

CHAPTER I

*We Know More Than We Can Tell**

The heart has its reasons of which reason knows nothing.

Blaise Pascal¹

Intuition is a very powerful thing, more powerful than intellect.

Steve Jobs²

After years of conducting research as a cognitive psychologist, I remain fascinated by the power of intuition – the ability to know more than we can explain. Most people recognize a face without being able to specify its features. An experienced physician can sense in a blink of an eye when something is wrong with a patient, without being able to articulate why. Chess masters such as Judith Polgár and Magnus Carlson report that their intuitive play is the secret of their success. Intuition emerges from years of experience and is a form of unconscious intelligence.

Intuition and reason are no opposing war parties. The physician's hunch initiates a deliberate search for the ailment. A musician's conscious and meticulous practice is the very basis from which those precious moments of flow emerge, where improvisation progresses without conscious guidance. Similarly, the majority of 17 Nobel Laureates explained in an interview that their "big leap" had occurred by them switching back and forth between intuition and analysis.³ This interplay has enabled generations of scientists and engineers to create technology. Blaise Pascal, the French mathematician whose beautiful words are cited in this chapter's epigraph, was also one of the inventors of the calculus of probability. Intuition and reason not only go together, they depend on each other. Without reason, there would be no mathematics. Without intuition, there would be little innovation.

* The phrase is from Michael Polanyi (1966/2009), p. 4. ¹ Pascal, B. (1669/1995). *Pensées*.

² Cited by his biographer, Walter Isaacson, in his book *Steve Jobs* (2011).

³ Dörfler & Eden (2019).

Nevertheless, intuition is subject to increasing mistrust. People confuse it with God's voice or the arbitrary decisions of an inept political leader. Some psychological theories even portray intuition as suspect and reason as superior. Representatives of tech companies at popular artificial intelligence (AI) events contrast dubious human feelings with trustworthy algorithms in their efforts to convince us that we should be anxious to give away our private data and let machines make our personal decisions. However, this mistrust was not born in the digital age. Albert Einstein already noted it when he said:⁴

The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honors the servant and has forgotten the gift.

Einstein was so right. Whereas calling something *intuitive* indicates great respect in the hard sciences, the term is often used to indicate irrationality in the social sciences as something generally inferior that should be avoided whenever possible. As we will see, this disrespect of intuition has a history. But first, let us be clear about what intuition is.

What Is Intuition?

Thomas Aquinas and other medieval philosophers believed that angels are endowed with intuition.⁵ Angels have no bodies and thus no sensory organs that could deceive them; therefore, they can intuit the truth directly with impeccable clarity. Similarly, philosophers, including René Descartes and Immanuel Kant, were looking for certainty beyond mere experience. Intuition could make us “see” the self-evident truths in mathematics, morals, or God.⁶ While philosophers have debated the function of intuition, they themselves widely hold that they rely on it. The link between intuition and certainty was disentangled in the sciences when the great 19th-century physiologist Hermann von Helmholtz spoke of *unconscious inferences* and the 20th-century psychologist Egon Brunswik spoke of the mind as an *intuitive statistician*.⁷ They were not the first; the idea that intuition is uncertain inference rather than direct knowledge of truths had been anticipated by David Hume and others before him. Unlike angels, mortals cannot perceive the world directly and have to rely on cues to infer

⁴ Calaprice (2011), p. 477, lists this quote as “possibly or probably by Einstein.” ⁵ Goris (2012).

⁶ Kant's word for intuition was “Anschauung,” which derives from seeing (“schauen”). For an excellent introduction into the highly diverse philosophical views about intuition, see Osbeck & Held (2014).

⁷ Brunswik (1955). Brunswik, following Helmholtz, focused on the intuitive nature of perception.

their world. Similarly, the idea that intuition would not need experience became dispelled. Unlike Kant who was looking for certainty independent of experience, Helmholtz and Brunswik understood intuition as a result of experience. In this way, intuition eventually became divorced from (the illusion of) certainty and wedded to learning from experience.

Nevertheless, those philosophers who think of intuition as directly providing certain knowledge, and those psychologists who think of it as uncertain inference based on experience, share one important belief. Both assume that intuition is a form of intelligence. For Descartes, intuition was the most fundamental of the two routes to knowledge, the other being deduction.⁸ For Helmholtz, unconscious inferences enable the amazing intelligence of perception and, at the same time, explain perception illusions. Following this tradition of unconscious inferences, I understand intuition as unconscious intelligence.

In this book, I use a working definition:⁹

An intuition is a feeling:

1. based on long experience,
2. that appears quickly in one's consciousness, and
3. whose underlying rationale is unconscious.

The emphasis on experience contrasts with the idea that intuition is arbitrary, a sixth sense, or God's voice. The cases of the doctor and the chess masters emphasize the role of experience. The learning of one's first language is another case in point. Consider the sentence "I could not agree to you." A native speaker would sense immediately that something is wrong with that sentence without necessarily being able to say what rules of grammar are violated. Someone with another mother tongue who hasn't mastered the language cannot depend on intuition in the same way.

Learning from experience requires feedback, meaning that having good intuitions in one domain does not guarantee having good intuitions in others. Intuitions are domain-specific. Professional tennis players may have excellent intuitions about the perfect forehand, but not about investing their money. Be it acting, driving, dancing, programming, or playing bridge and chess – the superior intuitions of experts require extensive training, with elite performance estimated at some 10,000 hours of

⁸ See Osbeck & Held (2014) for a more detailed analysis.

⁹ See Gigerenzer (2007). Similar definitions have been used by Bruner (1973) and, more recently, Hogarth (2001), Gladwell (2007), and Klein (1998/2017).

deliberate practice.¹⁰ The importance of experience also contrasts with rational choice theory, whose axioms are about being consistent and where experience plays little role.

The second aspect, “appears quickly in one’s consciousness,” provides a first indication of why intuition is indispensable. When fast decision-making is required, people have to act within the constraints of time. In life-and-death situations, deliberating all possible options can be fatal. Similarly, soccer players have to decide in a fraction of a second where to pass the ball. They may occasionally err, but would otherwise always miss opportunities if they deliberated extensively during a game. That limit of thinking too long is well known and time pressure is often considered a regrettable circumstance. However, the scientific study of intuition has revealed a stunning phenomenon: If players had more time to make a decision, their performance would not necessarily improve. Thinking deliberately can actually decrease performance. For an experienced player, intuition is guided by a simple rule:

Fluency heuristic: Choose the first option that comes to mind.

Studies with expert handball and golf players show that options come to mind *in the order of their validity*. That is, the first option is typically the best, the next option second-best, and so on (Figure 1.1). This explains why following one’s first hunch is likely the best decision. If the first option cannot be carried out in the situation at hand, then following the second impulse is probably the best decision. In an experiment, experienced handball players were shown 10-second video sequences from top games. Then the sequences were frozen and the players had to say what option they would take, such as throw at the goal or pass to the right.¹¹ After their immediate and intuitive response, they were given another 45 seconds to deliberately inspect the frozen image and asked once again what they now thought the best option was. In about 40 percent of the cases, the players changed their minds. Yet, more time did not lead to better choices. Most of the time, the first intuitive choice was better than the action chosen after reflection. Similarly, when experienced golfers were given only 3 seconds to make their put, they were more successful in getting the ball into the hole than when given unlimited time.¹² Novices, in contrast, have not yet developed good intuitions and perform better when granted more time. They need deliberation because they lack

¹⁰ See Ericsson et al. (1993); Cokely & Felz (2014).

¹¹ Johnson & Raab (2003).

¹² Beilock et al. (2004).

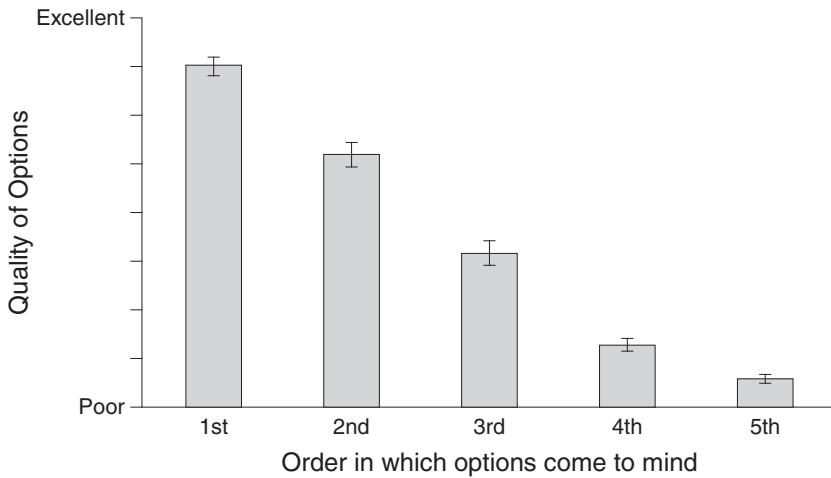


Figure 1.1. Fluency heuristic. For expert players, the quality of options decreases with the order they come to mind (adapted from Johnson & Raab, 2003). Thus, relying on the fluency heuristic enables not only fast but also accurate decisions. Note that this heuristic requires expertise and does not work as well for novices.

experience. The fluency heuristic is one illustration of how intuition is aided by heuristics.

Studies with chess players showed similar results: The first option that came to mind to chess masters (grand masters and international masters) was nearly always the best one.¹³ Moreover, under time pressure, their decisions did not suffer, whereas less experienced chess players then chose inferior moves. The higher the expertise, the more the chess players trust their intuition and the more often they are right in doing so.

Thus, the first two aspects of intuition form a close couple: The more experience in a domain, the more likely that what quickly comes to mind is actually the best option. Note that this finding contradicts the hypothesis of a general speed–accuracy trade-off, where less time leads to less accurate decisions. As we have seen, this trade-off holds for novices, but not necessarily for experts. Fast decisions are not automatically inferior to slow decisions. How then did fast thinking come to be associated with errors and slow thinking with rationality?¹⁴ Psychological experiments mostly

¹³ Medvegy et al. (2022). Forgetting aids the fluency heuristic, see Schooler & Hertwig (2005).

¹⁴ The opposition between fast, intuitive decisions that are prone to error and slow, rational decisions that avoid error is commonly made in dual-system theories, specifically in Kahneman's (2011a) version. Despite the vagueness of these theories, there is little evidence that the attributes of

enlist undergraduates or crowdworkers who have no experience with the task at hand or confront them with artificial tasks they have never seen before. In this situation, the speed–accuracy trade-off does exist. The story of fast, intuitive decisions that are often wrong versus slow, reasoned decisions that are generally better is an overgeneralization based on the study of nonexpert undergraduates.

The third defining feature of intuition is crucial: that the process underlying an intuition is unconscious. To repeat the words of Pascal, “the heart has its reasons of which reason knows nothing.” A skillful player is unaware of the process that generates the first option that comes to their mind. Unconscious processes are not oddities, but essential for cognitive functioning. Conscious attention is a limited resource, which is the reason why multitasking is difficult.¹⁵

If one simultaneously performs two tasks that require deliberate attention, one’s performance on each of the tasks deteriorates.

Human attention can fully focus on one task alone, meaning that multitasking leads to a decrease in performance on the task(s) that demand focus. Our brain’s solution is to perform as many tasks as possible unconsciously. If all of its tasks, including breathing and walking upright, needed to take place consciously, they would interfere with each other. In the words of the Portuguese poet Fernando Pessoa, “Could it think, the heart would stop beating.”¹⁶ Once a process is unconscious, it no longer interferes with attention. Breathing while driving does not interfere with driving safety; texting while driving does.

Nevertheless, the unconscious has not received much appreciation in consciousness-centered philosophy, particularly in the 20th-century analytic tradition. In psychology, the unconscious has similarly met with suspicion. Sigmund Freud’s revelation that our behavior is heavily influenced by unconscious processes has been hailed as the third blow dealt to the human ego – after Copernicus and Kepler demonstrated that the Earth is not the center of the solar system, and Darwin found that humans and animals have common ancestors. Freud’s unconscious processes were discovered when studying hypnosis and hysteria, which he investigated mostly in women. While unconscious influences, as embodied in the term

cognitive processes actually cluster into two poles, but substantial evidence against it (Keren & Schul, 2009; Melnikoff & Bargh, 2018; Rizzo & Whitman, 2020).

¹⁵ Tombu & Jolicoeur (2004). ¹⁶ Pessoa, F. (1996).

Freudian slips, are now common wisdom, accounts of them are mostly negative and refer to unintentional influences that cannot be controlled and should better not happen.

The supposed link between unintentional and unconscious is, however, a misconception. Unconscious processes are typically initiated by intention. For instance, an experienced driver drives intuitively, but intentionally. An experienced scientist may have a sudden hunch while pondering a puzzling finding, but the hunch is motivated by conscious intention. Similarly, when typing, we do not move our fingers consciously, but typing is nevertheless an act of intention. These unconscious, but intentional, processes are the subject of psychological research on the automaticity of higher mental processes.¹⁷ The general lesson is: The fact that much of what we do is unconscious does not mean that it is irrational or unintentional. Unconsciousness is a necessary condition for a rational being.

Fear of Admitting Gut Decisions

Not being able to explain one's intuitions has led philosophers and psychologists to mistrust intuitive decisions. Those who cannot explain their actions are subject to suspicion. Mistrust of intuition fuels a culture of post hoc justification, motivated by fear of liability. In large corporations and administrations, justification and self-protection have become the primary motive in place of achievement. In this world, intuition is not talked about openly, but relied on surreptitiously.

In a series of studies, I asked hundreds of executives from half a dozen international corporations how often an important professional decision they made or participated in was ultimately a gut decision (their term for intuition). That is, if the available data did not provide a clear answer, which often happens in the uncertain world of business, how frequently did they rely on their intuitions? On average, the answer was for 50 percent of important decisions.¹⁸

Yet, the majority of the same executives would never admit to this practice in public. Many executives were unwilling to take personal responsibility for their decisions. They feared making errors and being blamed if they were unable to explain an intuitive decision.

¹⁷ Bargh & Morsella (2008).

¹⁸ Artinger et al. (2019); Gigerenzer (2014a).

The Business of Justifying Decisions Post Hoc

I have observed two ways in which managers cope with this anxiety. The first is to hire a consulting firm to justify the intuitive decision after the fact. Curious about how often this happens, I asked the principal of one of the largest consulting firms worldwide what proportion of their customer contacts involved justifying decisions post hoc. On the condition of anonymity, he disclosed that it was more than 50 percent. That gives a rough idea of the time, resources, and intelligence spent on concealing intuitive decisions and avoiding responsibility. In these cases, the function of reasoning and argumentation is to rationalize intuitive decisions and to hide them from view.

A second strategy is even more expensive for the companies: defensive decision-making. It occurs when a manager feels that option A is the best for the company, yet nevertheless recommends and pursues a second-best option B that is less risky for their own career if something goes awry. In my studies with managers from large corporations, the majority admitted to such practices for an average of 30–40 percent of all their important professional decisions.¹⁹

Both strategies to camouflage intuitive decisions – hiring consulting firms or choosing second-best decisions – are costly. For every 1 percent loss in corporate income due to defensive decisions, a rough estimate is that, in highly industrialized countries such as Germany, large corporations lose billions of dollars each year.²⁰ In family-owned businesses, by contrast, there is much less fear of admitting to following one's intuition; after all, it is their own money that is at stake, and most plan a generation ahead rather than up to the next quarterly report. If there is skin in the game, good intuitions are welcome. Wasting one's own money to cover these up would be a poor business strategy. Independent of whether leaders admit or deny gut decisions, both the analysis of data and intuition are required. Intuition and reasoning work with, not against, each other.

Reasoning and Intuition: Two Sides of the Same Coin

Intuition is based on experience. There are two ways in which experience is gathered: by *implicit* or *explicit learning*.²¹ In implicit learning, also called

¹⁹ Gigerenzer (2014a). ²⁰ Artinger et al. (2019).

²¹ Reber (1989) identified intuitive thought as the product of implicit learning. Yet, intuition can also be the product of explicit learning.

incidental learning, a person is not aware of the process (such as a heuristic or a grammar) underlying an intuition. The learning of one's first language proceeds in this way without being aware of the rules of grammar underlying one's speech. Second languages, in contrast, are typically taught by making the rules of grammar (and their exceptions) explicit. Similarly, in order to catch a fly ball, baseball outfielders rely on the gaze heuristic without being fully aware of it (see Chapter 6). Yet, ever since research figured out the heuristic process, it can be explicitly taught to novices. The important point is that the *same* heuristic rules, such as those of grammar and of catching a ball, underlie both intuition and deliberate reasoning.

Intuition can also start out as deliberate reasoning, that is, by explicit learning. Tying shoelaces is learned consciously, as a sequence of movements, but, with experience, it becomes unconscious. Once this state is achieved, the process works fast and flawlessly. At that point, consciously thinking about the sequence of movements can actually disrupt one's ability to tie the laces. Similarly, a difficult piece on the piano is learned consciously by paying attention to the right sequence and timing of fingers, but true music starts when piano players are no longer conscious of what their fingers are doing. Many skills have passed through this trajectory from deliberate to intuitive. Alfred Whitehead, the English mathematician who coauthored the *Principia Mathematica* with Bertrand Russell, emphasized this trajectory to counter the axiom that deliberate thinking is all that matters:²²

It is a profoundly erroneous truism, repeated by all copy-books and by eminent people when they are making speeches, that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of operations which we can perform without thinking about them.

Contrast Whitehead's statement with the belief that free will denotes always consciously deciding before acting. In the widely discussed experiments by the American neuroscientist Benjamin Libet, for instance, a change in participants' electroencephalogram (EEG) signals occurred before the participants actually reported their decision to act (a simple motor action).²³ The conscious decision thus did not appear to cause the action, a finding that has been interpreted by others as proof that free will is illusory. Yet that conclusion assumes volition and intention to be unremittingly conscious, and it overlooks the fact that intuitive processes

²² Cited in Egidi & Marengo (2004), p. 335. ²³ Libet (2004).

guide many of our decisions. Our unconscious is every bit part of our identity. We would get nowhere by deliberating all day long, leaving our body to wait patiently for orders.

Einstein's concern that we have forgotten the gift of intuition is as timely today as it was then. And the campaign against intuition has a history.

The War on Intuition

Even into the 20th century, prominent psychologists were convinced that men are rational and women intuitive and that only men could master abstract thought. It was asserted as a scientific fact that women's concrete and intuitive thinking prevented them from grasping abstract moral principles, going so far as to claim that women who lied were simply incapable of comprehending that their actions were evil. According to this line of reasoning, women needed men's guidance and should be kept out of politics, economics, and other important decision-making domains. In Chapter 2, I tell the story of this peculiar idea of women's intuitive intelligence and how the opposition of female intuition and male reason faded away due to the emerging concept of a single intelligence shared by both sexes. Women and men were eventually deemed equal partners, but intuition and rationality were kept unequal.

In spite of these changes, women continue to be associated with intuition today. For instance, when asked whether women recognize emotions better than men, women and men responded in the affirmative, a result also consistently obtained in self-report questionnaires on emotional intelligence. However, when actually testing people's abilities, studies did not find a difference for strong expressions of emotions; for emotional expressions of lower intensity, the results are inconsistent.²⁴ In one study, 5,000 participants were shown 24 faces with emotional expressions, either at a high or low intensity, and were asked to rate these on each of six emotions: anger, disgust, fear, happiness, sadness, and surprise. Both genders rated the target emotions equally correctly, regardless of whether the expression was intensive or subtle. There was no evidence that women have better intuitions than men about others' emotional expressions.²⁵

Beginning in the 1970s, a group of psychologists and behavioral economists began a new war on intuition, pitting it once again against rationality. This time, the target of attack extended beyond female intuition to

²⁴ Hoffmann et al. (2010); Montagne et al. (2005). ²⁵ Fischer et al. (2018).

include everyone's intuition. The key message, spread by bestselling books such as Ariely's *Predictably Irrational* (2008), Kahneman's *Thinking, Fast and Slow*, (2011a), or Thaler and Sunstein's *Nudge* (2008), is that only the abstract logic of rational choice theory is worthy of trust. Just as female intuition had been opposed to male reason, two antagonistic systems were posited, one fast, intuitive, inconsistent, and often wrong, and the other slow, rational, and apparently always right. Humans err if the rational "System 2" does not pay sufficient attention and fails to correct what the intuitive "System 1" gets wrong. The similarity of this new opposition with that of female intuition versus male reason may not be entirely coincidental. It is based on a philosophical and psychological tradition that differs strongly from the angelic view of intuition. From the 19th century to the first half of the 20th century, it was not uncommon that psychologists contrasted what they believed to be the intuitive, primitive, and fast judgments of children, women, and the mentally retarded, with the slower and more deliberate rational judgments of male adults.²⁶ In the more current view, everyone's intuition is riddled by dozens of cognitive biases, many of which have become household words.

The new target is a specific kind of intuition, namely, understanding chance and randomness, at which humans are claimed to be miserably incompetent. This dismal picture, however, is surprising. Prior to the 1970s, two decades of psychological research concurred that human intuition about chance and randomness is fairly accurate – at least by age 12 or so, as Swiss psychologists Jean Piaget and Bärbel Inhelder were the first to conclude in 1951. Why did people show fairly good intuitions about chance before the 1970s and shoddy ones thereafter? The 1970s brought the Watergate scandal, the end of the Vietnam War, and the death of Elvis Presley. But how would such events explain a decline in our intuition?

Weapons of Destruction

I argue that there was no such decline in intuition in the first place. Rather, three measures were taken to make human intuition look wanting. For one, quite a few researchers bore a "bias bias," that is, a tendency to spot cognitive biases even when there were none. This led them to mistake what were, in fact, people's intelligent intuitions for persistent irrationality. Second, studies demonstrating biases introduced a new kind of classroom and online experiment that produces data in a few minutes and does not

²⁶ For an overview, see Osbeck & Held (2014).

allow participants to learn from experience. Pre-1970s psychological experiments, by contrast, gave participants the opportunity to learn. When people can learn from experience, their intuitions about chance, randomness, and risk are not perfect, but fairly good. It was only recently understood that this change in experimental practice was one of the factors that made intuitions suddenly appear to be infected with biases.²⁷ Strikingly few people are even aware of research unveiling the marvels of intuition. This blind spot is fueled by a third measure, a conspicuous citation bias: Studies reporting good intuitions are rarely mentioned and cited, whereas those reporting biases are highly popularized.²⁸ The bias bias and the lack of learning opportunities were crucial in producing the new negative view of intuition, and the massive citation bias, now and then, makes the untrustworthiness of intuition appear to be a hard, scientific fact.

These three weapons in the war against intuition have created a distorted picture of intuition and reinforced the misleading idea that intuition is hostile to reason. This war, eventually called the *great rationality debate*, or *rationality war*,²⁹ spilled over into politics. If ordinary people's intuitions are riddled with biases, citizens cannot make appropriate decisions by themselves and therefore need steady guidance by experts and governments. Governments, so the argument continues, know better what their citizens really want and should nudge them along that path.³⁰ This new paternalism is reminiscent of the male paternalism of the past, where women were seen as irrational and in need of male guidance. Now the verdict is on people's intuition across the board, and governments have a scientific blueprint to nudge their citizens into "proper" behavior. Once again, intuition has been discredited in the name of science.

The Bias Bias in the Service of Governmental Paternalism and Reckless Companies

Male paternalism is, of course, not the same as governmental paternalism, even if both have been justified by attacking intuition. Yet there are striking parallels. Female intuition had been linked to moral flaws, while

²⁷ Lejarraga & Hertwig (2021).

²⁸ See Christensen-Szalanski & Beach (1984); Lejarraga & Hertwig (2021); and Chapter 3 of this volume.

²⁹ Gigerenzer (1996); Kahneman & Tversky (1996); Tetlock & Mellers (2002); Stanovich et al. (2011); Sturm (2012).

³⁰ Thaler & Sunstein (2003, 2008).

in the 21st century, intuition was linked to individual moral weaknesses and considered the cause of individual wrongdoings such as failure to take care of one's health, to use condoms as protection from AIDS, and to save money for the future. Moreover, intuition was increasingly seen to be at the root of social problems, causing more than individual damage. Obesity was suspected to result from a "present bias" (overweighting the present moment), addictive gambling from wrong statistical intuitions, and the financial crisis of 2008 from traders' overconfidence bias. Once again, governments were called to step in and nudge their citizens in order to protect them – not from criminals, but from themselves. As we will see, these brash claims were rarely based on independent evidence. In fact, when my colleagues and I reviewed over a thousand studies, we found little reliable evidence that so-called biases of intuition are associated with loss of wealth, health, happiness, or any other measurable costs.³¹ Yet, blaming intuition for society's ills has become a story too powerful to be disturbed by facts.

Attributing obesity or financial crises to a failure of the brain's rational part to prevent its intuitive part from irrational action amounts to a one-sided, individualistic view of responsibility. This internal narrative deflects attention from some of the real culprits in the external world. The food industry earns billions from advertising and selling unhealthy food, the gambling industry has deliberately designed personalized slot machines to make people addicted, and legal systems allow bankers to profit from taking undue risks and letting taxpayers pick up the bill.³² In this way, the war against intuition can serve quite a few parties' interests. For instance, the House of Lords criticized the UK government under former prime minister David Cameron for nudging citizens to avoid obesity instead of considering more efficient solutions such as prohibiting the television advertising of products high in sugar, salt, and fat.³³

Focusing on systematic errors made by human intuition is also of interest for companies that severely pollute the environment, as the 1989 Exxon Valdez oil spill in Alaska illustrates. In 1994, an Alaskan federal jury awarded \$5.3 billion to fishermen and others whose livelihoods had been devastated by the spill. When Exxon waged its appeal, a new line of research emerged that used studies with mock juries to question jurors'

³¹ Arkes et al. (2016).

³² On the design of addictive slot machines, see Schüll (2012); on the reckless practices of banks, see Admati & Hellwig (2013).

³³ House of Lords (2011).

intuitions. Without mentioning that it had funded the research, Exxon argued “that jurors are generally incapable of performing the tasks the law assigns to them in punitive damage cases.”³⁴ The results served Exxon well in court. This new line of research on jurors’ intuitions eventually became part of a new field known as *behavioral law and economics*. Its key program is to show how intuition fails in legal contexts.

By no means do I defend intuition for its own sake. A “war on reason” would be equally dangerous. The scientific method has struggled for centuries to promote fact over opinion and encourage people to look at the evidence rather than to defend their favored theories. Today, we witness new versions of this long-standing struggle, amplified by the rapid dissemination of fake news by social media. The international Programme for International Student Assessment (PISA) study reported that over 90 percent of 15-year-olds worldwide do not know how to distinguish facts from mere opinion or fake news.³⁵ Even worse, many do not seem to be motivated to do so in the first place. Social scientists and philosophers themselves struggle to respect the evidence if it does not validate their theories, as the accounts of female intuition versus male reason and of the bias bias illustrate.

This struggle has a long history. In the early 17th century, disputes among scholars grew so fierce and insults so intolerable that the Royal Society of London prevented scholars from publishing their pet theories and focused on oddities of nature instead. For about half a century, the annals were filled with striking observations for which no theories existed, such as double-headed calves, blood rain in Bavaria, and cold light. Francis Bacon, one of the spearheads of the movement, complained that observations are too often contaminated with arbitrary dogmas.³⁶ Looking at strange facts helped to reduce the avalanche of personal insults.

Common Sense, Freedom, and Dignity

The war on intuition, be it on female’s or everyone’s intuition, intersects with the struggle for freedom and dignity of a group of people and the effort of others to control them. Thomas Paine’s *Common Sense*, written in 1776 against the rule of authority – about the then king of Great Britain and his injustices to American colonists – exemplifies the ideal that people should be free and trust their own senses to rule themselves. *Common Sense*

³⁴ Zarembo (2003).

³⁵ OECD (2019).

³⁶ Daston & Park (1998).

swept through the colonies like a firestorm, selling half a million copies and fueling the American War of Independence.

Today, digital technology is being misused to convince people that they should submit to a new rule of authority, technological paternalism. We are told that Google knows us better than we ourselves do and that we would be better off following the recommendations of algorithms rather than our own intuition. Underlying technological paternalism is the idea that algorithms will soon outperform human intelligence in all respects, if they have not done so already, and it is thus only prudent to stop making decisions on our own and defer to AI. In this view, AI is seen not as a complement to human intuition, but as an authoritative superintelligence that is immune to the errors we make. Yet, the evidence to back such technological paternalism is as scarce as for the claim that women are intuitive and men rational.³⁷ What drives this narrative is marketing hype and techno-religious faith. Statistical machines such as deep artificial neural networks are excellent for some tasks, but incorporating intuition and common sense into AI remains an enormous challenge.

Toward a Science of Intuition

To develop a scientific perspective on intuition, we first need to dispense with the old and misleading dualistic opposition of intuition and reason that has survived in many psychological theories. Instead, intuition and reason go hand in hand: In the case of the doctor who feels that something is wrong with a patient, intuition comes first, followed by a deliberate search for what is wrong. Even in abstract disciplines such as mathematics, both intuition and reasoning are needed. As George Pólya emphasized, finding a problem or discovering a proof requires intuition and heuristics; checking whether the proof is correct requires logic and analysis.³⁸

Accordingly, psychological studies do not support the polarization of intuition and reason. If intuition and analysis were exclusive poles, their use would be negatively correlated (either the one or the other). An evaluation of 75 studies, however, showed that intuition and analysis were uncorrelated.³⁹ Nor is the alignment of intuition with heuristics and biases in popular dual-systems theories supported by evidence. Every heuristic

³⁷ Gigerenzer (2022a).

³⁸ Pólya (1945/1988). See also Mercier & Sperber (2011) on the close relation, not opposition, between intuition and deliberate argumentation.

³⁹ Wang et al. (2017).

can be used both intuitively (unconsciously) and consciously; intuition can lead to errors, but so can deliberate reasoning, logical argument, and big data.⁴⁰ Although the dichotomies in dual systems are quite vague, it is easy to see that they do not even align. Rather, they reflect the centuries-old view that pits reason against intuition, with reason as the dominant force. Instead of simply positing value-laden polar opposites, it is more fruitful to empirically study the nature of intuition and its relation to reason.

To get there, we also need to dispose of the bias bias, that is, the preoccupation with showing that people's intuition is flawed, even when evidence of that is scarce or nonexistent. For instance, at the beginning of the Covid-19 pandemic, *Bloomberg* published an article entitled "The Cognitive Bias That Makes Us Panic About Coronavirus." The author confidently asserted that "most people in North America and Europe do not need to worry much about the risk of contracting the disease" and are "more scared than they have any reason to be."⁴¹ People's fear of getting infected was attributed to a bias of intuition, *probability neglect*. This means that people *overestimate* the danger because they fixate their attention solely on the potentially severe consequences of Covid-19 and neglect the low probability of these actually happening. At that time, however, nobody could know whether the probability was low or high, or how the pandemic would develop. When, during the following months, hundreds of thousands of people became infected with the virus and died, it became clear that people's intuitions were not so wrong. Other fighters in the war against intuition now blamed people for *underestimating* how quickly the virus spreads. People were said to suffer from an *exponential growth bias*, that is, a flawed understanding of the virus's exponential growth.⁴² Many people have never been taught exponential functions and, thus, may indeed have difficulties in understanding them, but that is not the point. As it turned out, the spread of the virus was not exponentially increasing, but instead came in waves, growing and fading. The Covid-19 pandemic was a situation of uncertainty, not calculable risk, where no one could know the ever-changing probabilities and ups and downs, which left both experts at the World Health Organization (WHO) and ordinary people in the dark.⁴³

⁴⁰ Gigerenzer et al. (2011); Kruglanski & Gigerenzer (2011). ⁴¹ Sunstein (2020).

⁴² Understanding exponential growth does indeed appear to be a problem, both for researchers and their subjects. Hamann (2022) shows the lack of understanding of exponential growth among the authors (not only the participants) of a classic experiment on the perception of exponential growth.

⁴³ Many physicians had originally hoped that the virus's harm would be comparable to that of the swine flu, which governments had overestimated. For instance, the British government announced

Thus, there are two indispensable preconditions for a mature science of intuition. First, one needs to eliminate the opposition between intuition and reason, both of which are needed for human intelligence. Second, one needs to eliminate the bias bias. Only by taking both intuition and reasoning seriously can we find out how they work, how they relate to each other, and when they each err.

What Follows

Part I of this book deals with the widespread mistrust of intuition. It begins with the opposition of female intuition versus male reason in the context of ideas about female intelligence. This chapter not only presents the history of the idea of a peculiarly female intelligence but also provides a larger context for the struggle to understand the mystery of intelligence and for the historical bias against women masked as science. It shows how the polarity eventually became resolved, even though beliefs in male superiority have not yet been fully extinguished. However, the opposition between intuition and reason has survived in present-day dual-systems theories of reasoning, which wage a new war against intuition. I make the case that there is little evidence for this opposition, even after it was cleansed of its problematic association with gender. The last chapter in Part I shows, in more depth, how the war against intuition has not only fueled male paternalism but also governmental and technological paternalism.

In Part II, I address the question of the nature of intuition. I argue that intuition is guided by the unconscious use of adaptive heuristics. These heuristics are ecologically rational and can lead to better decisions with little to no deliberate thinking. The fluency heuristic is an example. Heuristics can be embodied, that is, enlist motor and perceptual abilities without awareness. I also show how professional intuitions can be explicated by models of heuristics, such as the heuristics that Elon Musk and Jeff Bezos have used for hiring. The final chapter looks at the social world of science: How can one establish and maintain an environment that fosters successful collaboration in a research group? Using my 20 years of experience in directing a research group at the Max Planck Institute for Human Development in Berlin as a case study, I illustrate how heuristics shape the intellectual and social climate of research and how they influence

that as many as 65,000 citizens might die from swine flu, while, in the end, fewer than 500 had died. But there was no way to know where and how fast the new virus would spread.

whether a group culture can become more or less open, more or less formal, and more or less inclusive.

The important point is that intuition and adaptive heuristics can deal with situations of uncertainty (where we cannot know all possible future states and their consequences), with situations of intractability (where no computer can find the best solution), and with incommensurability (where there is no common currency). Rational choice theory cannot deal with these situations and is forced to reduce uncertainty to risk (where one knows everything that can happen in the future), to ignore intractability, and to exclude all problems where a dollar value cannot be attached to each option.