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Avoid Illusions of Knowing

AT THE ROOT of our effectiveness is our ability to grasp the world around us and to take the measure of our own performance. We're constantly making judgments about what we know and don't know and whether we're capable of handling a task or solving a problem. As we work at something, we keep an eye on ourselves, adjusting our thinking or actions as we progress.

Monitoring your own thinking is what psychologists call metacognition (*meta* is Greek for "about"). Learning to be accurate self-observers helps us to stay out of blind alleys, make good decisions, and reflect on how we might do better next time. An important part of this skill is being sensitive to the ways we can delude ourselves. One problem with poor judgment is that we usually don't know when we've got it. Another problem is the sheer scope of the ways our judgment can be led astray.[1]

In this chapter we discuss perceptual illusions, cognitive biases, and distortions of memory that commonly mislead people. Then we suggest techniques for keeping your judgment squared with reality.

The consequences of poor judgment fill the daily papers. During the summer of 2008, three stickup artists in Minneapolis had a system going of phoning in large fast-food orders and then relieving the delivery man of all the goods and cash he carried. As a livelihood it was a model of simplicity. They kept at it, failing to consider the wisdom of always placing their orders from the same two cell phones and taking delivery at the same two addresses.

David Garman, a Minneapolis cop, was working undercover that summer. "It was getting more aggressive. At the beginning, it was 'maybe they had a gun,' then all of a sudden there were a couple of guns, and then they were hurting the people when they were robbing them."

It was a night in August when Garman got a call about a large order phoned in to a Chinese restaurant. He organized a small team on short notice and prepared to pose as the delivery guy. He pulled on a bulletproof vest, covered it with a casual shirt, and shoved his .45 automatic into his pants. While his colleagues staked out positions near the delivery address, Garman picked up the food, drove there, and parked with his brights shining on the front door. He'd cut a slit in the bottom of the food bag and tucked a .38 inside to rest in his hand as he carried the package. "The .38 has a covered hammer on it, so I can shoot it in a bag. If I were to put the automatic in there, it'd jam and I'd be screwed."

> So I walk up with the package and I say, "Hey, sir, did you order some food?" He says, "Yup," and I'm thinking this guy's really just going to pay me and I'm going to be out of here,

> and this is going to be the dumbest thing we've ever done. I'm thinking if he hands me $40, I don't even know how much this food is. But he turns his head to look halfway back and two other guys start to come up, and as they're walking towards me they flip hoods over their heads. That's when I know it's game time. The first guy whips a gun out of his pocket and racks it and puts it to my head all in one motion, saying, "Give me everything you've got motherfucker or I'll kill you." I ended up shooting him through the bag. It was four rounds.[2]

Not such a great livelihood after all. The guy was hit low and survived, although he is a lesser man as a result. Garman would have aimed higher if the food package hadn't been so heavy, and he took a lesson from the experience: he's better prepared for the next time, though he'd rather we didn't describe just how.

We like to think we're smarter than the average doodle, and even if we're not, we feel affirmed in this delusion each year when the newest crop of Darwin Awards circulates by email, that short list of self-inflicted fatalities caused by spectacularly poor judgment, as in the case of the attorney in Toronto who was demonstrating the strength of the windows in his twenty-two-story office tower by throwing his shoulder against the glass when he broke it and fell through. The truth is that we're all hardwired to make errors in judgment. Good judgment is a skill one must acquire, becoming an astute observer of one's own thinking and performance. We start at a disadvantage for several reasons. One is that when we're incompetent, we tend to overestimate our competence and see little reason to change. Another is that, as humans, we are readily misled by illusions, cognitive biases, and the stories we construct to explain the world around us and our place within

it. To become more competent, or even expert, we must learn to recognize competence when we see it in others, become more accurate judges of what we ourselves know and don't know, adopt learning strategies that get results, and find objective ways to track our progress.

Two Systems of Knowing

In his book *Thinking, Fast and Slow,* Daniel Kahneman describes our two analytic systems. What he calls System 1 (or the automatic system) is unconscious, intuitive, and immediate. It draws on our senses and memories to size up a situation in the blink of an eye. It's the running back dodging tackles in his dash for the end zone. It's the Minneapolis cop, walking up to a driver he's pulled over on a chilly day, taking evasive action even before he's fully aware that his eye has seen a bead of sweat run down the driver's temple.

System 2 (the controlled system) is our slower process of conscious analysis and reasoning. It's the part of thinking that considers choices, makes decisions, and exerts self-control. We also use it to train System 1 to recognize and respond to particular situations that demand reflexive action. The running back is using System 2 when he walks through the moves in his playbook. The cop is using it when he practices taking a gun from a shooter. The neurosurgeon is using it when he rehearses his repair of the torn sinus.

System 1 is automatic and deeply influential, but it is susceptible to illusion, and you depend on System 2 to help you manage yourself: by checking your impulses, planning ahead, identifying choices, thinking through their implications, and staying in charge of your actions. When a guy in a restaurant walks past a mother with an infant and the infant cries out "Dada!" that's System 1. When the blushing mother says,

"No, dear, that's not Dada, that's a *man*," she is acting as a surrogate System 2, helping the infant refine her System 1.

System 1 is powerful because it draws on our accumulated years of experience and our deep emotions. System 1 gives us the survival reflex in moments of danger, and the astonishing deftness earned through thousands of hours of deliberate practice in a chosen field of expertise. In the interplay between Systems 1 and 2—the topic of Malcolm Gladwell's book *Blink*—your instantaneous ability to size up a situation plays against your capacity for skepticism and thoughtful analysis. Of course, when System 1's conclusions arise out of misperception or illusion, they can steer you into trouble. Learning when to trust your intuition and when to question it is a big part of how you improve your competence in the world at large and in any field where you want to be expert. It's not just the dullards who fall victim. We all do, to varying degrees. Pilots, for example, are susceptible to a host of perceptual illusions. They are trained to beware of them and to use their instruments to know that they're getting things right.

A frightening example with a happy ending is China Airlines Flight 006 on a winter day in 1985. The Boeing 747 was 41,000 feet above the Pacific, almost ten hours into its eleven-hour flight from Taipei to LA, when engine number 4 lost power. The plane began to lose airspeed. Rather than taking manual control and descending below 30,000 feet to restart the engine, as prescribed in the flight book, the crew held at 41,000 with the autopilot engaged and attempted a restart. Meanwhile, loss of the outboard engine gave the plane asymmetrical thrust. The autopilot tried to correct for this and keep the plane level, but as the plane continued to slow it also began to roll to the right. The captain was aware of the

deceleration, but not the extent to which the plane had entered a right bank; his System 1 clue would have been his vestibular reflex—how the inner ear senses balance and spatial orientation—but because of the plane's trajectory, he had the sensation of flying level. His System 2 clues would have been a glimpse at the horizon and his instruments. Correct procedure called for applying left rudder to help raise the right wing, but his System 2 focus was on the airspeed indicator and on the efforts of the first officer and engineer to restart the engine.

As its bank increased, the plane descended through 37,000 feet into high clouds, which obscured the horizon. The captain switched off the autopilot and pushed the nose down to get more speed, but the plane had already rolled beyond 45 degrees and now turned upside down and fell into an uncontrolled descent. The crew were confused by the situation. They understood the plane was behaving erratically but were unaware they had overturned and were in a dive. They could no longer discern thrust from engines 1–3 and concluded those engines had quit as well. The plane's dive was evident from their flight gauges, but the angle was so unlikely the crew decided the gauges had failed. At 11,000 feet they broke through the clouds, astonished to see that they were roaring toward earth. The captain and first officer both pulled back hard on the stick, exerting enormous forces on the plane but managing to level off. Landing gear hung from the plane's belly, and they'd lost one of their hydraulic systems, but all four engines came to life, and the captain was able to fly on, diverting successfully to San Francisco. An inspection revealed just how severe their maneuver had been. Strains five times the force of gravity had bent the plane's wings permanently upward, broken two landing gear struts, and torn away two landing gear doors and large parts of the rear horizontal stabilizers.

"Spatial disorientation" is the aeronautical term for a deadly combination of two elements: losing sight of the horizon and relying on human sensory perception that doesn't jibe with reality but is so convincing that pilots conclude their cockpit instruments have failed. As Kahneman says, System 1, the instinctual, reflexive system that detects danger and keeps us safe, can be very hard to overrule. Flight 006's initial incident, the loss of an engine cruising at altitude, is not considered an emergency, but it quickly became one as a result of the captain's actions. Rather than following prescribed procedure, and rather than fully engaging his System 2 analytic resources by monitoring all his instruments, he let himself become preoccupied with the engine restart and with a single flight indicator, airspeed. Then, when things spiraled out of control, he trusted his senses over his gauges, in effect trying to construct his own narrative of what was happening to the plane.

There's a long list of illusions to which pilots can fall prey (some with mordant names like "the leans," "graveyard spin," and "the black hole approach") and sites on the Internet where you can listen to the chilling last words of pilots struggling and failing to understand and correct what's gone wrong in the sky. Spatial disorientation was deemed the probable cause of the crash that killed Mel Carnahan, the governor of Missouri, while being flown through a thunderstorm one night in October 2000, and the probable cause of the crash that killed John F. Kennedy Jr. and his wife and her sister off the shore of Martha's Vineyard on a hazy night in July 1999. Fortunately, the China Airlines incident came to a good end, but the National Transportation Safety Board report of that incident reveals just how quickly training and professionalism can be hijacked by System 1 illusion, and therefore why we need to

cultivate a disciplined System 2, conscious analysis and reasoning, that always keeps one eye on the flight instruments.[3]

Illusions and Memory Distortions

The filmmaker Errol Morris, in a series of articles on illusion in the *New York Times,* quotes the social psychologist David Dunning on humans' penchant for "motivated reasoning," or, as Dunning put it, the "sheer genius people have at convincing themselves of congenial conclusions while denying the truth of inconvenient ones."[4] (The British prime minister Benjamin Disraeli once said of a political opponent that his conscience was not his guide but his accomplice.) There are many ways that our System 1 and System 2 judgments can be led astray: perceptual illusions like those experienced by pilots, faulty narrative, distortions of memory, failure to recognize when a new kind of problem requires a new kind of solution, and a variety of cognitive biases to which we're prone. We describe a number of these hazards here, and then we offer measures you can take, akin to scanning the cockpit instruments, to help keep your thinking aligned with reality.

Our understanding of the world is shaped by a *hunger for narrative* that rises out of our discomfort with ambiguity and arbitrary events. When surprising things happen, we search for an explanation. The urge to resolve ambiguity can be surprisingly potent, even when the subject is inconsequential. In a study where participants thought they were being measured for reading comprehension and their ability to solve anagrams, they were exposed to the distraction of a background phone conversation. Some heard only one side of a conversation,

and others heard both sides. The participants, not knowing that the distraction itself was the subject of the study, tried to ignore what they were hearing so as to stay focused on the reading and anagram solutions. The results showed that overhearing one side of a conversation proved more distracting than overhearing both sides, and the content of those partial conversations was better recalled later by the unintentional eavesdroppers. Why was this? Presumably, those overhearing half a conversation were strongly compelled to try to infer the missing half in a way that made for a complete narrative. As the authors point out, the study may help explain why we find one-sided cell phone conversations in public spaces so intrusive, but it also reveals the ineluctable way we are drawn to imbue the events around us with rational explanations.

The discomfort with ambiguity and arbitrariness is equally powerful, or more so, in our need for a rational understanding of our own lives. We strive to fit the events of our lives into a cohesive story that accounts for our circumstances, the things that befall us, and the choices we make. Each of us has a different narrative that has many threads woven into it from our shared culture and experience of being human, as well as many distinct threads that explain the singular events of one's personal past. All these experiences influence what comes to mind in a current situation and the narrative through which you make sense of it: Why nobody in my family attended college until me. Why my father never made a fortune in business. Why I'd never want to work in a corporation, or, maybe, Why I would never want to work for myself. We gravitate to the narratives that best explain our emotions. In this way, narrative and memory become one. The memories we organize meaningfully become those that are better remembered. Narrative provides not only meaning but also a

mental framework for imbuing future experiences and information with meaning, in effect shaping new memories to fit our established constructs of the world and ourselves. No reader, when asked to account for the choices made under pressure by a novel's protagonist, can keep her own life experience from shading her explanation of what must have been going on in the character's interior world. The success of a magician or politician, like that of a novelist, relies on the seductive powers of narrative and on the audience's willing suspension of disbelief. Nowhere is this more evident than in the national political debate, where like-minded people gather online, at community meetings, and in the media to find common purpose and expand the story they feel best explains their sense of how the world works and how humans and politicians should behave.

You can see how quickly personal narrative is invoked to explain emotions when you read an article online whose author has argued a position on almost any subject—for example, an op-ed piece supporting the use of testing as a powerful tool for learning. Scan the comments posted by readers: some sing hallelujah while others can scarcely contain their umbrage, each invoking a personal story that supports or refutes the column's main argument. The psychologists Larry Jacoby, Bob Bjork, and Colleen Kelley, summing up studies on illusions of comprehension, competence, and remembering, write that it is nearly impossible to avoid basing one's judgments on subjective experience. Humans do not give greater credence to an objective record of a past event than to their subjective remembering of it, and we are surprisingly insensitive to the ways our particular construals of a situation are unique to ourselves. Thus the narrative of memory becomes central to our intuitions regarding the judgments we make and the actions we take.[5]

It is a confounding paradox, then, that the changeable nature of our memory not only can skew our perceptions but also is essential to our ability to learn. As will be familiar to you by now, every time we call up a memory, we make the mind's routes to that memory stronger, and this capacity to strengthen, expand, and modify memory is central to how we deepen our learning and broaden the connections to what we know and what we can do. Memory has some similarities to a Google search algorithm, in the sense that the more you connect what you learn to what you already know, and the more associations you make to a memory (for example, linking it with a visual image, a place, or a larger story), then the more mental cues you have through which to find and retrieve the memory again later. This capacity expands our agency: our ability to take action and be effective in the world. At the same time, because memory is a shape-shifter, reconciling the competing demands of emotion, suggestions, and narrative, it serves you well to stay open to the fallibility of your certainties: even your most cherished memories may not represent events in the exact way they occurred.

Memory can be distorted in many ways. People interpret a story in light of their world knowledge, imposing order where none had been present so as to make a more logical story. Memory is a reconstruction. We cannot remember every aspect of an event, so we remember those elements that have greatest emotional significance for us, and we fill in the gaps with details of our own that are consistent with our narrative but may be wrong.

People remember things that were implied but not specifically stated. The literature is full of examples. In one, many people who read a paragraph about a troubled girl named Helen Keller later mistakenly recalled the phrase "deaf, dumb, and blind" as being in the text. This mistake was rarely made

by another group who read the same paragraph about a girl named Carol Harris.[6]

Imagination inflation refers to the tendency of people who, when asked to imagine an event vividly, will sometimes begin to believe, when asked about it later, that the event actually occurred. Adults who were asked "Did you ever break a window with your hand?" were more likely on a later life inventory to report that they believed this event occurred during their lifetimes. It seems that asking the question led them to imagine the event, and the act of having imagined it had the effect, later, of making them more likely to think it had occurred (relative to another group who answered the question without having previously imagined it occurring).

Hypothetical events that are imagined vividly can seat themselves in the mind as firmly as memories of actual events. For instance, when it is suspected that a child is being sexually abused and he is interviewed and questioned about it, he may imagine experiences that the interviewer describes and then later come to "remember" them as having occurred.[7] (Sadly, of course, many memories of childhood sexual abuse are absolutely true, usually ones reported soon after the occurrence.)

Another type of memory illusion is one caused by *suggestion*, which may arise simply in the way a question is asked. In one example, people watched a video of a car running a stop sign at an intersection and colliding with another car passing through. Those who were later asked to judge the speed of the vehicles when they "contacted" each other gave an average estimate of thirty-two miles per hour. Those who were asked to judge the speed when the two vehicles "smashed" into each

other estimated on average forty-one miles per hour. If the speed limit was thirty miles per hour, asking the question the second way rather than the first could lead to the driver's being charged with speeding. Of course, the legal system knows the danger of witnesses being asked "leading questions" (ones that encourage a particular answer), but such questions are difficult to avoid completely, because suggestibility can be very subtle. After all, in the case just discussed, the two cars did "smash together."[8]

Some witnesses to crimes who are struggling to recall them are instructed to let their minds roam freely, to generate whatever comes to mind, even if it is a guess. However, the act of guessing about possible events causes people to provide their own misinformation, which, if left uncorrected, they may later come to retrieve as memories. That is one reason why people who have been interviewed after being hypnotized are barred from testifying in court in almost all states and Canadian provinces. The hypnotic interview typically encourages people to let their thoughts roam freely and produce everything that comes to mind, in hopes that they will retrieve information that would not otherwise be produced. However, this process causes them to produce much erroneous information, and studies have shown that when they are tested later, under instructions only to tell exactly what they remember of the actual events, their guesses made while under hypnosis cloud their memories about what truly happened. In particular, they remember events they produced under hypnosis as actual experiences, even under conditions (in the laboratory) when it is known that the events in question did not occur.[9]

Interference from other events can distort memory. Suppose the police interview a witness shortly after a crime, showing

pictures of possible suspects. Time passes, but eventually the police nab a suspect, one whose picture had been viewed by the witness. If the witness is now asked to view a lineup, he may mistakenly remember one of the suspects whose photo he saw as having been present at the crime. A particularly vivid example of a related process happened to the Australian psychologist Donald M. Thomson. A woman in Sydney was watching television in midday when she heard a knock at the door. When she answered it, she was attacked, raped, and left unconscious. When she awoke and dialed the police, they came to her aid, got a description of her assailant, and launched a search. They spotted Donald Thomson walking down a Sydney street, and he matched the description. They arrested him on the spot. It turns out that Thomson had an airtight alibi—at the exact time of the rape, he was being interviewed on a live television show. The police did not believe him and sneered when he was being interrogated. However, the story was true. The woman had been watching the show when she heard the knock on the door. The description she gave the police was apparently of the man she saw on television, Donald Thomson, rather than the rapist. Her System 1 reaction—quick but sometimes mistaken—provided the wrong description, probably due to her extreme emotional state.[10]

What psychologists call the *curse of knowledge* is our tendency to underestimate how long it will take another person to learn something new or perform a task that we have already mastered. Teachers often suffer this illusion—the calculus instructor who finds calculus so easy that she can no longer place herself in the shoes of the student who is just starting out and struggling with the subject. The curse-of-knowledge effect is close kin to *hindsight bias,* or what is often called the

knew-it-all-along effect, in which we view events after the fact as having been more predictable than they were before they occurred. Stock market pundits will confidently announce on the evening news why the stock market behaved as it did that day, even though they could not have predicted the movements that morning.[11]

Accounts that sound familiar can create *the feeling of knowing* and be mistaken for true. This is one reason that political or advertising claims that are not factual but are repeated can gain traction with the public, particularly if they have emotional resonance. Something you once heard that you hear again later carries a warmth of familiarity that can be mistaken for memory, a shred of something you once knew and cannot quite place but are inclined to believe. In the world of propaganda, this is called "the big lie" technique—even a big lie told repeatedly can come to be accepted as truth.

Fluency illusions result from our tendency to mistake fluency with a text for mastery of its content. For example, if you read a particularly lucid presentation of a difficult concept, you can get the idea that it is actually pretty simple and perhaps even that you knew it all along. As discussed earlier, students who study by rereading their texts can mistake their fluency with a text, gained from rereading, for possession of accessible knowledge of the subject and consequently overestimate how well they will do on a test.

Our memories are also subject to *social influence* and tend to align with the memories of the people around us. If you are in

a group reminiscing about past experiences and someone adds a wrong detail about the story, you will tend to incorporate this detail into your own memory and later remember the experience with the erroneous detail. This process is called "memory conformity" or the "social contagion of memory": one person's error can "infect" another person's memory. Of course, social influences are not always bad. If someone recalls details of joint memory on which you are somewhat hazy, your subsequent memory will be updated and will hold a more accurate record of the past event.[12]

In the obverse of the social influence effect, humans are predisposed to assume that others share their beliefs, a process called the *false consensus effect*. We generally fail to recognize the idiosyncratic nature of our personal understanding of the world and interpretation of events and that ours differ from others'. Recall how surprised you were recently, on commiserating with a friend about the general state of affairs, to discover that she sees in an entirely different light matters on which you thought the correct view was fundamental and obvious: climate change, gun control, fracking of gas wells—or perhaps something very local, such as whether to pass a bond issue for a school building or to oppose construction of a big box store in the neighborhood.[13]

Confidence in a memory is not a reliable indication of its accuracy. We can have utmost faith in a vivid, nearly literal memory of an event and yet find that we actually have it all wrong. National tragedies, like the assassination of President John Kennedy or the events surrounding 9/11, create what psychologists call "flashbulb" memories, named for the vivid

images that we retain: where we were when we got the news, how we learned it, how we felt, what we did. These memories are thought to be indelible, burned into our minds, and it is true that the broad outlines of such catastrophes, thoroughly reported in the media, are well remembered, but your memory of your personal circumstances surrounding the events may not necessarily be accurate. There have been numerous studies of this phenomenon, including surveys of fifteen hundred Americans' memories of the September 11 attacks. In this study, the respondents' memories were surveyed a week after the attacks, again a year later, and then again three years and ten years later. Respondents' most emotional memories of their personal details at the time they learned of the attacks are also those of which they are most confident and, paradoxically, the ones that have most changed over the years relative to other memories about 9/11.[14]

Mental Models

As we develop mastery in the various areas of our lives, we tend to bundle together the incremental steps that are required to solve different kinds of problems. To use an analogy from a previous chapter, you could think of them as something like smart-phone apps in the brain. We call them mental models. Two examples in police work are the choreography of the routine traffic stop and the moves to take a weapon from an assailant at close quarters. Each of these maneuvers involves a set of perceptions and actions that cops can adapt with little conscious thought in response to context and situation. For a barista, a mental model would be the steps and ingredients to produce a perfect sixteen-ounce decaf frappuccino. For the receptionist at urgent care, it's triage and registration.

The better you know something, the more difficult it becomes to teach it. So says physicist and educator Eric Mazur of Harvard. Why? As you get more expert in complex areas, your models in those areas grow more complex, and the component steps that compose them fade into the background of memory (the curse of knowledge). A physicist, for example, will create a mental library of the principles of physics she can use to solve the various kinds of problems she encounters in her work: Newton's laws of motion, for example, or the laws of conservation of momentum. She will tend to sort problems based on their underlying principles, whereas a novice will group them by similarity of surface features, like the apparatus being manipulated in the problem (pulley, inclined plane, etc.). One day, when she goes to teach an intro physics class, she explains how a particular problem calls for something from Newtonian mechanics, forgetting that her students have yet to master the underlying steps she has long ago bundled into one unified mental model. This presumption by the professor that her students will readily follow something complex that appears fundamental in her own mind is a metacognitive error, a misjudgment of the matchup between what she knows and what her students know. Mazur says that the person who knows best what a student is struggling with in assimilating new concepts is not the professor, it's another student.[15] This problem is illustrated through a very simple experiment in which one person plays a common tune inside her head and taps the rhythm with her knuckles and another person hearing the rhythmic taps must guess the tune. Each tune comes from a fixed set of twenty-five, so the statistical chance of guessing it is 4 percent. Tellingly, the participants who have the tune in mind estimate that the other person will guess correctly 50 percent of the time, but in fact the listeners

guess correctly only 2.5 percent of the time, no better than chance.[16]

Like Coach Dooley's football players memorizing their playbooks, we all build mental libraries of myriad useful solutions that we can call on at will to help us work our way from one Saturday game to the next. But we can be tripped by these models, too, when we fail to recognize a new problem that appears to be a familiar one is actually something quite different and we pull out a solution to address it that doesn't work or makes things worse. The failure to recognize when your solution doesn't fit the problem is another form of faulty self-observation that can lead you into trouble.

Mike Ebersold, the neurosurgeon, was called into the operating room one day to help a surgical resident who, in the midst of removing a brain tumor, was losing the patient. The usual model for cutting out a tumor calls for taking your time, working carefully around the growth, getting a clean margin, saving the surrounding nerves. But when the growth is in the brain, and if you get bleeding behind it, pressure on the brain can turn fatal. Instead of slow-and-careful, you need just the opposite, cutting the growth out very quickly so the blood can drain, and then working to repair the bleeding. "Initially you might be a little timid to take the big step," Mike says. "It's not pretty, but the patient's survival depends on your knowing to switch gears and do it fast." Mike assisted, and the surgery was successful.

Like the infant who calls the stranger Dada, we must cultivate the ability to discern when our mental models aren't working: when a situation that seems familiar is actually different and requires that we reach for a different solution and do something new.

Unskilled and Unaware of It

Incompetent people lack the skills to improve because they are unable to distinguish between incompetence and competence. This phenomenon, of particular interest for metacognition, has been named the Dunning-Kruger effect after the psychologists David Dunning and Justin Kruger. Their research showed that incompetent people overestimate their own competence and, failing to sense a mismatch between their performance and what is desirable, see no need to try to improve. (The title of their initial paper on the topic was "Unskilled and Unaware of It.") Dunning and Kruger have also shown that incompetent people can be taught to raise their competence by learning the skills to judge their own performance more accurately, in short, to make their metacognition more accurate. In one series of studies that demonstrate this finding, they gave students a test of logic and asked them to rate their own performance. In the first experiment the results confirmed expectations that the least competent students were the most out of touch with their performance: students who scored at the twelfth percentile on average believed that their general logical reasoning ability fell at the sixty-eighth percentile.

In a second experiment, after taking an initial test and rating their own performance, the students were shown the other students' answers and then their own answers and asked to reestimate the number of test questions they had answered correctly. The students whose performance was in the bottom quartile failed to judge their own performance more accurately after seeing the more competent choices of their peers and in fact tended to raise their already inflated estimates of their own ability.

A third experiment explored whether poor performers could learn to improve their judgment. The students were given ten

problems in logical reasoning and after the test were asked to rate their logical reasoning skills and test performance. Once again, the students in the bottom quartile grossly overestimated their performance. Next, half the students received ten minutes of training in logic (how to test the accuracy of a syllogism); the other half of the students were given an unrelated task. All the students were then asked to estimate again how well they had performed on the test. Now the students in the bottom quartile who had received the training were much more accurate estimators of the number of questions they got right and of how they performed compared to the other students. Those in the bottom quartile who didn't receive the training held to their mistaken conviction that they had performed well.

How is it that incompetent people fail to learn through experience that they are unskilled? Dunning and Kruger offer several theories. One is that people seldom receive negative feedback about their skills and abilities from others in everyday life, because people don't like to deliver the bad news. Even if people get negative feedback, they must come to an accurate understanding of why the failure occurred. For success everything must go right, but by contrast, failure can be attributed to any number of external causes: it's easy to blame the tool for what the hand cannot do. Finally, Dunning and Kruger suggest that some people are just not astute at reading how other people are performing and are therefore less able to spot competence when they see it, making them less able to make comparative judgments of their own performance.

These effects are more likely to occur in some contexts and with some skills than with others. In some domains, the revelation of one's incompetence can be brutally frank. The authors can all remember from their childhoods when a teacher would appoint two boys to pick other kids for softball teams.

The good players are picked first, the worst last. You learn your peers' judgments of your softball abilities in a very public manner, so it would be hard for the last-picked player to think "I must be really good at softball." However, most realms of life do not render such stark judgments of ability.[17]

To sum up, the means by which we navigate the world—Daniel Kahneman's Systems 1 and 2—rely on our perceptual systems, intuition, memory, and cognition, with all their tics, warts, biases, and flaws. Each of us is an astounding bundle of perceptual and cognitive abilities, coexisting with the seeds of our own undoing. When it comes to learning, what we choose to do is guided by our judgments of what works and what doesn't, and we are easily misled.

Our susceptibility to illusion and misjudgment should give us all pause, and especially so to the advocates of "student-directed learning," a theory now current among some parents and educators. This theory holds that students know best what they need to study to master a subject, and what pace and methods work best for them. For example, at Manhattan Free School in East Harlem, opened in 2008, students "do not receive grades, take tests or have to do anything they do not feel like doing." The Brooklyn Free School, which opened in 2004, along with a new crop of homeschooling families who call themselves "unschoolers," follows the precept that whatever intrigues the learner is what will result in the best learning. [18]

The intent is laudatory. We know that students need to take more control of their own learning by employing strategies like those we have discussed. For example, they need to test themselves, both to attain the direct benefits of increased retention and to determine what they know and don't know to more accurately judge their progress and focus on material

that needs more work. But few students practice these strategies, and those who do will need more than encouragement if they are to practice them effectively: It turns out that even when students understand that retrieval practice is a superior strategy, they often fail to persist long enough to get the lasting benefit. For example, when students are presented with a body of material to master, say a stack of foreign vocabulary flashcards, and are free to decide when to drop a card out of the deck because they've learned it, most students drop the card when they've gotten it right once or twice, far sooner than they should. The paradox is that those students who employ the least effective study strategies overestimate their learning the most and, as a consequence of their misplaced confidence, they are not inclined to change their habits.

The football player preparing for next Saturday's game doesn't leave his performance to intuition, he runs through his plays and mixes it up to discover the rough edges and work them out on the field well before suiting up for the big game. If this kind of behavior were anywhere close to the norm for students in their academics today, then self-directed learning would be highly effective. But of course the football player is not self-directed, his practice is guided by a coach. Likewise, most students will learn academics better under an instructor who knows where improvement is needed and structures the practice required to achieve it.[19]

The answer to illusion and misjudgment is to replace subjective experience as the basis for decisions with a set of objective gauges outside ourselves, so that our judgment squares with the real world around us. When we have reliable reference points, like cockpit instruments, and make a habit of checking them, we can make good decisions about where to focus our efforts, recognize when we've lost our bearings, and find our way back again. Here are some examples.

Tools and Habits for Calibrating Your Judgment

Most important is to make frequent use of *testing* and retrieval practice to verify what you really do know versus what you think you know. Frequent low-stakes quizzes in class help the instructor verify that students are in fact learning as well as they appear to be and reveal the areas where extra attention is needed. Doing cumulative quizzing, as Andy Sobel does in his political economics course, is especially powerful for consolidating learning and knitting the concepts from one stage of a course into new material encountered later. As a learner, you can use any number of practice techniques to self-test your mastery, from answering flashcards to explaining key concepts in your own words, and to peer instruction (see below).

Don't make the mistake of dropping material from your testing regime once you've gotten it correct a couple of times. If it's important, it needs to be practiced, and practiced again. And don't put stock in momentary gains that result from massed practice. Space your testing, vary your practice, keep the long view.

Peer instruction, a learning model developed by Eric Mazur, incorporates many of the foregoing principles. The material to be covered in class is assigned for reading beforehand. In class, the lecture is interspersed with quick tests that present students with a conceptual question and give them a minute or two to grapple with it; they then try, in small groups, to reach a consensus on the correct answer. In Mazur's experience, this process engages the students in the underlying concepts of the lecture material; reveals students' problems in

reaching understanding; and provides opportunities for them to explain their understanding, receive feedback, and assess their learning compared to other students. Likewise, the process serves as a gauge for the instructor of how well the students are assimilating the material and in what areas more or less work is needed. Mazur tries to pair students who initially had different answers to a question so that they can see another point of view and try to convince one another of who is right.

For two more examples of this technique, see the profiles of the professors Mary Pat Wenderoth and Michael D. Matthews in Chapter 8.[20]

Pay attention to the *cues* you're using to judge what you have learned. Whether something feels familiar or fluent is not always a reliable indicator of learning. Neither is your level of ease in retrieving a fact or a phrase on a quiz shortly after encountering it in a lecture or text. (Ease of retrieval after a delay, however, *is* a good indicator of learning.) Far better is to create a mental model of the material that integrates the various ideas across a text, connects them to what you already know, and enables you to draw inferences. How ably you can explain a text is an excellent cue for judging comprehension, because you must recall the salient points from memory, put them into your own words, and explain why they are significant—how they relate to the larger subject.

Instructors should give corrective *feedback*, and learners should seek it. In his interview with Errol Morris, the psychologist David Dunning argues that the path to self-insight leads through other people. "So it really depends on what sort

of feedback you are getting. Is the world telling you good things? Is the world rewarding you in a way that you would expect a competent person to be rewarded? If you watch other people, you often find there are different ways to do things; there are better ways to do things. 'I'm not as good as I thought I was, but I have something to work on.' " Think of the kids lining up to join the softball team—would you be picked?[21]

In many fields, the practice of peer review serves as an external gauge, providing feedback on one's performance. Most medical practice groups have morbidity/mortality conferences, and if a doctor has a bad patient outcome, it will be presented there. The other doctors will pick it apart, or say "You did a good job, it was just a bad situation." Mike Ebersold argues that people in his field should practice as a part of a group. "If there are other neurosurgeons around you, it's a safeguard. If you're doing something that's not acceptable, they'll call you to task for it."

In many settings, your judgment and learning are calibrated by working alongside a more experienced partner: airline first officers with captains, rookies with seasoned cops, residents with experienced surgeons. The apprentice model is a very old one in human experience, as novices (whether cobblers or attorneys) have traditionally learned their craft from experienced practitioners.

In other settings, *teams* are formed of people with complementary areas of expertise. When doctors implant medical devices like pacemakers and neural stimulators of the type that treat incontinence or the symptoms of Parkinson's disease, the manufacturer has a product representative right in the operating room with the surgeon. The rep has seen many

surgeries using the device, knows the kinds of patients that will benefit from it, knows the contraindications and adverse events, and has a hotline to the engineers and clinicians on the company's staff. The rep tracks the surgery to make sure the device is implanted in the correct position, the leads are inserted to the correct depth, and so on. Every part of the team benefits. The patient is assured of an appropriate and successful surgery. The doctor gets product and troubleshooting expertise at her fingertips. And the company makes sure its products are used correctly.

Training that simulates the kinds of demands and changeable conditions that can be expected in real-world settings helps learners and trainers assess mastery and focus on areas where understanding or competency need to be raised. Take police work, where many different forms of *simulation* are used in training. For firearms training it's often video-based scenarios, with a large screen set up at one end of a room where a number of props have been placed to imitate the situation confronting the officer, who enters the scene armed with a gun that has been modified to interact with the video.

Lieutenant Catherine Johnson of the Minneapolis Police Department describes a couple of such simulations in which she has trained:

> One was a traffic stop. The training room had the screen at one end and objects around the room—a big blue mailbox, a fire hydrant, a doorway—that you could use for cover in dealing with what was happening on the screen. I remember walking toward the screen, and the video simulating my coming up to the car as I did that, very realistic, and suddenly the trunk popped up and a guy with a shotgun rose out and shot me.

> Which, to this day, every time I go up to a car on a traffic stop, I push down hard on the trunk to make sure it isn't open. And it's because of that one scenario in the training that I went through.
>
> Another firearm simulation was a domestic call, and it starts where I am approaching the residence and there's a guy on his porch. The instant I show up I see that he has a gun in his hand. I order him to drop it, and the first thing he does is turn and start walking away. And my thinking at that point is that I can't shoot this guy in the back, and there's nobody over there that looks to be in danger, so what am I going to do? In the time it takes me to process whether or not I should shoot this guy, he's already turned around and shot me. Because my reaction was slower than his action. Action beats reaction every time. That's one mantra that's drilled into our minds.[22]

The firearms simulations can play out in a variety of ways both deadly and peaceful. There's not so much a right or wrong answer to the situation as there is a complex set of factors, some of which, like whether the individual on the porch has a criminal history, may be known to the officer when she enters the scene. At the conclusion, the officer debriefs with her trainer, getting feedback. The exercise isn't all about technique, it's about clear thinking and appropriate reflexes—visual and verbal clues to watch for, possible outcomes, being clear about the appropriate use of deadly force, and finding the words after the fact that will account for actions you have taken in the urgency of the moment.

Simulation is not perfect. Johnson recounts how officers are trained to take a gun from an assailant at close quarters, a maneuver they practice by role-playing with a fellow officer. It requires speed and deftness: striking an assailant's wrist with one hand to break his grip while simultaneously wresting the

gun free with the other. It's a move that officers had been in the habit of honing through repetition, taking the gun, handing it back, taking it again. Until one of their officers, on a call in the field, took the gun from an assailant and handed it right back again. In their mutual astonishment, the officer managed to reseize the gun and hang onto it. The training regime had violated the cardinal rule that you should practice like you play, because you will play like you practice.

Sometimes the most powerful feedback for calibrating your sense of what you do and don't know are the mistakes you make in the field, assuming you survive them and are receptive to the lesson.[23]