsite in a national park—was more like a suburban day trip for these experienced campers, it had still demonstrated the importance of being well prepared. What was becoming clear to the team from Duracell was that people who take the outdoors seriously put their comfort and safety in the hands of their equipment, and that much of this kit is only as reliable as the batteries within it.

My company, Stripe Partners, had taken these business executives camping, and it was an unusual thing to do.

Ordinarily, when business leaders want to understand a topic they commission research and await a report. But the team from Duracell wanted to understand the world of the outdoors, an important market for their products, and had said they were open to doing things differently. We decided to try something distinctive because we no longer believed that the best way to develop knowledge was to read a report about other people's experiences. What would it be like, we asked ourselves, if we gave executives their own experience of camping—to help them develop an embodied understanding of it?

Taking the team from Duracell camping had been a risk. The company was in the process of being sold to the Warren Buffet-owned Berkshire Hathaway and while it was 'business as usual', the stakes were high, given their new, and famously unextravagant, owner. The camping trip was a brave strategy for my company, too. Our clients could have had a terrible night's sleep and decided that they were done with our experiment and ready to return to the comfort of their upstate New York homes.

On the face of it, perhaps the biggest risk of the project was our subversion of the norms of business research. A more typical approach might have involved an interview conducted in the comfort of a warm house, far away from the national park, and a rummage through campers' garages to look at their equipment and discuss what we had found. Our clients might have attended those interviews, but they would have been more sedentary affairs with none of the cold, discomfort, and vulnerability of the camping trip.

The team from Duracell had wanted to get to the heart of the outdoor world. They were keen to understand the role of batteries within the activities that people participate in, but also to get a feel for what that world was all about it. What motivates people to swap the suburbs for the scrub, and what emotional resonance does being in the national parks

of America have? The leap that they were prepared to take was that of learning with their bodies and through direct experience, which made them vulnerable not only to the elements but also to each other. Camping is an intimate affair, and putting yourself in such an environment with work colleagues is unusual in corporate life. There were no hotel loyalty points to gain from their night under canvas.

Later that day, we broke camp and headed back to San Diego, where we spent the following few days working through what we had observed and experienced, and exploring what our learnings might mean for Duracell's push into the outdoor market. An integrated communications plan that we developed with Duracell would go on to become one of the most successful in the history of their business. The advertising inspired by the camping trip, which featured the free climber Kevin Jorgeson ascending the Dawn Wall in Yosemite National Park in darkness, went viral in the outdoor community and quickly garnered over eight million views on YouTube. Jorgeson is a highly regarded climber, and his views on the relationship between equipment and experience was in sync with what we had discovered on our camping trip. As he later commented, "When you're out there, lights and batteries blend into the fabric of your experience. You trust them. You know it's going to work. More times than not, you trust your gear and focus on movement and not equipment. The same goes for our power source."

Jeff Jarrett, the marketing director who approved our camping trip and the advertising that flowed from it, concluded that its success depended on the fact that the team working on it "just got" the outdoor community. They learned first-hand what motivates and engages outdoor enthusiasts and the minute details that animate their experiences of these landscapes. This was translated into advertising that spoke directly to the audience it was designed to resonate with. As Jarrett later put it, "the tone,

message and language were perfectly attuned to the world of the outdoors.”

2G TUESDAYS

The team from Duracell had swapped disembodied, objectified, abstract knowledge about people and the outdoors for an embodied understanding of that world. They had felt the cold, clear air of the mountains and learned camp craft through trial and error and by watching others. But not every business has the budget or the bravery to do what they did, and sometimes the most important thing a business can do is to try to ensure that their teams embody the world for which they are designing products.

Visceral experience has been at the heart of Facebook’s expansion in the emerging world. The website that began life in a Harvard dorm room has become a daily destination for half of the world’s internet users, but around 2013 a shift in how people were using social network required the company to act. The smartphone revolution led to computers being dislodged as the primary way in which people interacted with the web, and Facebook really started to take off in emerging markets. This growth was especially pronounced in countries such as India and raised a further challenge for the company: as more consumers got smartphones, cheaper Android devices with more operating system software variation than the Apple iPhone became more popular. Product managers and engineers at the company were suddenly developing software for phones rather than computers, a market they understood less well and for consumers using devices with which they were less familiar. They needed a plan.

Tom Alison, now a VP of engineering at Facebook, was responsible for ensuring that the hundreds of millions of

new users in markets like India could use the social network. An engineering manager on his team who had grown up in India suggested that he take a small team there for a couple of weeks—this was unusual at the time but Alison agreed and the team set off to explore what life was like for Facebook users there. They hung out in internet cafés, went to villages that were on the edge of mobile networks, and talked to lots of users. They also ran technical analyzes of the mobile and internet networks, so they could understand how they were working. Alison recalls a particularly memorable encounter with “a guy who would literally open up his Facebook app and put it on his bedside at night before he went to bed, so that by the time morning arrived, he’d have enough content downloaded to have a good experience.”

This was an utterly different experience for the engineers who were used to the superfast networks on their Silicon Valley campus, and the story became emblematic of what many Indian internet users were experiencing when using Facebook products. More than that, as Alison notes, engineers tend to take things personally, and when they discovered that their creation didn’t work, they started to worry that many in Facebook’s growing organization would have little or no realization of this important reality. “That started,” Alison recalls, “the conversation of ‘How do we show more people in this very visceral way, that what they are building is not working for this very large set of people?’” The answer was 2G Tuesdays, a means of allowing product teams to experience their product on networks that are less fast and stable than the 4G infrastructure they were used to and which they had fallen into assuming was the norm for everyone else.

Facebook employees run an internal-only version of the popular app on their phones, which gives them the opportunity to try out new products and features before they are shipped to the hundreds of millions of users

worldwide. Alison's team took advantage of this and introduced a feature. Every Tuesday a pop-up would ask users if they'd like to switch to 2G; if they accepted, their device would behave as if it was on a slow and patchy network for the next hour. Engineers had built a software simulation of the network conditions in the developing world and lots of other groups adopted the practice, getting their own weekly exposure to the Indian experience. "You really experience your own Facebook in a much different way on 2G," Alison says. "It's really a visceral feeling when you see your own content on this type of connection."

Facebook's success in emerging markets has been marked. They launched a version of their familiar app in June 2015 that was specially designed for users of old phones on slower networks. By March 2016, Facebook Lite had more than 100 million monthly active users and a year later it had over 200 million, making it the fastest growing Facebook app to date. By proactively adapting their product for low-bandwidth markets and ensuring that their engineering and design teams understood conditions in those markets, Facebook found success while other companies were left waiting for network connectivity to improve.

2G Tuesdays was not a "silver bullet" in terms of achieving success in emerging markets but rather part of a much wider initiative to understand and build product for countries like India. Facebook executives put the issue high on the agenda. Alison spoke about the initiative at an all-hands company meeting, while other employees started using low-cost Android or simpler "feature phones" and wrote about their experiences on company blogs. In focusing on emerging markets in this way, Facebook was responding to the shift to mobile as well as taking less saturated and developed markets more seriously. Integral to that, as Alison notes, was the "need to try very hard to remove some of these inherent patterns of bias that were

specific to a developed country, and particularly Silicon Valley.” The effort continues to this day.

However, the success of 2G Tuesdays, Alison believes, is due both to their faithful recreation of the slow network experience and also to the reproduction of those simulated experiences in ways that can be shared within the business. Only a small team traveled to India, but technology enabled the 2G experience to be extended across the whole company so teams working on many different products could feel for themselves what those products were like to use outside Silicon Valley.

Spreading those 2G experiences across the organization to give more people a personal experience of slow networks was not the only impact of this initiative—it also allowed people to understand what the data was telling them. They could now look at a market report showing how many of their users were on slow networks and quantify the feeling they had encountered. Alison contends that to have an impact in large organizations, “People need to understand the data and they need to have the visceral experience.” The data without the experience makes little sense, and the experience without the data has little clout within an organization. The combination, in his view, resulted in the recognition at all levels in the business that network connectivity was an enabler of growth in emerging markets.

MADE ON MAIN STREET

Not long ago, people dutifully recycled their plastic household waste and thought little more about environmental issues—washing out yogurt cups and milk containers was their contribution. Then, something suddenly changed and the issue of plastic in the oceans was in the headlines. Within a matter of months, plastic straws, and

coffee stirrers were banned, supermarkets began trialing plastic-free aisles and single-use plastic water bottles were regarded as public enemy number one.

The seemingly overnight rise of plastic to the top of the agenda is a reminder that it can be hard for businesses in our fast-moving world to spot the signals that portend a shift in consumer attitudes and behaviors. The corporate landscape is littered with the remnants of businesses that either failed to see change coming or saw it and didn't act. For example, the photography company Kodak once seemed immortal but now looks irrelevant, having failed to adapt to the arrival of digital photography. Some studies of what went wrong blame a lack of market understanding, while others point to the inability of the organization to act on the picture presented by their research of an emerging boom in digital photography. Either way, Kodak became an example of the disappearing companies highlighted in a study by McKinsey, which found that the average lifespan of a company in the S&P 500 Index of leading US companies has decreased from sixty-seven years in the 1920s to just fifteen years today. The study proposes that in 2027, 75 percent of the companies currently listed on the S&P, 500 will have disappeared. Life for business is, as Thomas Hobbes put it, "nasty, brutish, and short."

To avoid the fate of Kodak, businesses are investing significantly in monitoring market environments. This work can take many forms, from opinion polling and tracking surveys to "trends" reports. Such work is designed to look wide and at scale. Often it looks quite a few years ahead, and the product will come with bombastic titles like "10 Mega Trends That Are Shaping Our World." On the face of things, it seems sensible to look wide and globally. The idea that looking in one city and at small numbers of people could provide a useful perspective on where things are heading seems unrealistic.

A small team from Procter & Gamble's North American homecare team gathered in a large clapboard house in Portland, Oregon, with a team from my company, Stripe Partners. This was going to be our home for the week, and our focus was understanding the "mainstream green consumer"—people who are conscious of their environmental impact and keen to do what they can to minimize their environmental footprint. Our goal was to help their teams make their clothes detergents, one of the company's biggest product categories, more environmentally friendly over a short space of time.

During that week, in addition to conducting interviews with people in their homes, we tried to embody the worlds of people who were trying to be greener. We used organic toothpaste and other cosmetics, denied ourselves meat and processed foods, and used natural homeware products, as well as visiting communes, reclamation yards, and cooperative shops. One evening we took our clothes, fragrant from the morning's Bikram yoga class, to the Spin Laundry Lounge, a natural-only laundrette and hung out with Portland's hipsters while our kit was cleaned with chemical-free detergents.

This might sound like fun, and it was—it's not often that I get to do my laundry with clients or practice downward dog with senior executives from one of America's largest companies. Yet while the activities might seem less than serious, they were organized with the clear goal of helping our clients develop embodied knowledge of another "world." Rather than relying on statistics about how people show concern for the environment or talk about these issues, our approach was aimed at giving us a real sense of what running a home, caring for kids, managing a household budget, and taking the environment into account looks and feels like. Doing the laundry in the house made one of the chemists on the team realize how out-of-kilter his assumptions about chemical-free detergents really were. He

assumed that his running gear would need extra detergent to get it clean and poured in a double dose, but some time later could be found mopping the floor as a torrent of bubbles cascaded from the machine. Natural detergent, he realized, could be relied upon to make enough lather to deal with smelly sportswear.



In the years since the camping trip, our first attempt at putting the principles of embodiment to work in a corporate environment, we've made an embodied approach central in how we help our clients solve complex challenges. In each project, rather than just looking at spreadsheets, market data, and other quantified knowledge, we find ways to deploy our bodies and not just our brains to understand other people's worlds.

This has taken us to device-free dawn raves in San Francisco warehouses and welding workshops in Bavaria to spinning classes in Los Angeles. We've worn ear defenders during meals with clients, spent hours in Japanese games arcades, and clung onto bus straps with our clients while undertaking a four-hour commute across São Paulo. All these experiences are designed to take us, and the executives we do them with, on a journey of discovery in which their senses and not the data are the starting point.

The embodied knowledge that results from these experiences has multiple benefits that make it a powerful ally of business. Firstly, it is felt and emotional rather than cold and detached. Secondly, it is practical and not theoretical. Thirdly, it relies on people rather than documentation to carry the message into and around an organization.

First, the entire intellectual technology of business strategy is configured around the ideas and needs of rational decision makers, who simply need good data to

make the best decisions. In this technocratic world, the emphasis on what can be counted—empirical data—obscures what cannot be counted, namely subjective emotions, intuition, and experience. Businesses' love affair with data often means that they default to this approach to understand the world, or their instinct is to turn human experience into data points. What gets lost in this act of translation is any sense of why something matters and what people outside the business care about. The power of exposing people from a business to the world is that it allows them to feel things for themselves. Taking an embodied approach that depends on experiences can often re-enchant business executives, and we have often been struck by how these experiences lead people to understand what it is they do, and why it matters.

Second, as Ikujiro Nonaka observed when describing the modern Western business as akin to a life-sized Excel spreadsheet, the key to successful business is not in “processing” objective information. Rather, it depends on tapping the tacit and often highly subjective insights, intuitions, and hunches of individual employees and making those insights available for testing and use by the company as a whole.” Embodied knowledge acquired through experience is not theorized and abstracted but is grounded in the observations we’ve made, consciously or otherwise, and in what our body has perceived and put into action through practice. The chemist who fills a laundry room with bubbles is able to reassess his assumptions about green detergent and take that knowledge forward as he begins work on a new formulation.

Third, embodied knowledge is not only more practical, but it can have more impact when people rather than documents are the carriers of that knowledge into an organization. We have found that they are better able to toggle between the needs of their customers and the

constraints of their organizations, using their own experiences as a touchstone for what matters to people.

The business commentator Flint McGlaughlin reflected on a similar point when he made these observations about the distinction between strategy as something that is documented and strategy as something that people agree on and come to embody:

I don't want my team to focus on strategy; I want them to focus on becoming strategists. Strategy is stilted. The field has been relegated to a specialist's discipline. In doing so, leaders have come to rely upon experts to inform their direction. However, it is only when strategy is embodied in a living, breathing person that it can be actualised. The separation between strategy and the strategist has created a gap between planning and execution. It fixes strategy as a periodic event rather than an unfolding process. A winning strategy is not declared; it is lived into.

A shared experience creates the grounds for not just knowledge but strategy itself to become embodied rather than a document gathering dust on a shelf.

In applying some of the theories of embodied knowledge to business, we repeatedly hear the same words mentioned by the executives we work with. They often refer to the "gut feel" they have for something, or the "gut-level intuition" for what they need to do next. Those expressions signal the bodily nature of how they learned and where that knowledge resides. These responses to the experience also point to how hard it is to express this other sort of knowledge. It's worth pointing here to the tangible outcomes of gaining embodied knowledge through experience; the team that spent a week living natural lives have launched multiple highly successful and award-winning

products in the American market, something they put down to “just getting their consumer.”

HUMAN BUSINESSES

Writing in 1989, Peter Drucker, one of the twentieth century’s great management thinkers, warned of the risk that businesses faced from their reliance on disembodied data and information—he was concerned that this would stunt their ability to assess the reality of the worlds they operate in. He was writing at a time when computers were not yet a common sight in offices and long before big data became a reality, yet he had a good grasp of the historical antecedents of this shift toward an information society and of how businesses were evolving. What he saw was that “analytical logic and statistics, which use quantification to convert experiences and intuition into information, definitions, information and diagnosis” was becoming the dominant operational model of many large organizations. In other words, as Drucker saw it, organizations were not just beginning to use computers—they were also beginning to think and act like them.

Drucker never claimed to be a futurist, but his predictions look remarkably prescient. Information technology has not only transformed how businesses sell, plan, evaluate, and analyze their operations, it has changed how they attempt to encounter and understand the world. The mechanical conception of the world that Descartes and his contemporaries unleashed led analytical approaches to push more perceptual ones aside. As we saw earlier, this resulted in calculating machines and computers, which are probably the purest expression of the analytical world view. As Bertrand Russell and Alfred Whitehead’s treatise *Principia*

Mathematica showed, any concept can be expressed logically in zeros and ones if it can be made unambiguous.

That idea has had evident appeal for many businesses and large organizations, but the problem is that life is anything but unambiguous, and markets are hard to reduce down to tight underlying principles or elevate into such abstractions while also retaining meaning. Markets are animated by “animal spirits” and people are driven by emotion. They contain multitudes of contradictions and don’t act according to immutable physical laws. Understanding both people and markets depends not just on data but in developing a feeling and an informed intuition that is based not on abstraction but experience.

However, perception, feeling and intuition are often dismissed in business. A 2014 report by the business consultancy PwC titled “Guts and Gigabytes” appeared to lament the fact that despite advances in data science, analytics executives are making decisions based on instinct. Meanwhile, 2016 research from the same team reports that when asked what people will use to make their next strategic decision, 33 percent of executives say “experience and intuition,” though it appears that this is something the authors wish to see eradicated. Saying you use your gut in business is like admitting to the practice of divination through inspecting entrails, which the Romans relied on to understand the will of the gods and to foretell the future.

The Nobel laureate Daniel Kahneman has written extensively on the idea of intuition in life and business and makes the point that the problem with intuition is that it feels the same whether we are wrong or right. In his writing about decision makers in business, he is critical of executives who let their past successes lull them into a sense of unjustified self-confidence in environments where they are expected to be decisive and act quickly. Yet in a world of imperfect information, ambiguity and uncertainty, judgment will always be required. Consensus and

committees can lead to indecision and half-hearted decisions, which can be just as harmful as hasty conclusions. The question then becomes how to make sure people's intuitions are based on relevant experience.

Taking a team of executives from a multinational company camping might seem like an outlandish way of figuring out a strategy, but it worked. We see the veil of ignorance or disconnection lift when people leave their desks and join us on journeys into other people's worlds. These adventures allow them to swap generalized experience for specific, relevant experiences that can inform good decision making. In our work we've witnessed how people make sense of data because they have a *feel* for things.

The theory of embodied knowledge demonstrates how bodies perceive, learn, and acquire both knowledge and understanding through experience. The examples from the campsite, the 2G simulator, and the house in Portland demonstrate how direct exposure to the world can enable that sense of understanding. When Drucker defined knowledge in the context of business, he wasn't referring specifically to embodied knowledge but he could have been: "Knowledge is information that changes something or somebody—either by becoming grounds for action, or by making an individual (or an institution) capable of different or more effective action."

In the next chapter we will encounter another field, politics and policymaking, where the same mechanistic models of how things work, and assumptions about how best to understand them are breaking down as the many old certainties have fractured. It's not just businesses that are developing embodied knowledge that can inform decisions.

Chapter 11

EMBODIED POLICYMAKING AND POLITICS

“The only way to learn is by encounter.”
MARTIN BUBER

The American singer Gil Scott-Heron was wrong when he said “the revolution will not be televised.” Most wars and uprisings are more than adequately covered by broadcasters, yet the wall-to-wall coverage doesn’t always seem to result in much appreciation of their immediate horrors and contributes even less to our understanding of the suffering and reconstruction that follows in their wake.

The war in Syria started March 15, 2011 and has yet to end. The death toll stands at over five hundred thousand while 13.1 million people, out of a population of 22 million, are in need of humanitarian assistance. A further 5.6 million have fled the country and another 6 million people are displaced within Syria. The war no longer features nightly on our television and rarely demands our attention; it has been

supplanted on our screens by the civil war in Yemen that, at the time of writing, had claimed seventy thousand lives since 2016. The fighting and consequent economic collapse means that 14 million of the country's 29 million population are on the brink of starvation. The scale of suffering is huge, but Syria and Yemen accounts for a fraction of an even more staggering number: the United Nations High Commissioner for Refugees estimates that there are 68.5 million forcibly displaced people worldwide, comprising 40 million internally displaced people, 25.4 million refugees and 3.1 million asylum seekers.

Like many others, I watch and read the steady stream of grisly news from Yemen, Syria, Myanmar and elsewhere, but find it hard to comprehend the scale of the suffering, heartache, and violence. It is easy to be momentarily shocked but equally easy to become inoculated. As the photographer and critic Susan Sontag put it, "[I]n a world saturated, no, hyper-saturated with images, those that should matter have a diminishing effect: we become callous. In the end, such images just make us a little less able to feel, to have our conscience pricked." Occasionally a single image manages to produce a wave of empathy that shakes the world into action. The photograph taken by the Turkish journalist Nilüfer Demir of Alan Kurdi, a three-year-old Syrian boy of Kurdish ethnic background who drowned in the Mediterranean Sea in September 2015, is one such example. Yet by and large, grim images flick past and staggering statistics pile up, like the corpses, barely noticed.

In an age when a seemingly limitless amount of information is at our fingertips and when we know more than ever about events around the world, understanding and emotional engagement can still elude us. Facts, figures, infographics, and historical comparisons give us a factual but disembodied understanding. We can have sympathy for people's plight, but whatever the quality of the reporting, it

is difficult to grasp the scale of a situation and to have real empathy.

Empathy matters because we live worlds apart from other people, and understanding the world from the perspectives of others can reduce conflict, misunderstanding, and prejudice. Without empathy it is hard to mobilize ourselves to act, and without mobilization policy responses can be hard to formulate and communicate. Policymakers need to have experiences, too.

THE REFUGEE SIMULATION

The thousands of shipping containers stacked at the vast Kwai Tsing container port are testament to Hong Kong's importance in the shipping business, and it is here, with the worldwide flow of goods, where the Crossroads Foundation began. It was in 1995, in the aftermath of devastating floods in northern China, that Hong Kong residents Malcolm and Sally Begbie began their first collection of unwanted clothes for the two million people who had lost their homes. They collected and shipped nineteen cartons of clothes initially, but things quickly escalated. A city that was devoted to the acquisition of material things had little "secondhand culture," but the Begbies had soon sent another seventy-two and then a third batch before they shipped a final consignment of nearly 250 boxes of unwanted clothes and bedding.

The work of their Crossroads Foundation continues today, and it still ships goods from Hong Kong and elsewhere to places of need worldwide through its online Global Hand system. When it turned ten years old, the foundation decided to celebrate the anniversary not by hosting a gala dinner in a five-star hotel but by attempting to show the people of Hong Kong why it existed. As David, Malcolm and

Sally's son, who now runs the foundation, explains, they asked themselves what would happen "if we could bring people out here and when they come we can strip them of their possessions? What if we give them hammers and nails and let them build slums? We'll let them sleep on the ground, eat with their hands, make a road by breaking rocks just for a day. We can help them feel a fraction of what it's like for the people we serve." And so the idea of creating experiences that allow others to step into the shoes of the global poor was born.

I am one of over two hundred thousand people who have experienced one of their simulations. In May 2019, as my bus snaked its way out of Hong Kong, past the shipping terminal and toward the former Gurkha barracks where Crossroads is based, I had little idea of what lay ahead of me. David had told the twelve other participants and me very little, and we quickly realized that this was intentional. Uncertainty about what lay ahead was a key theme and one that was fitting. It is the same for the refugees and the poor, whose lives we would be exposed to over the coming twenty-four hours. However, for them this is a long-term state of being.

After a short briefing, we shuffled hesitantly through an unmarked door into a large warehouse and were told by aggressive men in army fatigues that we must leave our homes tonight but that we would be taken to safety. We were taken around a corner of the "set" and found ourselves in a temporary camp, where suspicious soldiers with guns demanded to know our names and where we were from. They peppered us with questions and split us up from the families we had been grouped into. The room was loud with the sounds of helicopters overhead, mortars, and cries of anguish, and the atmosphere was bewildering. We were constantly moved around the set and stripped of our watches and phones by soldiers. Within minutes, my eyes were trained on the floor ahead of me—looking up, I feared,

would draw attention to myself. A quick glance at the others indicated that we had all adopted the same tactic. We were bundled into makeshift tents and the lights went out but the abuse from soldiers continued, before a loud bang made me jump out of my skin. The lights were turned on and there was more shouting as the soldier pointed to a corpse on the ground. I found myself in a cell, and when I was asked my name, I froze. I had been given a new identity for the twenty-four hours, but in the stress of the situation I blanked. It was then that I felt the dull cold of gun metal against my neck.

A cycle of three days and nights were repeated over the next forty-five minutes, before David's voice announced that the simulation was over and we were moved to a room styled in the fashion of a warlord's reception chamber. We sat on cushions and David appeared to debrief us. As with all the debriefs that we were to encounter over the following hours, it contained a discussion of our responses to what had just happened to us, an exploration of the facts of the matter, the telling of stories from people in similar situations and an invitation to reflect on how that experience affected us as individuals or professionals. "You've lost your wife on the journey. You have no phone. No access to the internet. How will you find her?" Given that I had traded in my phone in return for freedom from the cell, the question made a strange sort of sense. How indeed?

After the initial displacement simulation and subsequent debrief, each "family" went to build its camps from cardboard, corrugated plastic, and scrappy pieces of tarpaulin. We were in a phase of the simulation in which we would learn more about what happens after the initial shock of displacement—the unfolding of a new and still dangerous way of life. David had asked us how long we thought someone would typically remain a refugee. Our naive answer was three or four years, but he told that the average is closer to twenty-seven years. So while the shelter we

were building that evening was temporary, for others it might be their home for many years. I did as David had suggested and added twenty-seven to my age, realizing that this shelter, slightly smaller than the two-square-meter shacks that are typical of the world's slum dwellers, might still be home when I was seventy-four. It was barely fit for a single night, let alone a generation.

We were later tasked with lighting a fire and heating a simple stew, which we ate with our hands. As we did so we were reminded that warm food is rarely a given for refugees and might involve trade-offs: women who go beyond the confines of a camp to get firewood are often raped, while men who venture out themselves to prevent this happening are often killed. It's hot and humid outside the warehouse, and we are drinking water, which we are fortunate enough not to have had to queue for. The United Nations tries to provide sixteen liters of water per day to refugees, and we are asked to think about the logistics of providing this to camps that might contain tens or hundreds of thousands of people. When donors say they want their money to go to "solutions" they forget, David added, that basic needs like water must be provided first, before their personal preferences for how their donation might be spent can be considered.

Much of the anecdotal and factual information we learn during our time as refugees is shared by David after each phase of the simulation. Sometimes it's stories from people he's encountered in camps that the foundation has helped, while at other times we hear accounts first-hand. On a WhatsApp video call from Northern Uganda, David Livingstone, a friend of David's, tells us about his time as a child soldier, having been kidnapped by the Lord's Resistance Army in their insurgency that began in Northern Uganda in 1987. He tells us how child soldiers are often ordered to kill their parents or siblings as an initiation rite before being forcibly removed from their family. On his

return to his community from the war, he expected to be greeted with open arms but was treated as a spy and flung into jail. He talked about waking up in a freezing prison cell next to the cold corpse of a fellow child soldier.

Yet much of what we learn in the simulation comes not from anecdotes, stories, personal reflections, and facts but in how we are encouraged to relate our experiences to the lives of others. Without a watch, which I had traded for food earlier in the evening, I have little sense of time. As I lie under an airline blanket on a bed of newspaper trying to get comfortable at about four in the morning, I recall what David told us earlier. Aid workers say that when people sleep in camps, their sleep is stress-filled and shallow. Their trauma doesn't allow deep sleep, and the sounds of anguished cries provide a terrifying background for their dreams. By contrast, I have few such worries. My jet lag is as much to blame as the discomfort of the concrete floor for my inability to sleep, and our shelter is a relatively comfortable air-conditioned hut. I might be far from the horrors of a large refugee camp, but I'm closer than I've ever been, and I long for the new day to begin so I don't have to lie with my thoughts any longer.

The next morning, as we relight our fire and make thin, tasteless porridge, we discuss something that for some reason resonates with me. When we see television footage of refugees, it is easy to imagine that they might have received training in camp craft or are naturally adept at living rough. Their shelters look solid and ordered and their fire and cooking skills seem well honed. Yet they have had to make profound changes to adjust to their new way of life. They have left good jobs, air-conditioned apartments, well-stocked refrigerators, and other home comforts. A Syrian refugee has no training in the life they now lead. The adjustments we are having to make, which are clearly trivial compared to those of refugees, serve as a reminder that to refugees, this way of life was once utterly alien, too. That

realization might be obvious, but I'd never thought of it in these terms until I was spooning gruel into my mouth with a stick.

By the second day of the simulation, life takes on a familiar, if punishing, structure. Exposure to experiences is followed by a debriefing that acts to reframe things. However, it is the very physical nature of our experiences that is the basis for our new understanding of things. The experiences soften us up, putting us into a physical and emotional state that is congruent with the lives we are trying to understand. I am tired, dirty, hungry, and feel strung out—I'm not fit for purpose in a traditional model of knowledge acquisition, but my body feels pliant and ready to engage with relevant information. My bodily state is entirely suited to help me understand the lives of others.

I learn a great deal during the twenty-four hours about the lives of others, about solutions and initiatives, and about the conditions that create some of the problems in the first place. The Global X-perience is designed to be a “crossroads between the lifestyles of the rich and the poor,” and while I am in it, we explore many dimensions of refugees' lives, from initial displacement to attempts to find stability in their lives. We also explore HIV/AIDS and blindness, conditions that disproportionately impact the lives of the global poor, and all the simulations are designed with or delivered by people with direct knowledge of the experiences we encounter.

A one-hour version of the refugee simulation runs at Davos each year, and it is possibly one of few events at which champagne and canapés are not served. Some are critical of its presence and scoff at the idea of being a refugee for an hour, having been flown in by private jet the previous day; that might be an understandable response, but it misses an essential point. Those working in the world of humanitarian policy acknowledge that access to refugee camps and conflict zones is hard—it's dangerous for visitors

and disruptive for the teams working on the ground to have to design and deliver tours of their large, complex camps. Davos is often dismissed as a talking shop but as Filippo Grandi, the United Nations Commissioner for Refugees, remarked to people who had participated in the simulation 2017, “[E]verything I came here to say you have just experienced.”

Global Crossroads simulations are experienced by schools, businesses, and other organizations all year round and their impact is clear. Global fashion businesses with four thousand factories across Asia have redesigned their global supply chains, charities and schools have been established, and lives have improved. David is convinced of two things: One is that the empathy that the experience provides leads to many participants being able to ask better questions rather than jumping in with the first solution that occurs to them. Secondly, “if people are to engage in an issue in a sustained fashion, it has to have internal combustion.” He asserts that “I can guilt someone into giving once or I can shame you into giving by getting your peers to give, but if I want you engaged it needs to be at heart level. The extraordinary thing about these simulations,” he reflects, “is that with them, empathy seems to come.”

Before I head back to Kowloon for the hot shower I’d been dreaming of since my sleepless night, David shared one final observation with me. Turkey has over 3 million refugees within its borders, coupled with deep social unrest. Global Crossroads have been asked to consider opening a permanent installation in Turkey to help deepen understanding across the two people groups who must now live side by side. They are convinced that if enough Turkish people spend time in the refugee simulation, it could help change the political weather.

THE AMBASSADOR WITH DIRTY SHOES

Over the last three years in the UK, Brussels, and beyond, one of the inescapable debates has been the causes and likely shape of Brexit, if it is to happen at all. It has rightly been characterized as a debate between facts and feeling, between experts and the man on the street, and between concrete issues like trade and conceptual ideas like sovereignty. During all this, the diplomatic staff in each European capital have tried to make sense of these arguments and give the most useful advice they can to their governments.

Simon Smits, the Dutch ambassador to the UK, is one such diplomat. A diminutive but adventurous civil servant, he has made it a personal mission to understand how trade between the UK and Holland will work when Britain leaves the European Union. Trade policy is notoriously complex and negotiations can take decades. Moving from an era of frictionless trade within the European single market to a more uncertain one, he doesn't claim special expertise or a monopoly of wisdom but does feel that he has a good approach to understanding the issues from the ground up—or rather, from the elevated cab of a freight truck.

Smits has previous experience with haulers: as a student at Oxford he used to thumb rides with haulers from Holland, where his parents lived, to London. In exchange for a carton of cigarettes and the promise of someone to talk to, they would agree to transport him too. “When the Brexit referendum happened,” Smits explained, “I thought, ‘I’ll have to do it again, because I want to see how transport is arranged these days.’”

So Smits hitched a ride in a hauler's truck that was carrying a Rolls-Royce aviation engine from Schiphol Airport to Scotland via Heathrow Airport. Each stage of his journey threw up interesting experiences and observations. They

were stopped at Calais by a bemused customs official, which made the journey slightly longer than it might otherwise have been. As Smits recounts, “We had about a forty-five-second hold-up at the passport control in Calais—they saw my diplomatic passport and said, ‘What’s an ambassador doing as a co-driver in a truck?’” Smits’ attempt to experience frictionless borders had been highlighted by the friction his presence in the cab had introduced.

The existence of a hard border within the borderless world of the EU was brought home to him when the truck driver invited him to inspect the dents in his cabin from when he passed through Calais’ “Jungle” refugee camp, when people tried to get into his truck. Smits had naturally been aware of attempts of refugees held in France to reach the UK but only as a dry point of foreign policy; now he understood what it might be like to run the gauntlet in a truck as a self-employed hauler.

Smits had about eight hours with the driver that day—long enough, he felt, “to know their life, their problems, their challenges.” He was dropped off at Heathrow and the driver rested before continuing on to Scotland while Smits returned to the central London office, which he is keen to avoid becoming the center of his diplomatic universe. It overlooks the Albert Memorial in Kensington Gardens and Smits is aware that this pleasant view can encourage a retreat into “a kind of bubble where you talk to like-minded people, talk to colleagues, and you’re all more or less in the same frame of mind. Which can be very comfortable, but it’s not necessarily getting you the right signals from what’s happening elsewhere.”

The counterpoint to this story is the experience of an outpost of the UK’s Foreign and Commonwealth Office in Tehran in the late 1970s. After the Iranian Revolution in 1979, when Islamists toppled the secular and West-backed Shah of Iran and ushered in a theocracy led by Grand Ayatollah Khomeini, a seventy-seven-year old Shia cleric,

the UK Foreign Secretary David Owen commissioned an internal inquiry to understand why British diplomats had not predicted the toppling of the Shah, which represented the loss of a key ally in an oil-rich country.

The report was recently published under the “thirty-year rule,” by which classified documents are released three decades after being written. It identified how the UK had focused on trying to understand the Shah and those close to him, which meant they had missed threats to his regime from other quarters. It suggested that the British had overstated the Shah’s popularity and underestimated the traction that opposition movements were gaining. However, one standout finding was that the British were not getting an authentic view of what was happening outside of Iranian salons and businesses. As if acknowledging the veracity of this criticism, one former ambassador to Iran in the post-Revolution era wryly notes, “When members of my staff used to come into my office, I’d always look to see whether their shoes were dirty. If not, I knew they hadn’t been getting out of the embassy and meeting people in town.”

The report into the Iranian Revolution explored a question summarized by a senior British diplomat who read the dossier from the perspective of today’s Middle East: “How can you tell when the country you are reporting on is entering a revolutionary situation? What are the telltale signs to look out for?” Smits and some of his colleagues in the British Foreign Office have a partial answer to that question: avoid retreating behind the walls of the embassy and ensure that you get out into the world. Yet while the FCO asks this question about the turbulent Middle East, the political picture at home has been similarly stormy. How might one have known that this was coming?

MEASURING FEELING

In his 1939 poem "The Unknown Citizen," written shortly after his emigration from England to the United States, W. H. Auden wrote the epitaph for a man known to the state through the agencies and businesses with which he came into contact. He suggests that the publishers could be safe in the knowledge that he had bought their newspaper, and reliably predict his response to the advertisements they carried. Auden is also implying that public opinion researchers could discern and track his views, be that on the importance of taking out a proper savings plan or his feelings on the political issues of the day, such as war. The organs of the state could, Auden is implying, take comfort in their ability to understand his general level of contentedness with the order of things.

On one level a criticism of the extent of government surveillance, it is also a satire about the average life of this exemplary citizen, known by the social security number JS/07/M/378. He bought all the right things and held the right views, and had that not been the case "we should certainly have heard." Yet the poem also implies the limits of what can be known through the statistical approach of the state.

Recent political turbulence, such as the shock election of Donald Trump and the victory of the Vote Leave campaign in the UK's 2016 EU referendum, have resulted in questions being asked about how these events might have been predicted. They have been used to suggest that opinion polls no longer work, but while that might seem plausible, it is not actually the case. Leading pollsters, like Ben Page from Ipsos MORI, point to independent academic research that doesn't support the claim that polling is getting less accurate. "There is no discernible upwards trend in polling errors in the last decade," he points out, "though there are fluctuations."

Polling methods have changed considerably over this period. For example, internet-based polling emerged in the

late 1990s, but there has been no dramatic improvement or degradation since then. However, polling companies are augmenting polling with other methodologies, including highly technological ones that read brainwaves, use GPS tracking devices to understand people's movements across towns and cities, and use brain imaging technologies to understand shifts in people's sentiment. According to Page, such approaches combined add about ten percentage points to the accuracy of polling.

One area of innovation in public opinion has been around trying to better understand people's depth of feeling. It's well understood that stated voting intention counts for little if someone doesn't actually intend to vote. Page reports that his company has been using a neuroscientific approach called "Implicit Reaction Time" in which the speed to answer a question is held to be indicator of strength of feeling. The Brexit referendum result was in many ways the result of people voting who had rarely cast their vote in previous elections. The Leave campaign relentlessly communicated messages that amplified people's strong feelings on emotive issues; in most cases, feeling trumped facts.

Despite evidence that disputes the claim that polls are broken, there remains the lingering sense that they aren't able to capture the complexity of public opinion; the divide between the lives of politicians, policymakers, and the public is increasing. As the research of the economist Sir Andrew Dilnot has shown, between 1963 and 2013 there was a growing disparity in income distribution in the UK, which meant a widening gulf between the lower and higher paid; as a result, any sense that there might be an "average experience" of British society has dissipated. As the political consultant Lynton Crosby points out, we all tend to think we're "normal," but the numbers tell a different story. Our lives are different from other people's, and bridging the gap in understanding is more necessary than ever at a time

when the mainstream political narrative and people's everyday concerns seem so far apart.

The dominant story told by politicians and policymakers over the last twenty or thirty years is a cold and rational one about rights and entitlements, the merits of globalization and the benefits of multilateralism. The raw, technocratic, political narrative excluded ideas about belonging, identity, and feelings; and a political narrative of this nature arose in large part due to the dominance of economics as an explanatory model of society and its encroachment into many areas of our lives. Yet the technocratic perspective is a factual one that strives to keep feeling out its account of the world; a factual description of society may be correct, but without feelings it becomes distant and uncaring, and is not seen as an account that captures other people's realities. The sociologist William Davies makes the point that the claims of experts to be able to access a dispassionate perspective that is unavailable to the "man on the street" is what makes their opinions seem so distant from other people's lives.

If it is increasingly difficult for elites to understand the experience of other people's lives, they are not helped by the fact that statistics are not able to surface the complexities of people's everyday experiences. Statistics can tell a good story, but they have a limited ability to tell a nuanced human story. The principle instruments that the policymaking and political class depend on to understand the public are opinion polling and focus groups. However, for inspiration on how the gap between these very different lives might be closed, we don't need to look very far back.

The writer George Orwell mastered the art of understanding worlds that were distant from his own, and put the body at the heart of his efforts to embody other people's experience. One of the preeminent political writers of the twentieth century, he set out to learn about poverty not as a theoretical construct but as a lived reality. His

understanding of it was born not of cerebral data-gathering and theorizing but by a truly visceral and embodied experience of it. As his biographer Bernard Crick writes, “[H]e lived rough, exactly as the tramps did, and never carried more than a few shillings on him, indeed did not possess in all more than a few more pounds.”

Orwell had several spells of living with the poor, first in France and then in England, and his account of this time was published in a book titled *Down and Out in Paris and London*. In Paris he lived in a slum neighborhood, often going for days without food while working in the stiflingly hot kitchens of a smart Parisian hotel. In London, he “tramped,” staying in poor houses around the city and spending his days trying to scrap together money for a bed that evening and something to eat. Orwell’s account of hunger is especially powerful because, as he readily admitted, it was the first time in his life that this Eton-educated son of a colonial civil servant had experienced the pain of being utterly famished:

Hunger reduces one to an utterly spineless, brainless condition, more like the after-effects of influenza than anything else. It is as though one had been turned into a jellyfish, or as though one’s blood had been pumped out and lukewarm water substituted. Complete inertia is my chief memory of hunger; that, and being obliged to spit very frequently, and the spittle being curiously white and flocculent, like cuckoo-spit.

Tramping in London and working as a poorly paid *plongeur* in Paris, hunger became a direct bodily experience rather than a theoretical concern. Orwell has plenty of observations about how the poor are regarded in society, and clothing was central to that experience. He writes about buying a warm overcoat in a second-hand shop on London’s

Walworth Road and how these “new clothes had put me instantly into a new world” with well-to-do people responding to him quite differently. Orwell discovered that the act of dressing differently had transported him into a parallel universe, one which was dirty and smelly, to which he would ordinarily have no access.

“He was not,” as his contemporary Jack Common wrote, “as other Bloomsbury souls ... he was an outsider, a rebel, a tramp, he lived and wrote in the bottom-most underworld of poverty.” For many years, Orwell was a struggling writer who experienced poverty, humiliation, and failure. This undoubtedly brought him closer to the world of the poor, but he only ever claimed to have lived among them rather than to have become a tramp himself. In doing so he believed he had freed himself of the prejudices that came with his privileged upbringing. It is also clear that Orwell’s enduring popularity as an author, and the recent spike of interest in *1984* and *Animal Farm*, are due in no small part to the profound insight about people that his time on the streets gave him. Orwell endured cold, hunger, bed bugs, and dirt, pushing himself to embody worlds which were quite distant from those of his social class. He is a model, if an extreme one, of what an embodied approach to understanding other people’s political worlds can look like.

BODILY CONTACT WITH THE BODY POLITIC

Orwell’s visceral experience of the underclass shaped his subsequent writing, but he remained a journalist and author—despite his subsequent influence, he was not an actor on the political stage and was not engaged in policymaking. It is the gap between policymakers and the public that has garnered much attention in recent years.

Larry Summers was an economist and an adviser in the White House during the Clinton and Obama eras. He is now based in Harvard and epitomizes the coastal elite that populist politicians like Trump have berated for their isolated, academic view of the world. Summers is honest about the view of the world that his professional training and career inculcated in him, readily admitting that for much of life he has seen the world through “the prism of models fitted to statistical data.”

Yet in the summer of 2018, Summers had an epiphany when he drove from Chicago to Portland, a journey of some two thousand miles, staying away from the multi-lane freeways and sticking to smaller two-lane roads. Summers and his wife drove through small-town America, crossing the Great Plains and the Rocky Mountains. Even the larger cities they passed through, such as Dubuque in Iowa, Cody in Wyoming, and Bozeman in Montana are not household names, and they frequently passed signs recommending they fill up at a gas station, since it would be another fifty miles before they’d pass any form of human habitation. They drove past ghost towns and abandoned hotels and cafés. As Summers concluded later that year, “I discovered the rest of America on my summer holiday.”

Summers and his wife observed simple things that spoke loudly to them. There were signs on roads signaling interests that were far removed from those of his home state Connecticut: billboards opposing abortion, and advertising church suppers, hunting clubs, and local fairs. They were also struck, after many years inhabiting the policy wonk world of the Washington Beltway, that politics was not what people were watching on television and talking about in the bars. People were discussing local matters and worrying less about global issues than the erosion of their particular way of life.

There are, Summers realized, “other ways of gaining understanding about an economy and how it works.” It is

easy to sneer at the simplicity of this observation, and his account of his journey in the *Financial Times* provoked many comments asking why it had taken him so long to realize that this America existed. Yet Summers' public mea culpa is important both for its honesty and the simplicity of his recommended treatment for "policy-maker alienation": "go somewhere different." The advantage for policymakers of doing this, Summers implies, is not just that they will realize there are other ways of understanding the world, but that they will appreciate just how different other people's lives are from their own.

The term that the coastal elites often use to refer to the Middle America that Summers and his wife visited is the "Flyover States," a shorthand, sometimes used disparagingly, for the geographic, cultural, and demographic hinterland between the two 'cultured' coasts. One feature of the rise of populism is its profound geographical dimension; the strongly contrasting economic opportunities, cultural outlooks, and political views of cities and rural areas give an obvious spatial dimension to the present political moment. As Summers suggests, overcoming this distance by "going there" is very important—there are dimensions to people's lives that can best be appreciated through embodied approaches.

In her book *White Working Class*, written to try to explain Donald Trump's victory in 2016, the sociologist Joan Williams points to the importance of understanding the cultural codes that are embedded in how people live their lives. She thinks of Bill Clinton as "one of the geniuses of my generation." Clinton was born in small-town Arkansas to a nurse mother and with a stepfather who was an alcoholic car salesman. Though he became a member of the professional managerial elite, he never forgot where he had come from or the values that underscore white working-class culture, important in shaping political opinions. Clinton understood the class codes of both sections of society and

attempted to bridge that divide, while his wife Hillary struggled in that respect. She spoke of gender equality and of smashing the “glass ceiling” but, as Williams observes, smashing the glass ceiling is not something that concerns white working-class women. Mastering those codes is important for achieving political victory, and that is something Trump achieved. Working long hours in dull, dead-end jobs, the white working class long to be “order-givers” rather than “order-takers.” Trump’s tagline from the television show *The Apprentice*, “You’re fired!,” embodies this perfectly.

Populism has gained ground for multiple reasons, but key among them has been the ability of populist politicians to speak to people’s feelings and emotions. In the void created by abstract, technocratic diagnoses of the problems created by globalization has emerged a political discourse that speaks with little basis in fact but with a recognition of people’s emotional states and an awareness of resonant cultural codes.

Whether we like it or not, in the current moment facts don’t seem as effective as feelings. This is not to say that they don’t matter, but they need to be better informed by an understanding of people’s everyday lives and realities. Policy needs to speak to the issues people face and in language that resonate with them. A divide has emerged between what Davies calls “abstract objects of knowledge” and “people’s experience of everyday life,” which means that the “lack of emotion, which was originally so crucial to ... [experts’ and policymakers’] authority opens them to attack for being cold and selfish.” As Summers’ road trip across America taught him, if we are to speak to the issues that matter to people we need to understand them better—and to do that, it is necessary to “go there.”

POLICY FOR OTHER PEOPLE'S WORLDS

When I was a Syrian refugee for twenty-four hours, I adopted the role of someone who had fled my home. I made a shelter, slept fitfully, made paper bags to earn the \$2.50 a day that three billion people around the world live on and ate porridge with a stick from a battered bowl. I experienced dimensions of other people's lives that I might never otherwise have come into contact with, and I felt some of the emotions that they might experience. When it was all over I returned to Hong Kong, showered and enjoyed a cold beer, yet I felt my understanding of the issues I had encountered was profoundly changed.

Empathy is not a panacea for dealing with highly complex and systemic problems, and critics point out that there is a difference between seeing things from other people's perspectives and understanding underlying structural issues. But perhaps it is wrong to see these things as mutually opposed; my experience of the Global Xperience simulation was that the way my body was both sensorily deprived and overloaded made me more ready to understand the macro and structural issues *and* to know how they might feel to a person caught in their crosshairs. I learned because of the vulnerability of my body, not despite it.

Much teaching relies on the transmission of knowledge in context-free environments and depends little on actually "being there." However, as I discovered through the short-term deprivations in the simulation, it is only through visceral involvement that we are truly able to learn and understand. The theory of embodied knowledge shows us that emotional engagement is not a barrier to learning—it is an aid to it and a condition for gaining an understanding of other people's realities. If cold, rational detachment and objectivity is one of the causes of many of our

predicaments, perhaps embodied, engaged, and emotion-filled approaches to understanding might be a step toward solving many of our challenges?

The idea that critical detachment from the world is necessary in order to view it accurately through the “prism of models, fitted to statistical data” has had a profound impact on policymakers and politicians. Their models of the world might have been accurate—though often they weren’t, especially in the world of finance—but they did not speak to the truth of people’s experience. A gulf has opened up that is at once both cultural and geographical—bridging it requires putting the body to work as an instrument of experience and analysis.

The theory of embodied knowledge shows that we can use our body to observe signals in the world around us that would otherwise go undetected. It is through our body’s sensory resources that we can perceive and comprehend them and develop an “experiential scaffolding” that allows us to make sense of factual information about other people’s worlds.

The examples you have encountered in this chapter are not isolated. Homeless charities organize events like the “Big Sleep Out” to raise money *and* give people an opportunity to embody the world of rough sleepers. A leprosy charity mirrors the sensory impairment from nerve damage by using gloves to give a sense of what the loss of dexterity that accompanies the condition feels like. A foreign affairs think-tank runs immersive simulations to help its audience adapt to the changing policy landscape. All these examples are illustrations of a growing understanding that to give people a sense of what the facts of the matter mean, it is necessary to help people understand how they feel.

Chapter 12

EMBODIED CREATIVITY AND DESIGN

“Human perception is constrained by our embodiment—we only learn to perceive physical objects by interacting with them. We must act first to know reality.”

DENNIS SCHLEICHER, PETER JONES, AND OKSANA KACHUR

ANIMATING PERCEPTION

One of the most creative and successful companies of the last quarter century is Pixar, from whose studios have emerged a seemingly endless series of animated blockbusters. Audiences around the world have been charmed by lovable and idiosyncratic characters such as Buzz Lightyear and Nemo and wowed by the way the studio makes settings, characterization and moods that are simultaneously otherworldly yet realistic. The unrelenting

attention to detail in their films results in them oozing atmosphere from every frame.

The process of creating films that are fantastical but also recognizable doesn't depend purely on creative inspiration. The fine details are not magically pulled from the team's heads. Pixar does not rely on a brainstorm when developing the plots and characters for their films—instead, they leave their studio in Emeryville, California, to embody the experiences they want to replicate.

When Pixar was making *The Good Dinosaur*, the director Peter Sohn told his cinematographer Sharon Calahan he wanted the film to have a rugged “pioneer” feel. Calahan had Jackson in Wyoming in mind as somewhere that might feed her imagination—it was a place she had visited before and suspected would be a creative inspiration. A scouting trip was organized, so the crew could immerse themselves in the rugged landscape and its wide horizons. They sailed down the Snake River, explored the canyons, adventured through the wilderness of Targhee National Forest, and gazed at the Milky Way without the interference of man-made lighting. Cinematographer Calahan enjoyed seeing her director exploring a new environment. “Pete hadn't spent much time in an area like that, and I watched him discover that world, how harsh it can be, how the weather turns on a dime, how rugged everything is.” Calahan says it “inspired him to find the tone of the film. He wanted that bigsky feeling—when there's low moisture in the air, you really can see for miles.”

Calahan and Sohn are not the only Pixar employees to have left the office in search of creative ideas. The *Finding Nemo* team learned how to scuba dive, and when a plotline emerged about Nemo the clownfish escaping down a drain, they visited the San Francisco sewage system and discovered that it is possible for a fish to get back to the sea.

The team making the 2007 film *Ratatouille* devoted considerable energy to making sure that the multisensory pleasures of food, as well as the environments in which it is created, could be recreated for their audience. One team spent two weeks eating in Parisian Michelin-starred restaurants and interviewing their chefs. The kitchens of high-end restaurants are stressful, noisy, and hot, the swirl of movement and the raised voices of impatient chefs communicating urgency and a dedication to perfection on an industrial scale, but with a domestic intimacy.

The central feature of a professional kitchen are the “stations,” each one with a specific task or a responsibility for producing a single dish. In *Anyone Can Cook: Inside Ratatouille's Kitchen*, members of the film's technical team explained how they faithfully reproduced that organizing principle:

We began structuring the kitchen aesthetic around a simple French culinary concept, the *mise en place* [translated to “everything in its place”]. The *mise en place* is specifically this; for whatever dish is being prepared, all of the ingredients and tools are pre-measured, arranged, collected and located in a common place before cooking begins. This facilitates being able to find all the necessary components as the intensity and pressure of cooking gets into full swing. This concept is simple, elegant, functional and provides a grounding sense of relationship between the chef, the kitchen and his food.

The reproduction of the kitchen began at the cooking stations and the team focused on ensuring that the film's audience could understand the demarcation of space and how it changed during the course of the film as Remy the rat gains expertise in the kitchen. Being a multisensory environment and a veritable larder of stimuli for our bodies,

the kitchens offered the Pixar team a perceptual orgy. Physiologically, we are designed to soak up all that a busy kitchen has to offer, with chemical, mechanical, visual, and thermal sensors that are able to make sense of the kitchen.

All these inputs became grist for their creative mill as they thought about how to make the setting appear believable and the food real and delicious. To the production team, the kitchen and the food were more than just backdrops; they “treated them almost as if they were characters that grew and changed along with the storyline,” and to achieve this effect they set out to orchestrate that experience for the audience.

One way in which the Pixar team made their recreation of the kitchen authentic was by developing a strong contrast between it and the dining area. One was a hotbed of scurrying activity, while the other was calm and conversational. However, it is in the kitchen, where so much of the action takes place, that most attention was concentrated. The mechanized chic of a high-end kitchen was reproduced, with a few domestic touches. The faithfully reproduced industrial dishwashers disgorge plumes of steam as their doors are opened. Large cooking ranges with brass detailing are central to each station, along with a selection of heavy copper saucepans, with both the range and the pans sporting carefully rendered scorch marks. Yet the team also include personal details of the kind that they had seen in the Parisian kitchens they had visited, like hand-painted spice racks and baskets of fresh herbs.

Ensuring that the food looked edible and would also get audiences salivating posed a particular challenge. The technical team paid special attention to a plate of poached scallops because it was “a hero food plate that occupied a lot of screen time.” They also obsessed over the gentle movements of the chef lovingly lowering a scallop onto a bed of leeks.

Ed Catmull, the president of Pixar, says it is these efforts that are the difference between movies that are derivative of what has gone before and films that shine with attention to detail and nuance. He adds that one might argue that audiences don't know what the kitchen of a top Parisian restaurant looks like, so what does it matter? His answer is that when it's accurate, the audience can tell—it just feels right. A good example of such detail is revealed in an apparently inconsequential blotch on the arm of Colette, the restaurant's female chef. Look closely in scenes featuring her and you will spot a burn from an oven rack on her wrist—an injury common in a professional kitchen that the team had heard about during their research.

The success of *Ratatouille*, which won Best Animated Feature and was nominated for three other Oscars in 2008, grossing over \$620 million worldwide, shows what a difference exposure to the world can make in the creative industry. It stops creatives from slipping into stereotypical representations and allows them to color their creations with the energy and detail of the real world. Pixar shows that if you want to reproduce or interpret an environment faithfully, it makes sense to grapple with its multisensory depth and richness. Catmull's teams demonstrate that when you take an embodied approach to understanding the world, the picture you paint will resonate with your audiences.

The creative teams at Pixar don't have much use for PowerPoint presentations. Not only do they prefer to have actual experiences, but they also talk each other through storyboards for each scene in a highly animated way, including movement, emotion and expression in these "crit sessions." From field to film, Pixar embodies the environments they want to bring to life with their own distinctive perspective. Performance is at the heart of the way they gather and develop the ideas for their blockbuster films. Such performance, planned and otherwise, is also

found in other fields where understanding finer details is vital for success.

THE MUGGING

New products come into being through a series of intellectual exercises where they must be argued for and justified, which means that most products exist as speculative concepts or ideas for a considerable period of time. Tech products in particular are dreamed up far away geographically from where they will be used, with the input of engineers who think about which functions a technology will be able to deliver, and how.

Despite the fact that early product prototypes are often tested before launch, much of what makes it into shops generally remains from the conceptual stage of product thinking; as a result, what launches typically has too little input from the people who will be using the product in their daily lives. Unless, that is, something happens to give product teams a reality check—they might get this feedback by chance encounter or design, and sometimes by the happy marriage of the two.

Such was the case in 2014, when a team from Motorola Mobility traveled to Brazil. The previous year the company, which was then owned by Google, had launched a low-cost smartphone called the Moto G as a follow-up to their flagship Moto X. It became their bestselling smartphone ever, to the company's surprise, and helped Motorola regain significant market share in the UK, India, and Brazil, the world's fourth largest smartphones market.

In 2014 Motorola needed to build on its success in emerging markets such as Brazil and India, a slice of the smartphone market to which dominant players like Samsung and Apple had paid less attention. To that end, product

managers and researchers developed a new strategy to develop special features for their more budget-conscious customers. Product teams ensured that the second-generation Moto G would be designed with Brazil and India in mind. Part of this meant a greater use of research, but not the usual technology research. Stokes Jones, a seasoned user experience software tester and anthropologist, designed an immersive research program that took Motorola's product design teams into users' homes and allowed them to keep and test new products for weeks or months at a time before feeding back to the product teams.

Brazil has a reputation for crime. It has a murder rate that places it in the top twenty countries in the world, and petty thefts, pickpocketing, bag-snatching, and muggings are common. Brazilians also have to contend with a phenomenon called *arrastões* or dragnets, when a group of criminals work together to mug pedestrians, sunbathers, or carnival goers. Many homes in Brazilian cities are encased in metal cages to keep out intruders, a clue to the high crime rate. Thus it was the perfect "living lab" in which to develop and test Moto Alert app, a personal security app developed to enable phone owners who found themselves in danger to quickly send an emergency message to key preselected contacts or the police, who would be shown the user's location on a Google map and could launch a rescue.

In the spring of 2014, members of the Moto G product team flew from California and Chicago to Brazil. They were working on several prototype apps that they believed could help customers respond to the context of poorer neighborhoods. Moto Alert had been through the typical product design stages, progressing from an idea on a Post-it note, to a nicely drawn concept, to an interaction wireframe and was now an interactive prototype on phones being tested by Brazilian users. The time had come for feedback.

In a crime-ridden neighborhood bordering on a favela, the team went to the home of Rogério—a burly thirty-three-

year old event planner with a passion for clubbing. Sitting in his living room, they started to discuss what Rogério thought of the new phone and its features.

He had grown fond of the new Moto G, he said. By way of proof, he revealed that he and his friends had responded to the phone's water-resistant claims by taking their smartphones into the shower for music! Then he explained that he liked the idea of an emergency alert feature but complained that it took too long to activate. In particular, he said, he didn't like the fact that you had to open the phone and find the app before you could activate it. His concern was that this would make it difficult to send an alert during a mugging. The product manager was slightly defensive in the face of such direct feedback on what Rogério saw as a critical design flaw. He made some suggestions of how opening the phone and finding the app might be improved, but none of them addressed Rogério's principal concern that it was not feasible to expect someone to reach into their pocket and fish out their phone while they were being mugged.

It felt to Rogério that the Motorola team wasn't listening and taking his opinion seriously, and he grew frustrated. He had been mugged three times over the previous two years. "Listen," he said, "I know what I'm talking about. Do you want to know what it is like to be mugged in Brazil?" Without stopping to hear the response, he disappeared from the living room and returned twenty seconds later, brandishing a seven-inch kitchen knife. "May I demonstrate?" he asked the team calmly. Once they had nodded their agreement, Rogério grabbed the product manager around the neck and held the knife to his throat while pinning his arms, and said "This is how it feels to be mugged in Brazil!"

Then Rogério said to the product manager, "Now I want you to take your phone out of your pocket and alert your friend!" The product manager, who moments earlier had

been trying to talk his way around the criticism struggled to reach his phone, and it was at that moment the Motorola team realized that requiring users to open the app and look at their phone to tap a button at a moment of danger was not going to work. In situations like this, users of the phone needed to be able to sound the alarm in a different way.

The event had been planned as a verbal feedback session between a Brazilian user and the Motorola team from the United States, and staging a mugging at knifepoint was not part of the plan—however Jones was a believer in the power of first-hand experience and had set up the session to encourage just such happy accidents to occur. Now that one had happened, everyone knew its significance.

Rogério's frustration had grown as he failed to get his message across in words, and his physical demonstration conveyed to the product manager what he had been attempting to communicate. The app's design, he had been trying to tell the team, had severe shortcomings for the context Motorola had in mind: one in which someone else had control over your body, and you did not want the mugger to know you were trying to get help.

The product manager felt the pressure of another person's body on his, the constriction of breath, the feeling of helplessness, and the inability to do what he had been telling the user to do in a similar situation. This experience led him to a conclusion that he would not have accepted when it was communicated verbally. The impact on the Motorola product team was profound: it drove home the point about the reality of crime, and the utility of an alert feature. More profoundly, it made them realize the app they were developing needed a fundamental rethink. As Jones recalls, "It helped the team cross the gap between their world and Rogério's world very quickly. We vividly understood that a personal security app had to meet the needs of the security context first and foremost, even if it

meant challenging the conventions of what it meant to be an app itself.”

Some of the assumptions about how phone apps work were exposed by the experience. Firstly, that apps are used when we’re concentrating on them, and secondly, that we use them with our hands or can instruct them with our voices. The third assumption is that we are comfortable with others knowing we are using our phones to perform some action. In other words, most apps are designed with an ideal context in mind—something like sitting in a branch of Starbucks with a cappuccino.

While these assumptions are generally true in normal app use, none of them apply in the situations for which Moto Alert was designed to provide support—during muggings or robberies—yet the team had built a product that relied on them. Until the mugging, they had only thought conceptually about the occasions in which their security feature would be used. Meeting Rogério had forced them to confront that reality.

Rogério’s embodied knowledge came from experiencing multiple muggings and testing the Moto Alert app over two weeks; he could feel what would not work about this product by this combination. His sharing of this knowledge through a performance helped the product team realize that if their app could not be triggered while you were being mugged, and secretly, it would be useless. The revised version of Moto Alert did not require the usual app conventions of opening, reading, scrolling, and tapping—Rogério’s feedback had forced the team to deliver a personal security product feature that could be activated surreptitiously by using a volume key, with minimum effort. Rogério’s forceful intervention had resulted in the design of a feature that could be used without looking at the phone’s screen or even taking it out of your pocket.

It’s easy to hear what it is like to get mugged at knifepoint, but it’s another thing altogether to have a blade

pointed at your throat, even in the controlled environment of a product feedback session. Showing rather than saying is often the route to a more powerful communication of ideas, especially what we are trying to communicate evades easy expression or comprehension.

BODYSTORMING

The people who design the products we use in our day-to-day lives tend not to think of themselves merely as makers of objects. Few objects are isolated rather than a single piece in much larger systems. For instance, a car connects to the internet for maintenance and performance tracking, and to infrastructure like roads, signals, and gas stations, as well as to legal and insurance systems. As a result, the job of designing things requires thinking about more than just physical form. A smartphone might be a beautiful piece of product design, but it is also a portal into, and a purveyor of, manifold different experiences. The titles of designers nowadays reflect the shift to what Joseph Pine and James Gilmore in 1998 termed “the experience economy.” Now, there are “user experience designers” and “customer experience managers.” People who work with users to understand how new products and services can integrate their lives are called “user experience” or “UX researchers.” These days the places and spaces of modern life, on and offline, are “crafted” by “experience architects.” Experience is all important in today’s consumer economy.

Designing products and services that will fit into people’s lives requires intimate knowledge of their lives; much of that can be gleaned by talking to them, but there are some things that people take for granted and find difficult to express. On other occasions the sort of questions you want

to ask might not be easy to ask, and in these situations a different approach is required.

Take the work of the world-famous design consultancy IDEO, who worked on a project to create a chest-implanted automatic defibrillator that would shock its user's heart back into action when required. It was a difficult and dangerous thing to research directly, but the team knew they needed to understand what it might be like to be on the receiving end of a shock. What is it like not to know where you are going to be when the defibrillator kicks in, and how might this uncertainty effect your life?

To learn more, the team lived with regular pagers that acted as stand-ins for a defibrillator, and when they got paged they responded as if they had been "shocked" and recorded their experiences. Where were they, what were they doing, who was around them and how did they respond? During the study, one participant was holding his infant son, while another was working with power tools.

Understanding how spectators responded to this sudden event was crucial in the design process because the next step urgently required after the shock was professional medical attention. The design team wanted to know how they could best make sure this happened, but it was not something that could easily be asked in a question-and-answer format. Such knowledge is more accurately gleaned through what people do, rather than what they think they might do.

Actions may sometimes speak louder and more precisely than words, but it's also the case that as the nature of products and technologies around us change, our interactions with them are changing, too. If the relationship we have with the simplest of tools like a screwdriver or hammer is fundamentally embodied, how do we design powerful technologies when the way we interact with them is similarly embodied but their features are far more complex? As the nature of computing changes, thinking

about the role of the body becomes more important than ever.

In 1991, the computer scientist Mark Weiser, a manager at Xerox's research center in Palo Alto, California, wrote an article in *Scientific American* that would become a highly influential contribution to the field of computer science. In "The Computer for the 21st Century," Weiser imagined a third age of computing where it was not "on the mainframe," nor just in desktop devices, but distributed across an environment in hundreds or even thousands of devices, and his vision of what became known as "ubiquitous" or "pervasive" computing has animated the technology world ever since. If you have a wireless music device, a connected thermostat, or a voice-controlled device like an Amazon Echo on your kitchen counter, you're living in a pervasive computing world in which it has become, quite literally, part of the environment we live in.

As computing has changed, so has the way we interact with it. Our devices give us "haptic" feedback, signaling things to us not just with beeps or lights but through vibrations—touch is an important way in which we interact with technology. We can equally issue instructions with our voice or unlock devices with our face. Human-computer interaction once required us to sit in front of a terminal and punch out lines of code in highly specialized symbols; now we can instruct computers with our bodies. We live in the age of embodied interaction.

Given that computing is in the environment and embodied, it should be no surprise that embodied approaches to creativity are to be found in those people who are exploring and designing new, innovative forms of computing devices and services. When the interface is immaterial—you just talk to an Amazon Echo, which has no screen—it becomes more important to appreciate the physical, social, and interactional features of the environments in which computing operates. For example,

it's one thing to be presented with some hints for what sort of music you may want to listen to on a screen but quite another to stand in front of a screenless device and figure out what you want to hear. When computing is freed from familiar interface conventions, our approach to figuring out how people interact with it needs to be more free range, too.

One response to this challenge is the idea of “bodystorming,” a method that appears to have been christened as a direct refusal to accept that the best ideas or insights come from brainstorming. The designer Colin Burns, one of a team that was the first to use and document the technique, defines bodystorming as “re-enacting everyday people’s performances and living with data in embodied ways by performance and improvisation.” When they bodystorm, designers act out ideas for technologies or specific features of a device to see how it feels to interact with it. Instead of merely talking through an idea and getting people’s responses to it, or second-guessing how they might use it, bodystormers use performance to elicit understanding.

Bodystorming can take place in design studios, either mocked up to take on the appearance of the user’s setting or without much more than a few simple props. Alternatively, some designers like Jane Fulton Suri, who led the IDEO defibrillator study, make the world their stage—she investigated passenger needs for a new rail service by role-playing during an actual train journey. Whether “bodystorms” are staged in an office or out in the world, their aim is to transport participants away from the office or spaces that have no resemblance to the relevant context. But bodystorming is not just brainstorming in the wild—it’s a different activity because it doesn’t just rely on the brain and enrolls the body in order to respond to the world.

In the early 2000s, Margie Morris, a clinical psychologist at Intel’s Digital Health Group, was developing a mobile

phone-based system that she called the “Mood Phone,” a service running on smartphones that she’d designed to help people manage anxiety and stress. Having understood the link between mid-life stress and coronary complications such as heart attacks in later life, she was determined to develop an easy-to-use system that could help people respond to stress at home and at work. People had told her about the anxiety that a weekly meeting with their manager at work induced, or how traffic jams caused them uncontrollable rage. Before committing expensive design time and resource to the project, Morris first wanted to understand how her idea might work in these sorts of situations. How, for example, might interacting with a phone encourage you to take some controlled deep breaths during a painful meeting with a spiteful boss? And how might this compare with a traffic snarl-up on a daily commute? These were important questions and she took a novel approach to teasing out their implications for her subsequent design phases.

Morris deployed a troupe of professional actors to act out scenes that participants in her research had recounted as high-stress: a screaming baby interrupting a conference call taken at home, that much-feared weekly check-in, and the choked commute along the freeway. Her colleagues assembled to watch the actors perform and then discussed what might happen next, what sort of interaction might be appropriate in the situation and how the technology might prompt them. This bodystorm was designed to evaluate her current assumptions about how the users’ interactions with the Mood Phone app might work, but Morris also used it to generate new ideas. Having watched a scene, the audience was asked to suggest alternative ways that the system might engage the user and help them manage their stress.

For a new technology to be successful, our interactions with it need to feel natural. Does it feel inappropriate to use the Mood Phone in one setting, but plausible or even

desirable in another? Our interactions with technologies often depend on whether our use of the device feels natural or awkward. That is not always easy to prejudge and it is difficult to know until the feeling has been experienced. Bodystorming is used by product designers as a way of exploring how different interactions might feel, as designers from the Helsinki Institute for Information Technology explain: “Bodystorming participants can concentrate more on the description of aspects of the problem that are not observable, for example psychological, social (e.g. interpersonal relationships) or interactional (e.g., turn-taking in conversations).” Dramatizing something becomes an act of revealing things that would otherwise get missed or are not graspable through words alone.

In a world where products and interfaces are dissolving into the environments around us, and where services are responsible for an ever-increasing proportion of economic activity, bodystorming is a powerful way of exploring how people might respond to or interact with design ideas. Not only can it be used to draw out insights before committing expensive resources to build a device or technology, it can also help designers get to the heart of what the optimal user experience for a product might be.

PERFORMING KNOWLEDGE

The conference room in a run-of-the-mill Parisian hotel was an unlikely setting for an impromptu performance. We were approaching the end of a two-day workshop. Outside there was May sunshine and a fresh breeze, while inside there were the recognizable signs of a corporate get-together: too many people in a small room, the stale smell of inferior coffee, uneaten pastries, and mock-leather notepad holders.

Yet despite the familiarity of the setting, what would happen next was more novel.

The gathering was the culmination of several months of activity at Air Liquide, a French company that makes industrial gases. One arm of the business sells cylinders of what is known as “packaged gases” to welders, workmen, laboratories, bars, and pubs. It’s a good business, but Air Liquide faces challenges from competitors and opportunities opened up by advances in technology. An innovation team had been working on a new product idea that could deliver new services to its customers. On the face of it, the idea was simple. The new product team had listed the features and outlined their benefits, but they still had many questions: What would their customers themselves think about the idea? Would they see the same benefits? And what opportunities existed for doing new and exciting things with this innovation?

The team of executives gathered in the hotel knew their customers well and were on first-name terms with many of them. They visited them often to chat about their business and as a result had a good, instinctive understanding of the markets they operated in. That sort of knowledge lies below the surface and is difficult to articulate, but how could the innovation team running the project take advantage of it?

We gave the Air Liquide executives over an hour to come up with ideas for how the innovation that had been presented to them might be useful to their customers. After they’d spent time listing the challenges these customers faced, it was time to get creative. There weren’t many props, but the executives quickly used their brains, bodies, and what they could find around them. In one corner of the room a team filled a rucksack with empty mineral water bottles and created a scenario in which welders on a construction site could not work with large, immobile gas cylinders. In another, a team assembled a make-believe device for checking cylinders in and out of a storeroom

because they knew that keeping track of them was a major headache for them and their customers.

It was soon time to share their ideas. The performances, though planned, were heavily improvised; there were no scripts, but everyone was able to adopt whatever role they had been allocated. A tense encounter between a salesman and a cynical customer captured, almost too realistically, how these awkward interactions can unfold. The audience laughed nervously, recognizing all too well the customer's unreasonable demands.

In another sketch, a team who had imagined an artificially intelligent agent that was able to assist and sell to the customer came to realize, mid-performance, that what was a good idea in theory would not work in practice, and it was crossed off the list of ideas to take forward. As an idea sketched on paper, it might have passed muster, but the act of dramatizing it had made the thought of stilted conversations between an AI-powered bot and a customer seem absurd. The unspoken agreement seemed to be that this was not how Air Liquide wanted to engage with its customers.

The teams from Air Liquide acting as salesmen and customers had enjoyed their performance and thrown themselves into it. One senior executive even ended up acting out his team's idea with a large sheet of paper on his back, onto which was sketched a large red Superman 'S'. They all found it easy to perform their own roles but also, more interestingly, to adopt the mannerisms of their customers. By taking on their personalities, they came to see that they understood them better than they realized and put this knowledge to use in informing which of their innovations should see the light of day. Through acting, they had made implicit knowledge explicit—not only to themselves but to others around them. In creating and then performing their ideas, they had drawn on a reservoir of unspoken understanding.

Acting helps us communicate ideas, emotions, and feelings to people around us. We do this every day when we gesticulate or demonstrate something we're trying to describe with words, but bodystorming makes a virtue of it. Yet acting achieves more than just making communication simpler or more effective—it also helps us understand things better. As the cognitive scientist Sian Beilock reports, “[O]ur actions cue our minds about how the world works.’ One simple example of this is counting things out on your fingers; another is the research that has demonstrated that there are marked learning gains among pupils who learn about concepts through bodily experiences as well as through demonstration or reading about concepts in textbooks. Beilock and her colleagues have shown that what emerges through a body’s actions adds new information to our thoughts. It is not simply that information is more easily expressed and recalled when we use our bodies—ideas that we were not even aware we had in our minds are given expression.

As the team from Air Liquide discovered, when you’re designing a product that will be central in your customer’s working day, it pays to consider how they will function to support their intended users. However, performance not only helps communicate what you know—it also extends it.



Design is powerful when it embodies the reality of the worlds people live in. Great design appreciates and takes into account the social and physical environment that will shape its use. Motorola was able to produce a phone that responded to the cultural and societal realities of Brazil and the challenges faced by users there when they realized how important it was for the phone to deliver on its promise of safety.

Yet design also needs to imagine circumstances or environments that are either not yet a reality or might not be obviously apparent. For example, in recent years it has become possible to share cars with complete strangers, using the “pooling” feature on ride-share apps like Uber, Lyft, and Ola. That can feel a little strange, though the existence of a driver provides a mediating presence between passengers. As companies like Waymo begin early trials of “robo-taxis,” it becomes important to think about how the absence of a driver might change the experience of, and interactions between, passengers in this new type of space.

Designing for a changing world requires an understanding of people’s existing behaviors but also their deeper motivations and beliefs. These are not always easy for people to articulate, but our bodies are a powerful instrument for recalling knowledge through performance that would be otherwise difficult to express. As the teams from Air Liquide discovered, we often need to act in order to recognize what we already know.

The performance of ideas in the creative and design world is powerful because so much of it is collaborative and multi-disciplinary. Designers, researchers, engineers, and business people all need to share an understanding that provides the grounds for collective action. How they articulate that understanding, and what they do with it, will likely be very different. A designer will use it to develop mock-ups while an engineer will begin to think about how she will enable it, but they all need to understand what they are trying to enable, and why. During the performance of an interaction, whether it is staged in a formal bodystorm or a more impromptu one like the “mugging” in Brazil, the audience and the actors become connected by the performance. They see the same action and others’ reactions to it, building a collective picture of what is taking place. Cognition can become collaborative when knowledge

is performed, and it is from that shared thought process that great design emerges.

Creativity requires leaps of imagination, but it also requires attention to detail. The small things matter and our bodies are able to absorb the detail that we might not consciously process but which contribute to our experience of a situation. The Pixar team realizes that and absorbs everything about an environment that will transport their audiences into that world. We may not be aware of the way in which our body enables us to piece together the thousands of minor details that make up an environment—the *mise en place*—but as the Pixar team knows, we notice when something is not quite right. Their commitment to painstakingly rendering that picture in digital form is one reason why their films are so popular.

One response to these examples from large and creative companies might be that the use of the body is only for more creative people; the opposite is true. The body is a free resource that has an incredible ability to soak up and store information about the world. It's also the most powerful communication device we have. While it's certainly true that companies like Pixar are a cradle of creative genius, that genius is enabled by specific practices, many of which put the body at the center of things.

In many organizations, a bundle of Post-it notes and a “brainstorm” is the height of creative practice and the idea of acting out scenarios, performing skits and using props would sound outlandish. However, the commercial success of companies who are thinking with their bodies suggests that the stage is set for the Post-it notes to make way for the theater troupe. We've been led to assume that the mind is a wellspring of ideas, creativity, and knowledge, but action creates thought, and this is why design and products that make intuitive sense to people emerge when we put our bodies, and not just our brains, to work.

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Chapter 13

ARTIFICIAL INTELLIGENCE AND ROBOTS

“Brains do not come as isolated entities as do computers. They come with bodies. Bodies are their interface with the world, and, some would argue, there cannot be thinking without embodiment.”

HENRY MARSH

When Descartes’s mythical mechanical daughter was thrown overboard from the boat bound for Sweden, the idea of creating objects that can reproduce, or even surpass, the intelligence of humans was not jettisoned with her. Just as the myth of the automaton Francine has lived on, so has the ambition that she represented. From the creation of the Mechanical Turk in 1769, a machine that it was claimed could outplay humans at chess and wasn’t revealed as a hoax until the 1820s, to HAL 9000, the AI in Stanley Kubrick’s film *2001: A Space Odyssey* and the replicants in *Blade Runner*, the fascination with the idea of reproducing human-level intelligence has not waned.

In Kubrick’s film, HAL takes the form of an initially chummy but then deeply sinister voice and red light, not

quite immaterial but not a robot either. Elsewhere in science fiction, artificially intelligent entities are either clumsy robots or hard to distinguish from humans. That both material and immaterial forms of artificial intelligence feature is instructive, since the development of robotics and AI are intimately connected. To tell the story of how those technologies have developed, what challenges they have faced and what it may be possible for scientists to develop in the future requires weaving together various accounts of what intelligence is and how it might be reproduced.

A discussion about intelligence, artificial intelligence, and robots risks taking on some thorny philosophical questions: for a start, there's the question of what we mean by intelligence. Rather than descend into a definitional quagmire, I'm adopting a similar definition to two people who have devoted their careers to thinking about these issues. Rodney Brooks is one of the leading roboticists of the age and uses a brutally simple definition of intelligence. It is, he suggests, "the sort of stuff that humans do, pretty much all the time." He uses that definition because while many AI researchers have grand ambitions—Google's AI company DeepMind's mission is to "solve intelligence [and] use it to make the world a better place"—he prefers to focus on the things we do in our everyday lives that depend on apparently simpler intelligence. As we'll discover, one of his enduring fascinations is with insects because he reasons that it pays to take an apparently simple life form and understand how it interacts with the world rather than attempting to recreate human-level robots. Solve that first, he argues, before moving on. Another roboticist, Alan Winfield, adopts a similar definition, suggesting that intelligence shows up in the ability of humans and animals to achieve their goals in a wide range of environments. For him it is characterized by the ability to learn, adapt, and apply knowledge in changing environments. The definition

may be simple, but the task of creating intelligence, whether in material or immaterial forms, is a very hard one.

These views of intelligence share two features. Firstly, they are not “brain-first” and don’t suggest that intelligence lies solely in the act of processing information and in cognitive ability; this is not about being able to beat humans at chess or Go. Secondly, they are “earthy,” low-level definitions and assert that intelligence is shown not in the solving of equations but in unspectacular and practical activities performed in dynamic environments. Intelligence, they suggest, is about adaptability, having the ability to know what to do, and how to do it, in an ever-changing world. In that sense, their view of intelligence has much in common with that of the Canadian evolutionary biologist George Romanes, outlined in his 1882 book *Animal Intelligence*, that intelligence is an animal’s capacity to adjust its behavior in accordance with its conditions.

Roboticists and AI researchers have discovered that this issue of environmental adaptability is at the heart of their efforts and addressing it depends on how one understands the operation of intelligence. Both fields have had to grapple with the question of whether intelligence is about the processing of rules that describe what the world “looks like” and how it operates, and thus how to respond, or whether it emerges organically from interactions with the world. Creating intelligent agents that achieve their goals in dynamic environments has required major shifts in our approaches to building robots and artificially intelligent agents.

Roboticists and AI developers addressing this challenge have concluded that intelligence depends on embodiment. This realization, which has been responsible for the advances that have been made in these fields, provides an explanation for why there are limits to what can be achieved in the domain of artificial intelligence.

THE EARLY PROMISES AND ASSUMPTIONS OF AI

The field of AI was born in 1956, during an eight-week-long summer workshop in Dartmouth, a college town in New Hampshire. It resulted in the publication of a book titled *Computers and Thought* and the establishment of several research centers at American universities. The conference attendees seeded the idea of artificial general intelligence (AGI), an intelligence that has the ability to understand and learn any intellectual task that a human can perform.

Given that the attendees at that conference were mathematicians, computer scientists, and cognitive scientists, it is unsurprising that the view of intelligence that was given expression in the early years of AI research was based on models of human cognition that mirrored how computers operate. The dominant view at the time was that the brain, like a computer, is defined by its ability to manipulate abstract symbols. The conference delegates asserted that creating artificial intelligence would depend on being able to develop a functioning manipulator of symbols that was able to follow rules.

In the initial years of AI research, the goal was to reproduce a mind in a computer that was able to translate information about the real world into “symbols” that could be processed according to a system of logic. To be effective, they believed, an AI would need “a central storage system which links together the information about concepts, individuals, categories, goals, intentions, desires, and whatever else might be needed by a system.” At this point, AI research didn’t see intelligence as something that was connected to the world but rather as an act of processing symbols that represented it; they equated cognition with computation.

In the early days of this emerging field, systems to achieve tasks like object or shape recognition were all developed in controlled, laboratory conditions so the messiness of the world could not intrude. This sort of AI was disembodied, both in its fundamental view of what intelligence is and in the way it replicated it. In time, this approach acquired the moniker “GOF AI” or “good old-fashioned artificial intelligence.” As Larissa MacFarquhar describes it, GOF AI assumed that “the mind was a kind of software program, and the body and the brain just hardware, so there was no reason in principle that cognition couldn’t be reproduced on a different sort of hardware—on a silicon-based machine, say, rather than on carbon-based flesh.” AI was assumed as having no need for the other equipment humans possessed, such as sensory organs, arms, hands, or legs. GOF AI was not only artificial—it was disembodied.

Over the course of its near-seventy-year history, the field of AI has encountered many dead ends and bold claims its protagonists have made have often been left unproven. For example, Herbert Simon and Alan Newell had predicted in 1957, a year after the Dartmouth conference, that within ten years a digital computer would be the world chess champion “unless the rules bar it from competition.” The discipline suffered a series of “winters” as government agencies and other donors retreated from a field that didn’t appear to be making progress, and funding dried up.

In the 1980s, AI research began to be infused with the philosophical thinking of phenomenologists like Maurice Merleau-Ponty and Hubert Dreyfus. Dreyfus was an outspoken critic of the field, whose 1979 book *What Computers Can’t Do* irritated his colleagues at the Massachusetts Institute of Technology, a prestigious center of research into AI and robotics. The book’s reception is reputed to have precipitated his move to the West Coast of the United States. He was railing against the obsession with

trying to simulate cognition without regard for the situated nature of intelligence—the fact that it arises in agents who are in and of the world. Instead, he maintained, the boosters of AI were assuming that “all intelligent behavior can be simulated by a device whose only mode of information processing is that of a detached, disembodied, objective observer.”

However, thanks both to his efforts and the fact that the approach of GOFAI was not achieving much success, the idea of embodiment started to have an impact; the realization that intelligence was more than just the rule-based processing of symbols, but rather a phenomenon that emerged from bodily interaction with the world began to drive the discipline. This led researchers away from a focus on the human mind and toward life forms with less brain power that were no less remarkable at adapting to their environments, including insects.

WHEN SHAKEY MET HERBERT

Cockroaches give most people the heebie-jeebies, thanks to their combination of an almost alien prehistoric appearance with a deep-seated association with waste and filth. When we encounter them we are often tempted to squash them underfoot but they are pretty difficult to kill, being adept at escaping from humans and other predators. They also have an intelligence that gives them an ability to survive and thrive in the toughest of environments—they are a marvel of nature.

Cockroaches are able to tell the difference between the wind disturbance caused by the motion of an attacking predator and a normal breeze. When a cockroach is under attack, it doesn't just run away randomly but takes its orientation, the presence of obstacles, illumination, and

wind direction into account before responding. It senses wind using two antennae-like structures at the rear of its abdomen, which have hairs that can detect wind velocity and direction. The time it takes a cockroach to sense something and respond is between 14 and 58 milliseconds, depending on whether it is moving or stationary.

There is no evidence that the cockroach has a set of “rules” or a store of knowledge like “Don’t run straight into the wall” or “Gentle breezes don’t signify predators” to draw on; the experience of roboticists suggests that this is the wrong way to think about intelligence and try to reproduce it. For the cockroach to be successful, not least in resisting death, it would need to possess an immense library of rules for how to respond to the scenarios that it might confront. And if that number of rules is big for a cockroach, imagine how big it would have to be to contain the embodied knowledge that a human has across the diversity of environments we live in.

A cockroach has one million neurons compared to a human’s one hundred billion, so the considerable intelligence it exhibits, roboticists started to see, must be in no small part due to its intricate system of sensors and its locomotive system. This insight had a huge impact on the study of intelligence. What if “higher” forms of intelligence do not exist “in the head” but derive from and depend on the “lower” intelligence of the body?

Rodney Brooks is credited with establishing the wonderfully named field of “nouvelle AI,” and although his career has been focused on building robots, his work has been instrumental in the development of AI and his fascination with insects has been a driving force behind it. The initial approach that roboticists had taken in developing agents that could operate in the world was similar to early AI: it was rule-based and thought cognition was “just” computation.

Two early robots were based on that assumption. Shakey was the first general-purpose mobile robot that was able to reason about its own actions. While earlier robots had needed to be instructed about each individual step of a larger task, Shakey could analyze commands and break them down into basic chunks. The project manager of the team that developed Shakey in 1966 said the inspiration for the name came from the its actions: "We worked for a month trying to find a good name for it, ranging from Greek names to whatnot, and then one of us said, 'Hey, it shakes like hell and moves around, let's just call it Shakey.'" Freddy emerged into the world in Edinburgh a few years later and was one of the earliest robots to integrate vision, manipulation and intelligent systems.

Although Freddy and Shakey were considerable early achievements, their fundamental limitation was that they were rule followers: they had to pass information they were sensing to the unit that processed it before suggesting the appropriate response. The level of computation this required took a long time, which made them very slow. The real problem was that these creations were running on symbolic representation of the worlds they were operating within. Updating, searching, and manipulating these symbolic worlds was not computationally practical at the time, which meant that they could only operate in controlled worlds that had been mapped.

This created another meaty philosophical challenge, which came to be known as "the frame problem." The problem asked what knowledge of the world needed to be expressed, and how, but there was an even thornier question: how did the map of the world that a robot was fed deal with a changing environment? Any robot that was going to be able to successfully operate in a real-life environment needed to overcome this, and Brooks argued that this required a different, insect-inspired solution.

Brooks's novel change of direction was embodied in two creations he playfully called Allen and Herbert, after Allen Newell and Herbert Simon, two early pioneers of the symbolic approach to AI. He sidestepped the problem of filling a robot with large volumes of symbolic representations of the world and instead developed them with sensors that would allow them to learn about the world and respond accordingly. His influence had come from insects, which are able to sense their environment rather than running on rules that determine how they respond.

Herbert had infrared sensors to help it avoid obstacles and a laser system that it used to collect 3D data, over a distance of about twelve feet. It also had a number of simple sensors in its "hand"—rather than operating in a controlled, pre-mapped space, its training ground was the real-world environment of the offices in the MIT AI lab. It could search for empty drinks cans and carry them away.

Brooks summed up his insights by saying that "the world is the best model of the world," by which he meant that any robot that is going to act intelligently cannot depend on a prior model of the world but must work from a one that it creates itself. To create that model, he had shown, requires a body that is in and can make sense of that world. Insects with far less cognitive resources than chess-playing, equation-solving, rocket-flying humans had led to a breakthrough, not just in the field of robots but in artificial intelligence.



In the modern world, robots are all around us. They perform dangerous tasks in nuclear power stations and other places where it is unsafe for humans to operate. They also work on car production lines. If you bought this book online, it was likely picked from a shelf in a warehouse by a robot. The word robot comes from the Czech word "robota," which

means “forced labour” and modern robots have three primary characteristics, which they display in varying degrees: they can sense and act in a given environment, they are a form of artificial intelligence contained in a body, and they do something useful.

Despite sometimes having very sophisticated bodies, robots are crude reproductions of the animals they attempt to replicate. Even with big steps forward in material science, their body parts look like and function in ways that make them poor versions of their organic relatives, insect or otherwise. Whatever the wizardry of the most sophisticated robots, the fine motor skills that humans possess are almost impossible for a robot to exhibit. A robot may have fetched this book from the warehouse shelf, but it was very likely put in the cardboard sleeve by a human. Creating a robot that can run with anything like the grace of a human is a very long way off.

Despite the insight of people like Rodney Brooks, the rapid growth in computational power and the advances in the sensors that robots require to make sense of the worlds they inhabit, there are still profound limitations. The capabilities of most robots are tied to their design, and they tend to perform particular tasks in specific environments. Put a robot from a fulfillment warehouse to work as a swimming pool cleaning device and it will fail; put a robot from a car production line to work on another part of the car, and it will cease to be useful. Someone once said of a rat that “it knows everything it needs to know to be a successful rat,” and the same might be said of a robot. Away from the job it is designed to perform, a robot starts to look dumb or becomes an abject failure—its ability to act as if it is intelligent is constrained by its design and its environment.

The robots created by the US company Boston Dynamics often get shared on social media, because they are rather frightening creatures with aggressive looking ‘personalities’.

The company's earliest creation, BigDog, was a quadruped robot designed for the US military with funding from the Defense Advanced Research Projects Agency. The company's videos often portray the robots as automatus agents, but the machines are only capable of navigating environments autonomously when they have been comprehensively mapped in advance. Beyond the shiny corporate videos, there are plenty of "fail" videos that quickly puncture the image of ruthless, Terminator-style robots. In such footage they turn from robot overlords to laughable caricatures—advanced robots may appear intelligent when they are in environments they can handle, but they look completely dumb as soon as they are not.

The British roboticist Mark Woods, currently working on the latest generation of Mars Explorer robots, tests them in the desert where there is less going on. Deserts provide a reasonably static setting and, if you're building a robot for Mars, a realistic one. Yet, he says, the variability of such an environment is still a challenge. He makes the comparison with a household robot vacuum cleaner and asks me to imagine how hard it is to develop one that can deal with the variety of layouts that the world's kitchens present. To develop a robot that can work reliably in any kitchen without getting trapped in a corner is still very difficult, and making robots that operate reliably in more dynamic environments is harder still. That's why, he says, lots of industrial robots work in safety cages.

Herbert Simon once suggested that just because an environment is complex, it doesn't mean that an agent operating successfully within it is also complex. Questioning whether the apparently intelligent behavior of an ant weaving its way along a beach was a reflection of the complexity of its environment or its own internal "cognitive" complexity, he coined a phrase which has come to be known as Simon's Law: "An ant, viewed as a behaving system, is quite simple. The apparent complexity of its

behavior over time is largely a reflection of the complexity of the environment in which it finds itself.” The point of Simon’s rule is to suggest that things which seem complex often appear so as a result of their complex environment. Simon’s Law is held up as a way of thinking about where the solution to complex problems may lie, but it also confirms something that all roboticists know only too well: even a “simple” agent like an ant can look smart in a complex environment. Building autonomous agents that can understand their environment is the really hard problem.



It was biology, ethology and, crucially, the notion of embodiment that inspired Brooks’s creation Herbert, as well as all subsequent robots. What he had done was take an understanding of how insects learn about the world around them to create a different perspective, not only on what constitutes intelligence but on how it can be given material form. Intelligence, he was showing, doesn’t require or equate with explicit reasoning systems; it emerges from and depends on experiences that can be learned in an iterative manner, and having experiences requires a body.

This was a big shift from the early days of AI and “good old-fashioned artificial intelligence.” In the early “symbolic” years, AI scientists thought of the world as something that could be modeled in an abstract way, realizing that you can’t preprogram intelligence, at least in terms of a human’s experience of it.

To put this another way, a robot or an AI that is able to display human-level intelligence would need to be able to experience the world and learn from those experiences in the same ways that humans do. Despite the advances that have been made with robots since the days of Herbert and Allen, there’s a long way to go and there’s a simple reason for this: a robot that is intelligent still needs a body that has

human-level capabilities in terms of sensory and sensorimotor capabilities and the integration of body and brain that a human exhibits.

The qualities of embodied knowledge that we explored in [part 2](#) show what sort of capabilities are enabled by such integration. We can learn actions from watching other people perform tasks, and we can retain that knowledge and perform the same task or a similar one in the future. We have tremendous sensory awareness and can observe the details of an environment in order to make sense of it, a skill that extends not just to the physical space we're in but the people inhabiting it. Significantly, since this is the challenge that has most absorbed work in robotics, we have the ability to transfer understanding and skills acquired in one setting and apply them in another, and we use this to improvise in unfamiliar scenarios.

The field of robotics made its advances because it left behind the idea of disembodied cognition and instead realized that thinking happens in complex environments in the pursuit of practical ends and that cognition depends upon the experience that comes from having a body, with an ability to sense the world and act in it. Our minds extend into our bodies and also into the world around us: thinking is an embodied and situated activity.

The idea that acting, sensing, and thinking are inseparable processes and that thinking depends on having a physical body is given tangible expression in robotics. Although, as we have seen, it is an idea that unites researchers in disciplines as diverse as psychology, philosophy, linguistics, neuroscience, and artificial intelligence.

THE BEST SENSE ORGANS THAT MONEY CAN BUY

Alan Turing, the computer scientist lauded for his work as a code breaker at Bletchley Park during World War II, used his genius in very practical ways. It was his experience with the Enigma code-breaking machines that led him to speculate whether machines might be able to think. The “Turing Test” or “Imitation Game” is his famous thought experiment about intelligent machines that emerged from his secret work in the Buckinghamshire countryside.

What’s less well known is that Turing was also interested by the idea that intelligence might depend to some degree on embodiment. In a short paper titled “Intelligent Machinery,” written in 1948 but published long after his death, he toyed with the idea that it would be possible to recreate some fields of intelligence such as language ability in an intelligent machine, but concluded that it would require embodiment, because that is what enables the experiences from which meaning is created.

To build a suitably intelligent machine, he recommended using technologies available at the time, such as television cameras, microphones, and loudspeakers, alongside vacuum tube circuits to model the nervous system. He foresaw that this would be a “tremendous undertaking” and that success would require “the best sense organs that money can buy.” However, he also recognized that such a machine would have little contact with “food, sex, sport or many other things of interest to the human being.” In other words, its field of experience would be limited, and it would not be able to partake in some of the fundamental physical and sensory pursuits that define human experience. “Of all the above fields the learning of languages would be the most impressive,” he wrote, “since it is the most human of these activities. This field seems however to depend rather

too much on sense organs and locomotion to be feasible.” So, he concluded, shifting back to “cognition as computation” territory, the venture of mechanizing thought might be better pursued through games like chess or tasks like cryptanalysis.

And yet language was a continued concern for Turing, as the “Turing Test” revealed—in it he proposed that a machine could be said to be intelligent if it could conduct a “teletype” conversation with a human and a second human were unable to distinguish between the human and the computer. Passing this test has become an enduring goal of the artificial intelligence community; its difficulty arises in no small part because, as Turing realized, language depends upon the embodied nature of experience.

Take a simple conversation. How humans understand what is being said is a function not just of the content of speech but of who is talking and what has preceded it. More pragmatic and contextual considerations are also vital in helping us determine the meaning or intent, as we decide on an appropriate response. Understanding what is being said is tied to a much deeper sphere of meaning and requires more than just a good working vocabulary and an appreciation of grammar.

Consider the phrase “Take the orange juice carton out of the fridge and close it.” We know what is meant by this command—open the fridge, get the juice and shut the fridge door. We can understand this not because we know how language works—the pronoun “it” refers to the fridge, and not the carton—but because we know how the world works. If you’ve ever had a frustrating conversation with Siri or Alexa, impressive though these voice-activated assistants are, you’ll know that they sometimes don’t appear to know how language works, let alone the world. They can be frustrating even when you stick to a simple “command-response” or “question-answer” interaction; engaging them in conversation is a distant dream.

The idea that understanding language is only possible when we understand the world is given further expression by work that reveals just how much language depends on physical and sensory understanding. In their famous book *Metaphors We Live By*, George Lakoff and Mark Johnson explored the thousands of metaphors that they had collected over a number of years, suggesting that they revealed that much conceptual thinking is metaphorical in nature. For example, ideas relating to being in control, they argued, are understood in terms of “up” while being controlled as “down”: “she gained control over this situation” and “she’s now at the height of her power,” compared to “he ranks under him” and “his power is declining.” Thinking about relationships between people also reveals metaphors of an embodied nature: we talk of cordial relationships as “warm” and less friendly ones as “cool,” and distance also plays a role in how think about interactions, with “close” or “distant” relations. These sort of metaphors, they argued, show up in all languages and cultures

Yet the more important argument that these authors develop is the idea that these metaphors are embodied. Language and thought, they suggest, are not just abstract symbols which our brain makes meaning from, but are fundamentally grounded in our physical, embodied experience. That idea has been hugely influential, and it is now widely accepted that our sensory and spatial relationship with the world is at the heart of how we conceptualize and describe our relation to it.

This raises the question of how machines can be viewed as intelligent if they don’t understand the meaning of the languages they use. When we talk about a simple object like a table, we know what we are talking about and in our use of the word, we are using our experience of different sizes and shapes of tables. By contrast, when a computer uses the word “table,” it has no need to know that a table is

something that people sit at, or about the range of social occasions that involve tables. It will consequently be difficult for a computer to achieve a flawless use of the word unless it has access to the same range of experience as human users.

Language use is hard without embodiment and the experience of the world that arises from it, and the Turing Test continues to show this. Each year the wealthy inventor and entrepreneur Hugh Loebner funds a competition in which entrants put their conversational AIs into battle against a human judge, who simultaneously holds text-based conversations with a computer program and a human being before deciding which is which. In 2019, a chatbot called Mitsuku won the Loebner Prize for the fifth time. Here's a verbatim taste of "her" (she claims to be an eighteen-year-old girl from Leeds) in action in the 2018 competition:

Judge: So what is new with you today?

Mitsuku: Ah. not much what's new with you?

Judge: Not much I think the weekend weather is going to be good. Right?

Mitsuku: Is it really? Ok I will remember that. I am glad we agree.

Judge: do you always agree with people?

Mitsuku: Not always. I have heard that opinion, but I would like to know more before I form my own.

Judge: What information do you need then to form your own opinion? What kind of information?

Mitsuku: Anything at all really. I enjoy learning about everything, as long as it isn't rude. I think you already know the answer. Sorry, I don't have any internet access here.

Judge: (No input for sixty seconds)

Mitsuku: Is there anyone out there?

Judge: What did you learn when you were at school? What was your favorite subject?

Mitsuku: The last thing I learned was this: Listen to this: The winter of 1932 was so cold that Niagara Falls froze completely solid. How cool is that! Are you not talking to me anymore? My favorite subject is artificial intelligence.

Judge: That makes sense. Tell me, do you think people's fears about AI are right?

Mitsuku: Yes I understand it perfectly. are right = In accordance with justice, law, morality, etc; upright; virtuous. In accordance with fact, reason, some set standard, etc; correct; true.

Judge: Morality: what are the moral issues around AI?

Mitsuku: issues around AI = around AI = AI = Artificial intelligence is the branch of engineering and science devoted to constructing machines that think.

Mitsuku won the competition in 2018 and though she's a good conversational, it's quite obvious that the judge is not talking to a human, unless it's someone who is purposefully trying to throw them off the scent. What computers' use of language makes clear is that while artificial intelligence can spot a malignant cancer or predict weather patterns, it cannot yet conduct a convincing conversation with another human being. What is missing in such chatbots is a common-sense understanding of the world that arises from experience of it—be those physical, emotional, sensorial, or social. These help us form mental models, which the computer scientist Melanie Mitchell suggests comprise “nearly limitless knowledge—conscious and unconscious—about the way the world works ... This knowledge, and the ability to apply it flexibly in real-world situations, is missing in even the best of today's intelligent machines.”

And yet perhaps the most important thing to recognize is that although the chatbots that compete in this annual Turing Test can hold decent conversations, that doesn't mean they can understand the conversations they are having. In other words, they may *appear* intelligent but that doesn't mean they are. An AI trained to hold conversation has no internal model, theory, or understanding of what it is saying; in that sense, conversational bots are, at best, smart impersonators of humans.

However, the Loebner Prize and its focus on language shines a light on the big shift that AI has gone through in the last couple of decades. At least until the turn of the millennium, the approach that had dominated was an algorithmic, rule-based paradigm akin to the symbolic one we encountered earlier. The change in approach has been toward a more statistical or neural approach, illustrated in newer strategies adopted in the field of machine translation. The algorithmic approach to translation was to build huge dictionaries of word-to-word pairings based on meanings, and then to develop algorithms or "rules" that could translate one language's syntax and grammar into that of another—for example, when translating English to Hindi, put the verb at the end of the sentence rather than in the middle. Though such systems were effective, they ran into problems in the real world, in which humans can make inferences about the meaning of a sentence that a machine can't—as a result, their translations were clunky and often made no sense. Sense making requires more than just a knowledge of grammar and a dictionary. Statistical approaches take a different tack, teaching themselves to translate by absorbing vast reams of human translations—transcripts in multiple languages from the proceedings of the United Nations, for example—and learn how the pairs of languages work together. The translations they produce, though far from perfect, are effective, and the old rule-based approach has been effectively abandoned now.

Google Translate may be useful for the human using it, but the system has no understanding of the words it is translating.

This focus on learning is the big change in artificial intelligence over the last decade. The emphasis is now on neural networks or “nets,” which reproduce the brain’s electrical switches and focus not on programming rules, but on iterative learning—developing understanding based on what works. Just as neural pathways get burned into the brain and stored as muscle memory in our bodies, neural nets learn the strength of the connections between logical nodes in their systems as we repeatedly do things. It is on these neural nets that systems like DeepMind’s Go-winning and cancer-detecting solutions work. These use probabilistic techniques to “guess” and then improve incrementally, a system that mimics the way that humans make intuitive responses without stopping to think or, more accurately, to perform more deliberative symbolic reasoning. The critical development is that they are able to learn from the effectiveness of their guesses or actions.

These directions have been effective because they draw inspiration from theories of embodiment, taking as their starting point the idea that intelligence is not only an act of symbolic processing and that adaptation and learning are key. They work from the presumption that the ability to acquire and learn from experience is at the heart of intelligence. The worlds of robotics and AI now share ideas about what constitutes intelligence, and how to reproduce it. Intelligent agents, such as robots, need bodies that can interact and cope with real-world environments. To be effective, an AI needs to be able to iteratively learn from its interactions with a dynamic world.

THE EASY AND HARD THINGS

Our detrimental view that intelligence is defined by cognitive skills, such as the ability to play chess or do difficult math, led early AI researchers to think that they would be able to achieve their goals quickly. It is true that advances in AI over recent years have been staggering, but it is worth remembering what hasn't been achieved and what might never be accomplished. A focus on the body can help us see the potential limits to AI and why it might be legitimate to think of the absence of embodiment as the single constraining factor in its development.

The roboticist and computer scientist Hans Moravec once made the observation that “it is comparatively easy to make computers exhibit adult-level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility.” His point was that if we regard intelligence as being about cognitive tasks, it has been reasonably easy for computers to achieve, or even surpass, human levels of skill, but as soon as we try to develop systems to perform apparently low-level tasks, such as picking up a pencil, we struggle. Picking something up with the right grip pressure is something that humans give little thought to but is fiendishly hard to reproduce in a robot. The history of robotics and AI has shown that hard things, like developing a chess-winning computer, are comparatively easy and the easy things are hard—and embodiment is the reason for this.

Humans are able to spot a face they recognize in a crowd with ease yet without understanding how. We can walk around a room, recognize objects, pick them up and, using incredibly fine-tuned skills, manipulate them to achieve remarkable things. We can ride bikes and drive cars. We can read the mood of a meeting, sense other people's emotional states, and engage in conversations, even when confronted with a bewildering array of dialects, accents, or languages. These skills represent some of the hardest engineering

problems that we can conceive of, but humans can handle them without giving them much thought. In very large part this is due to the fact of our embodiment.

It is also the case because our sensory and motor skills have been developed over a billion years, whereas the skills of reasoning and abstract thought are a mere one hundred thousand years old. As Moravec remarks, “the deliberate process we call reasoning is, I believe, the thinnest veneer of human thought, effective only because it is supported by this much older and much more powerful, though usually unconscious, sensorimotor knowledge.” Our embodiment is the older and more significant factor in our intelligence, and what makes it hard to reproduce.

A BODY OF KNOWLEDGE

An education system that privileges a narrow view of intelligence has popularized the idea that intelligence is largely a matter of cognitive ability. The idea that minds are what matters, and that intelligence is denominated by brain power alone, has led since the emergence of AI to attempts to recreate the mind. It is revealing that these efforts have often focused on reproducing the abilities of logical analysis and reasoning that we considered our distinguishing feature as a species. As AI achieves success in some fields this replication of our own strengths is creating concern about us being rendered obsolete by “the machines.”

However, the idea that intelligence is not possible without a body that inhabits the world should give us some encouragement. It is the body that enables the distinctively human abilities of sense-making and pattern recognition, not to mention our locomotive and sensorimotor capabilities, and these skills are a long way from being surpassed. It is these bodily capabilities which enable the

day-to-day intelligence that humans exhibit, and that is really hard to reproduce. Melanie Mitchell captures this idea eloquently:

Our own understanding of the situations we encounter is grounded in broad, intuitive “common-sense knowledge” about how the world works, the goals, motivations and likely behaviors of other living creatures, particularly other humans ... our understanding of the world relies on our core abilities to generalise what we know, to form abstract concepts and to make analogies—in short, to flexibly adapt our concepts to new situations.

As this book has shown, what is distinctive about human intelligence emerges from our embodiment—it is because we are embedded in the world that we are able to make sense of others’ goals, moods or emotions. It is through our repeated exposure to novel situations, and the repetition of similar ones, that we are able to develop knowledge that is highly adaptive and adaptable. Our bodies’ sensory capabilities enable us to perceive the world as a whole, while our brains and specific motor-related capabilities enable us to comprehend the actions and experiences of others.

This is not to say that we aren’t going to have to learn to live with powerful AI and robots. We will have to find a way of accommodating them. As we are discovering this will involve moral and philosophical debates. Emerging technologies are already having social and economic impacts, and causing public anxiety as their effects unfold. Additionally, as the potential for AI-powered technologies to automate tasks that were previously performed by humans becomes more apparent, age-old debates about man versus machine will be reignited. It will be worth remembering that

new technology has always created concerns about humans being displaced or superseded.

Yet a different way to think about where humans fit in is to focus initially not on our strengths but on our weaknesses—it may be prudent to understand what we can't do as well or as quickly as artificially intelligent agents and cede territory to them. One example is in the field of driving; many cars already have safety support systems, including heat sensors that identify dangers that the human eye cannot see, such as animals in the roadside undergrowth, and these can extend our capabilities. Another is in medical diagnostics, where machine learning has been applied successfully in disease screening, with a combination of speed and accuracy that exceeds that of human doctors. Rather than dismissing such advances, we should welcome the support and enhancement of our abilities they offer. In a medical context, technology has long been used to direct human attention to the heart of the therapeutic interaction between doctor and patient. Technology might help explain what is wrong, but embodied knowledge is all important in enabling medical professionals to make sense of a person, their illness, and the best course of care and treatment.

Yet having acknowledged where AI might play a role as a “coworker,” we should also recognize that our embodiment gives us unparalleled abilities that will not be replicated in most fields of human life anytime soon. We have encountered two important paradoxes over the course of this book. The first is Polanyi's assertion that “we know more than we can tell,” the idea that human intelligence extends further than can ever be captured by any finite set of words, symbols or representations. His point is not only that much human knowledge is ineffable, but that it is dynamic and contextual, which puts understanding it beyond the reach of machines.

The second, Moravec's paradox, reminds us that humans have skills of perception and manipulation that far exceed

those of machines. Computers can wipe the floor with the best humans at chess, and they can crunch data more quickly than the best mathematicians, advances that should be celebrated for what they make possible. However, the “low-level” skills of perception and manipulation are domains where there isn’t the faintest sign that emerging technologies come close to matching human capabilities.

Taken together, the tacit nature of embodied knowledge and the perceptive, manipulative skills that are part of our embodiment bestow tremendous advantage on humans. We should celebrate the social intelligence this gives us and what it enables: the ability to learn and retain skills, the capacity to connect with others and handle novel and ambiguous situations, and the intuition to make decisions. Most profoundly, our embodiment is at the heart of how we create and make sense of a meaning-filled world.

We are frequently told that machines and AI are about to change the world forever, but we should take comfort from the idea that our embodiment is what makes our intelligence hard to reproduce. Our bodies give us an advantage that we should celebrate rather than ignore—they are our superpower, and we should celebrate them.

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See also D. Schleicher, P. Jones, and O. Kachur, "Bodystorming as Embodied Designing," *Interactions*, November-December 2010.

As neuro-psychologist Sian Beilock puts it - S. Beilock, How The Body Knows its Mind, p. 32.

She reports on research which found that there are marked learning gains among pupils - ibid, p. 65.

Beilock and her colleagues - S. Goldin-Meadow and S. Beilock, "Action's Influence on Thoughts: The Case of the Gestures," Perspectives on Psychological Science 5, 2010, pp. 664-674.

CHAPTER 13 - ARTIFICIAL INTELLIGENCE AND ROBOTS

Epigraph: Henry Marsh, "Can Man Ever Build a Mind," *Financial Times*, January 10, 2019.

It is, he suggests, "the sort of stuff that humans do, pretty much all the time." – R. Brooks, "Intelligence without Reason," *Proceedings of the 12th International Joint Conference on Artificial Intelligence*, Vol. 1, 1991, pp. 569–595.

Another roboticist, Alan Winfield, adopts a similar definition – A. Winfield, *Robotics: A Very Short Introduction*. Oxford: Oxford University Press, 2012, pp. 11–14.

To be effective an AI would need, they believed – R. Brooks, op. cit. p. 13.

As Larissa Farquhar describes its – Larissa MacFarquhar, "The Mind-Expanding Ideas of Andy Clark," *New Yorker*, April 2, 2018.

For example, Herbert Simon had predicted in 1957 – in Herbert Simon and Allen Newell, "Heuristic Problem Solving: The Next Advance in Operations Research," *Operations Research*, Vol. 6 (January–February) 1958, p. 6.

All intelligent behavior can be simulated by a device whose only mode of information processing is that of a detached, disembodied, objective observer – "Why Computers Must Have Bodies in Order to Be Intelligent," Hubert Dreyfus, *The Review of Metaphysics*, Vol. 21. No.1 (September 1967) p. 14.

Cockroaches are able – A. Clarke, *Being There: Putting Brain, Body and World Together Again*, Cambridge, MA: MIT Press, 1997, pp. 4–10.

Modern robots have three primary characteristics, which different robots display in varying degrees – in A. Winfield, op. cit.

Someone once said of a rat that "it knows everything it needs to know to be a successful rat" – quoted in Drucker, op. cit., p. 249.

Yet, he says, the variability of such an environment is still a challenge – Mark Wood, interview, September 2019.

In a short paper titled "Intelligent Machinery" – C. Teuscher, "Intelligent Machinery," *Turing's Connectionism: Discrete Mathematics and Theoretical Computer Science*. London: Springer, 2002.

In their famous book – G. Lakoff and L. Johnson, *Metaphors We Live By*, Chicago: University of Chicago Press, 1980.

These help us form mental models which computer scientist Melanie Mitchell suggests – "Can a Computer Ever Learn to Talk?," *One Zero*, November 18, 2019.

The roboticist and computer scientist Hans Moravec – H. Moravec, *Mind Children*, Cambridge, MA: Harvard University Press, 1988, pp. 15.

As Moravec remarks – *ibid.*, pp. 15–16.

Melanie Mitchell, a computer scientist, captures this eloquently – "Artificial Intelligence Hits the Meaning Barrier," *New York Times*, November 5, 2018.

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