

# The Characters of the Story

To observe your mind in automatic mode, glance at the image below.



**Figure 1**

Your experience as you look at the woman's face seamlessly combines what we normally call seeing and intuitive thinking. As surely and quickly as you saw that the young woman's hair is dark, you knew she is angry. Furthermore, what you saw extended into the future. You sensed that this woman is about to say some very unkind words, probably in a loud and strident voice. A premonition of what she was going to do next came to mind automatically and effortlessly. You did not intend to assess her mood or to anticipate what she might do, and your reaction to the picture did not have the feel of something you did. It just happened to you. It was an instance of fast thinking.

Now look at the following problem:

$$17 \times 24$$

You knew immediately that this is a multiplication problem, and probably knew that you could solve it, with paper and pencil, if not without. You also had some vague intuitive knowledge of the range of possible results. You would be quick to recognize that both 12,609 and 123 are implausible. Without spending some time on the problem, however, you would not be

certain that the answer is not 568. A precise solution did not come to mind, and you felt that you could choose whether or not to engage in the computation. If you have not done so yet, you should attempt the multiplication problem now, completing at least part of it.

You experienced slow thinking as you proceeded through a sequence of steps. You first retrieved from memory the cognitive program for multiplication that you learned in school, then you implemented it. Carrying out the computation was a strain. You felt the burden of holding much material in memory, as you needed to keep track of where you were and of where you were going, while holding on to the intermediate result. The process was mental work: deliberate, effortful, and orderly—a prototype of slow thinking. The computation was not only an event in your mind; your body was also involved. Your muscles tensed up, your blood pressure rose, and your heart rate increased. Someone looking closely at your eyes while you tackled this problem would have seen your pupils dilate. Your pupils contracted back to normal size as soon as you ended your work—when you found the answer (which is 408, by the way) or when you gave up.

## Two Systems

Psychologists have been intensely interested for several decades in the two modaege fi Pn="cees of thinking evoked by the picture of the angry woman and by the multiplication problem, and have offered many labels for them. I adopt terms originally proposed by the psychologists Keith Stanovich and Richard West, and will refer to two systems in the mind, System 1 and System 2.

- *System 1* operates automatically and quickly, with little or no effort and no sense of voluntary control.
- *System 2* allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration.

The labels of System 1 and System 2 are widely used in psychology, but I go further than most in this book, which you can read as a psychodrama with two characters.

When we think of ourselves, we identify with System 2, the conscious,

reasoning self that has beliefs, makes choices, and decides what to think about and what to do. Although System 2 believes itself to be where the action is, the automatic System 1 is the hero of the book. I describe System 1 as effortlessly originating impressions and feelings that are the main sources of the explicit beliefs and deliberate choices of System 2. The automatic operations of System 1 generate surprisingly complex patterns of ideas, but only the slower System 2 can construct thoughts in an orderly series of steps. I also describe circumstances in which System 2 takes over, overruling the freewheeling impulses and associations of System 1. You will be invited to think of the two systems as agents with their individual abilities, limitations, and functions.

In rough order of complexity, here are some examples of the automatic activities that are attributed to System 1:

- Detect that one object is more distant than another.
- Orient to the source of a sudden sound.
- Complete the phrase “bread and...”
- Make a “disgust face” when shown a horrible picture.
- Detect hostility in a voice.
- Answer to  $2 + 2 = ?$
- Read words on large billboards.
- Drive a car on an empty road.
- Find a strong move in chess (if you are a chess master).
- Understand simple sentences.
- Recognize that a “meek and tidy soul with a passion for detail” resembles an occupational stereotype.

All these mental events belong with the angry woman—they occur automatically and require little or no effort. The capabilities of System 1 include innate skills that we share with other animals. We are born prepared to perceive the world around us, recognize objects, orient attention, avoid losses, and fear spiders. Other mental activities become fast and automatic through prolonged practice. System 1 has learned associations between ideas (the capital of France?); it has also learned skills such as reading and understanding nuances of social situations. Some skills, such as finding strong chess moves, are acquired only by specialized experts. Others are widely shared. Detecting the similarity of a personality sketch to an occupational stereotype requires broad knowledge of the language and the culture, which most of us

possess. The knowledge is stored in memory and accessed without intention and without effort.

Several of the mental actions in the list are completely involuntary. You cannot refrain from understanding simple sentences in your own language or from orienting to a loud unexpected sound, nor can you prevent yourself from knowing that  $2 + 2 = 4$  or from thinking of Paris when the capital of France is mentioned. Other activities, such as chewing, are susceptible to voluntary control but normally run on automatic pilot. The control of attention is shared by the two systems. Orienting to a loud sound is normally an involuntary operation of System 1, which immediately mobilizes the voluntary attention of System 2. You may be able to resist turning toward the source of a loud and offensive comment at a crowded party, but even if your head does not move, your attention is initially directed to it, at least for a while. However, attention can be moved away from an unwanted focus, primarily by focusing intently on another target.

The highly diverse operations of System 2 have one feature in common: they require attention and are disrupted when attention is drawn away. Here are some examples:

- Brace for the starter gun in a race.
- Focus attention on the clowns in the circus.
- Focus on the voice of a particular person in a crowded and noisy room.
- Look for a woman with white hair.
- Search memory to identify a surprising sound.
- Maintain a faster walking speed than is natural for you.
- Monitor the appropriateness of your behavior in a social situation.
- Count the occurrences of the letter *a* in a page of text.
- Tell someone your phone number.
- Park in a narrow space (for most people except garage attendants).
- Compare two washing machines for overall value.
- Fill out a tax form.
- Check the validity of a complex logical argument.

In all these situations you must pay attention, and you will perform less well, or not at all, if you are not ready or if your attention is directed inappropriately. System 2 has some ability to change the way System 1 works, by programming the normally automatic functions of attention and memory. When waiting for a relative at a busy train station, for example,

you can set yourself at will to look for a white-haired woman or a bearded man, and thereby increase the likelihood of detecting your relative from a distance. You can set your memory to search for capital cities that start with *N* or for French existentialist novels. And when you rent a car at London's Heathrow Airport, the attendant will probably remind you that "we drive on the left side of the road over here." In all these cases, you are asked to do something that does not come naturally, and you will find that the consistent maintenance of a set requires continuous exertion of at least some effort.

The often-used phrase "pay attention" is apt: you dispose of a limited budget of attention that you can allocate to activities, and if you try to i>Cyou try tgo beyond your budget, you will fail. It is the mark of effortful activities that they interfere with each other, which is why it is difficult or impossible to conduct several at once. You could not compute the product of  $17 \times 24$  while making a left turn into dense traffic, and you certainly should not try. You can do several things at once, but only if they are easy and undemanding. You are probably safe carrying on a conversation with a passenger while driving on an empty highway, and many parents have discovered, perhaps with some guilt, that they can read a story to a child while thinking of something else.

Everyone has some awareness of the limited capacity of attention, and our social behavior makes allowances for these limitations. When the driver of a car is overtaking a truck on a narrow road, for example, adult passengers quite sensibly stop talking. They know that distracting the driver is not a good idea, and they also suspect that he is temporarily deaf and will not hear what they say.

Intense focusing on a task can make people effectively blind, even to stimuli that normally attract attention. The most dramatic demonstration was offered by Christopher Chabris and Daniel Simons in their book *The Invisible Gorilla*. They constructed a short film of two teams passing basketballs, one team wearing white shirts, the other wearing black. The viewers of the film are instructed to count the number of passes made by the white team, ignoring the black players. This task is difficult and completely absorbing. Halfway through the video, a woman wearing a gorilla suit appears, crosses the court, thumps her chest, and moves on. The gorilla is in view for 9 seconds. Many thousands of people have seen the video, and about half of them do not notice anything unusual. It is the counting task—and especially the instruction to ignore one of the teams—that causes the blindness. No one who watches the video without that task would miss the gorilla. Seeing and orienting are automatic functions of System 1, but they depend on the allocation of some attention to the

relevant stimulus. The authors note that the most remarkable observation of their study is that people find its results very surprising. Indeed, the viewers who fail to see the gorilla are initially sure that it was not there—they cannot imagine missing such a striking event. The gorilla study illustrates two important facts about our minds: we can be blind to the obvious, and we are also blind to our blindness.

## Plot Synopsis

The interaction of the two systems is a recurrent theme of the book, and a brief synopsis of the plot is in order. In the story I will tell, Systems 1 and 2 are both active whenever we are awake. System 1 runs automatically and System 2 is normally in a comfortable low-effort mode, in which only a fraction of its capacity is engaged. System 1 continuously generates suggestions for System 2: impressions, intuitions, intentions, and feelings. If endorsed by System 2, impressions and intuitions turn into beliefs, and impulses turn into voluntary actions. When all goes smoothly, which is most of the time, System 2 adopts the suggestions of System 1 with little or no modification. You generally believe your impressions and act on your desires, and that is fine—usually.

When System 1 runs into difficulty, it calls on System 2 to support more detailed and specific processing that may solve the problem of the moment. System 2 is mobilized when a question arises for which System 1 does not offer an answer, as probably happened to you when you encountered the multiplication problem  $17 \times 24$ . You can also feel a surge of conscious attention whenever you are surprised. System 2 is activated when an event is detected that violates the model of the world that System 1 maintains. In that world, lamps do not jump, cats do not bark, and gorillas do not cross basketball courts. The gorilla experiment demonstrates that some attention is needed for the surprising stimulus to be detected. Surprise then activates and orients your attention: you will stare, and you will search your memory for a story that makes sense of the surprising event. System 2 is also credited with the continuous monitoring of your own behavior—the control that keeps you polite when you are angry, and alert when you are driving at night. System 2 is mobilized to increased effort when it detects an error about to be made. Remember a time when you almost blurted out an offensive remark and note how hard you worked to restore control. In summary, most of what you (your System 2) think and do originates in your System 1, but System 2 takes over when things get difficult, and it normally has the last word.

The division of labor between System 1 and System 2 is highly efficient:

it minimizes effort and optimizes performance. The arrangement works well most of the time because System 1 is generally very good at what it does: its models of familiar situations are accurate, its short-term predictions are usually accurate as well, and its initial reactions to challenges are swift and generally appropriate. System 1 has biases, however, systematic errors that it is prone to make in specified circumstances. As we shall see, it sometimes answers easier questions than the one it was asked, and it has little understanding of logic and statistics. One further limitation of System 1 is that it cannot be turned off. If you are shown a word on the screen in a language you know, you will read it—unless your attention is totally focused elsewhere.

## Conflict

Figure 2 is a variant of a classic experiment that produces a conflict between the two systems. You should try the exercise before reading on.

Your first task is to go down both columns, calling out whether each word is printed in lowercase or in uppercase. When you are done with the first task, go down both columns again, saying whether each word is printed to the left or to the right of center by saying (or whispering to yourself) “LEFT” or “RIGHT.”

LEFT		upper
	left	lower
right		LOWER
RIGHT		upper
	RIGHT	UPPER
	left	lower
LEFT		LOWER
	right	upper

**Figure 2**

You were almost certainly successful in saying the correct words in both tasks, and you surely discovered that some parts of each task were much easier than others. When you identified upper- and lowercase, the left-hand column was easy and the right-hand column caused you to slow down

and perhaps to stammer or stumble. When you named the position of words, the left-hand column was difficult and the right-hand column was much easier.

These tasks engage System 2, because saying “upper/lower” or “right/left” is not what you routinely do when looking down a column of words. One of the things you did to set yourself for the task was to program your memory so that the relevant words (*upper* and *lower* for the first task) were “on the tip of your tongue.” The prioritizing of the chosen words is effective and the mild temptation to read other words was fairly easy to resist when you went through the first column. But the second column was different, because it contained words for which you were set, and you could not ignore them. You were mostly able to respond correctly, but overcoming the competing response was a strain, and it slowed you down. You experienced a conflict between a task that you intended to carry out and an automatic response that interfered with it.

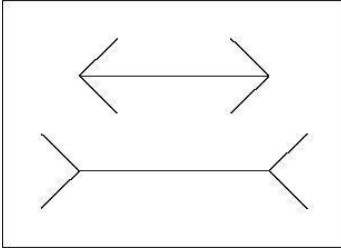
Conflict between an automatic reaction and an intention to control it is common in our lives. We are all familiar with the experience of trying not to stare at the oddly dressed couple at the neighboring table in a restaurant. We also know what it is like to force our attention on a boring book, when we constantly find ourselves returning to the point at which the reading lost its meaning. When winters are hard, many drivers have memories of their car skidding out of control on the ice and of the struggle to follow well-rehearsed instructions that negate what they would naturally do: “Steer into the skid, and whatever you do, do not touch the brakes!” And every human being has had the experience of *not* telling someone to go to hell. One of the tasks of System 2 is to overcome the impulses of System 1. In other words, System 2 is in charge of self-control.

## Illusions

To appreciate the autonomy of System 1, as well as the distinction between impressions and beliefs, take a good look at figure 3.

This picture is unremarkable: two horizontal lines of different lengths, with fins appended, pointing in different directions. The bottom line is obviously longer than the one above it. That is what we all see, and we naturally believe what we see. If you have already encountered this image, however, you recognize it as the famous Müller-Lyer illusion. As you can easily confirm by measuring them with a ruler, the horizontal lines are in fact identical in length.





**Figure 3**

Now that you have measured the lines, you—your System 2, the conscious being you call “I”—have a new belief: you *know* that the lines are equally long. If asked about their length, you will say what you know. But you still see the bottom line as longer. You have chosen to believe the measurement, but you cannot prevent System 1 from doing its thing; you cannot decide to see the lines as equal, although you know they are. To resist the illusion, there is only one thing you can do: you must learn to mistrust your impressions of the length of lines when fins are attached to them. To implement that rule, you must be able to recognize the illusory pattern and recall what you know about it. If you can do this, you will never again be fooled by the Müller-Lyer illusion. But you will still see one line as longer than the other.

Not all illusions are visual. There are illusions of thought, which we call *cognitive illusions*. As a graduate student, I attended some courses on the art and science of psychotherapy. During one of these lectures, our teacher imparted a morsel of clinical wisdom. This is what he told us: “You will from time to time meet a patient who shares a disturbing tale of multiple mistakes in his previous treatment. He has been seen by several clinicians, and all failed him. The patient can lucidly describe how his therapists misunderstood him, but he has quickly perceived that you are different. You share the same feeling, are convinced that you understand him, and will be able to help.” At this point my teacher raised his voice as he said, “Do not even *think* of taking on this patient! Throw him out of the office! He is most likely a psychopath and you will not be able to help him.”

Many years later I learned that the teacher had warned us against psychopathic charm, and the leading authority in the study of the

psychopathy confirmed that the teacher's advice was sound. The analogy to the Müller-Lyer illusion is close. What we were being taught was not how to feel about that patient. Our teacher took it for granted that the sympathy we would feel for the patient would not be under our control; it would arise from System 1. Furthermore, we were not being taught to be generally suspicious of our feelings about patients. We were told that a strong attraction to a patient with a repeated history of failed treatment is a danger sign—like the fins on the parallel lines. It is an illusion—a cognitive illusion—and I (System 2) was taught how to recognize it and advised not to believe it or act on it.

The question that is most often asked about cognitive illusions is whether they can be overcome. The message of these examples is not encouraging. Because System 1 operates automatically and cannot be turned off at will, errors of intuitive thought are often difficult to prevent. Biases cannot always be avoided, because System 2 may have no clue to the error. Even when cues to likely errors are available, errors can be prevented only by the enhanced monitoring and effortful activity of System 2. As a way to live your life, however, continuous vigilance is not necessarily good, and it is certainly impractical. Constantly questioning our own thinking would be impossibly tedious, and System 2 is much too slow and inefficient to serve as a substitute for System 1 in making routine decisions. The best we can do is a compromise: learn to recognize situations in which mistakes are likely and try harder to avoid significant mistakes when the stakes are high. The premise of this book is that it is easier to recognize other people's mistakes than our own.

## **Useful Fictions**

You have been invited to think of the two systems as agents within the mind, with their individual personalities, abilities, and limitations. I will often use sentences in which the systems are the subjects, such as, "System 2 calculates products."

The use of such language is considered a sin in the professional circles in which I travel, because it seems to explain the thoughts and actions of a person by the thoughts and actions of little people inside the person's head. Grammatically the sentence about System 2 is similar to "The butler steals the petty cash." My colleagues would point out that the butler's action actually explains the disappearance of the cash, and they rightly question whether the sentence about System 2 explains how products are calculated. My answer is that the brief active sentence that attributes calculation to System 2 is intended as a description, not an explanation. It

is meaningful only because of what you already know about System 2. It is shorthand for the following: “Mental arithmetic is a voluntary activity that requires effort, should not be performed while making a left turn, and is associated with dilated pupils and an accelerated heart rate.”

Similarly, the statement that “highway driving under routine conditions is left to System 1” means that steering the car around a bend is automatic and almost effortless. It also implies that an experienced driver can drive on an empty highway while conducting a conversation. Finally, “System 2 prevented James from reacting foolishly to the insult” means that James would have been more aggressive in his response if his capacity for effortful control had been disrupted (for example, if he had been drunk).

System 1 and System 2 are so central to the story I tell in this book that I must make it absolutely clear that they are<sup>217</sup>at they a fictitious characters. Systems 1 and 2 are not systems in the standard sense of entities with interacting aspects or parts. And there is no one part of the brain that either of the systems would call home. You may well ask: What is the point of introducing fictitious characters with ugly names into a serious book? The answer is that the characters are useful because of some quirks of our minds, yours and mine. A sentence is understood more easily if it describes what an agent (System 2) does than if it describes what something is, what properties it has. In other words, “System 2” is a better subject for a sentence than “mental arithmetic.” The mind—especially System 1—appears to have a special aptitude for the construction and interpretation of stories about active agents, who have personalities, habits, and abilities. You quickly formed a bad opinion of the thieving butler, you expect more bad behavior from him, and you will remember him for a while. This is also my hope for the language of systems.

Why call them System 1 and System 2 rather than the more descriptive “automatic system” and “effortful system”? The reason is simple: “Automatic system” takes longer to say than “System 1” and therefore takes more space in your working memory. This matters, because anything that occupies your working memory reduces your ability to think. You should treat “System 1” and “System 2” as nicknames, like Bob and Joe, identifying characters that you will get to know over the course of this book. The fictitious systems make it easier for me to think about judgment and choice, and will make it easier for you to understand what I say.

## **Speaking of System 1 and System 2**

“He had an impression, but some of his impressions are illusions.”

“This was a pure System 1 response. She reacted to the threat before she recognized it.”

“This is your System 1 talking. Slow down and let your System 2 take control.”

# Attention and Effort

In the unlikely event of this book being made into a film, System 2 would be a supporting character who believes herself to be the hero. The defining feature of System 2, in this story, is that its operations are effortful, and one of its main characteristics is laziness, a reluctance to invest more effort than is strictly necessary. As a consequence, the thoughts and actions that System 2 believes it has chosen are often guided by the figure at the center of the story, System 1. However, there are vital tasks that only System 2 can perform because they require effort and acts of self-control in which the intuitions and impulses of System 1 are overcome.

## Mental Effort

If you wish to experience your System 2 working at full tilt, the following exercise will do; it should bring you to the limits of your cognitive abilities within 5 seconds. To start, make up several strings of 4 digits, all different, and write each string on an index card. Place a blank card on top of the deck. The task that you will perform is called Add-1. Here is how it goes:

Start beating a steady rhythm (or better yet, set a metronome at 1/sec). Remove the blank card and read the four digits aloud. Wait for two beats, then report a string in which each of the original digits is incremented by 1. If the digits on the card are 5294, the correct response is 6305. Keeping the rhythm is important.

Few people can cope with more than four digits in the Add-1 task, but if you want a harder challenge, please try Add-3.

If you would like to know what your body is doing while your mind is hard at work, set up two piles of books on a sturdy table, place a video camera on one and lean your chin on the other, get the video going, and stare at the camera lens while you work on Add-1 or Add-3 exercises. Later, you will find in the changing size of your pupils a faithful record of how hard you worked.

I have a long personal history with the Add-1 task. Early in my career I spent a year at the University of Michigan, as a visitor in a laboratory that studied hypnosis. Casting about for a useful topic of research, I found an article in *Scientific American* in which the psychologist Eckhard Hess described the pupil of the eye as a window to the soul. I reread it recently

and again found it inspiring. It begins with Hess reporting that his wife had noticed his pupils widening as he watched beautiful nature pictures, and it ends with two striking pictures of the same good-looking woman, who somehow appears much more attractive in one than in the other. There is only one difference: the pupils of the eyes appear dilated in the attractive picture and constricted in the other. Hess also wrote of belladonna, a pupil-dilating substance that was used as a cosmetic, and of bazaar shoppers who wear dark glasses in order to hide their level of interest from merchants.

One of Hess's findings especially captured my attention. He had noticed that the pupils are sensitive indicators of mental effort—they dilate substantially when people multiply two-digit numbers, and they dilate more if the problems are hard than if they are easy. His observations indicated that the response to mental effort is distinct from emotional arousal. Hess's work did not have much to do with hypnosis, but I concluded that the idea of a visible indication of mental effort had promise as a research topic. A graduate student in the lab, Jackson Beatty, shared my enthusiasm and we got to work.

Beatty and I developed a setup similar to an optician's examination room, in which the experimental participant leaned her head on a chin-and-forehead rest and stared at a camera while listening to prerecorded information and answering questions on the recorded beats of a metronome. The beats triggered an infrared flash every second, causing a picture to be taken. At the end of each experimental session, we would rush to have the film developed, project the images of the pupil on a screen, and go to work with a ruler. The method was a perfect fit for young and impatient researchers: we knew our results almost immediately, and they always told a clear story.

Beatty and I focused on paced tasks, such as Add-1, in which we knew precisely what was on the subject's mind at any time. We recorded strings of digits on beats of the metronome and instructed the subject to repeat or transform the digits one indigit only one, maintaining the same rhythm. We soon discovered that the size of the pupil varied second by second, reflecting the changing demands of the task. The shape of the response was an inverted V. As you experienced it if you tried Add-1 or Add-3, effort builds up with every added digit that you hear, reaches an almost intolerable peak as you rush to produce a transformed string during and immediately after the pause, and relaxes gradually as you "unload" your short-term memory. The pupil data corresponded precisely to subjective experience: longer strings reliably caused larger dilations, the transformation task compounded the effort, and the peak of pupil size coincided with maximum effort. Add-1 with four digits caused a larger

dilation than the task of holding seven digits for immediate recall. Add-3, which is much more difficult, is the most demanding that I ever observed. In the first 5 seconds, the pupil dilates by about 50% of its original area and heart rate increases by about 7 beats per minute. This is as hard as people can work—they give up if more is asked of them. When we exposed our subjects to more digits than they could remember, their pupils stopped dilating or actually shrank.

We worked for some months in a spacious basement suite in which we had set up a closed-circuit system that projected an image of the subject's pupil on a screen in the corridor; we also could hear what was happening in the laboratory. The diameter of the projected pupil was about a foot; watching it dilate and contract when the participant was at work was a fascinating sight, quite an attraction for visitors in our lab. We amused ourselves and impressed our guests by our ability to divine when the participant gave up on a task. During a mental multiplication, the pupil normally dilated to a large size within a few seconds and stayed large as long as the individual kept working on the problem; it contracted immediately when she found a solution or gave up. As we watched from the corridor, we would sometimes surprise both the owner of the pupil and our guests by asking, "Why did you stop working just now?" The answer from inside the lab was often, "How did you know?" to which we would reply, "We have a window to your soul."

The casual observations we made from the corridor were sometimes as informative as the formal experiments. I made a significant discovery as I was idly watching a woman's pupil during a break between two tasks. She had kept her position on the chin rest, so I could see the image of her eye while she engaged in routine conversation with the experimenter. I was surprised to see that the pupil remained small and did not noticeably dilate as she talked and listened. Unlike the tasks that we were studying, the mundane conversation apparently demanded little or no effort—no more than retaining two or three digits. This was a eureka moment: I realized that the tasks we had chosen for study were exceptionally effortful. An image came to mind: mental life—today I would speak of the life of System 2—is normally conducted at the pace of a comfortable walk, sometimes interrupted by episodes of jogging and on rare occasions by a frantic sprint. The Add-1 and Add-3 exercises are sprints, and casual chatting is a stroll.

We found that people, when engaged in a mental sprint, may become effectively blind. The authors of *The Invisible Gorilla* had made the gorilla "invisible" by keeping the observers intensely busy counting passes. We reported a rather less dramatic example of blindness during Add-1. Our

subjects were exposed to a series of rapidly flashing letters while they worked. They were told to give the task complete priority, but they were also asked to report, at the end of the digit task, whether the letter *K* had appeared at any point during the trial. The main finding was that the ability to detect and report the target letter changed in the course of the 10 seconds of the exercise. The observers almost never missed a *K* that was shown at the beginning or near the end of the Add-1 task but they missed the target almost half the time when mental effort was at its peak, although we had pictures of their wide-open eye staring straight at it. Failures of detection followed the same inverted-V pattern as the dilating pupil. The similarity was reassuring: the pupil was a good measure of the physical arousal that accompanies mental effort, and we could go ahead and use it to understand how the mind works.

Much like the electricity meter outside your house or apartment, the pupils offer an index of the current rate at which mental energy is used. The analogy goes deep. Your use of electricity depends on what you choose to do, whether to light a room or toast a piece of bread. When you turn on a bulb or a toaster, it draws the energy it needs but no more. Similarly, we decide what to do, but we have limited control over the effort of doing it. Suppose you are shown four digits, say, 9462, and told that your life depends on holding them in memory for 10 seconds. However much you want to live, you cannot exert as much effort in this task as you would be forced to invest to complete an Add-3 transformation on the same digits.

System 2 and the electrical circuits in your home both have limited capacity, but they respond differently to threatened overload. A breaker trips when the demand for current is excessive, causing all devices on that circuit to lose power at once. In contrast, the response to mental overload is selective and precise: System 2 protects the most important activity, so it receives the attention it needs; "spare capacity" is allocated second by second to other tasks. In our version of the gorilla experiment, we instructed the participants to assign priority to the digit task. We know that they followed that instruction, because the timing of the visual target had no effect on the main task. If the critical letter was presented at a time of high demand, the subjects simply did not see it. When the transformation task was less demanding, detection performance was better.

The sophisticated allocation of attention has been honed by a long evolutionary history. Orienting and responding quickly to the gravest threats or most promising opportunities improved the chance of survival, and this capability is certainly not restricted to humans. Even in modern humans, System 1 takes over in emergencies and assigns total priority to self-protective actions. Imagine yourself at the wheel of a car that unexpectedly



skids on a large oil slick. You will find that you have responded to the threat before you became fully conscious of it.

Beatty and I worked together for only a year, but our collaboration had a large effect on our subsequent careers. He eventually became the leading authority on "cognitive pupillometry," and I wrote a book titled *Attention and Effort*, which was based in large part on what we learned together and on follow-up research I did at Harvard the following year. We learned a great deal about the working mind—which I now think of as System 2—from measuring pupils in a wide variety of tasks.

As you become skilled in a task, its demand for energy diminishes. Studies of the brain have shown that the pattern of activity associated with an action changes as skill increases, with fewer brain regions involved. Talent has similar effects. Highly intelligent individuals need less effort to solve the same problems, as indicated by both pupil size and brain activity. A general "law of least effort" applies to cognitive as well as physical exertion. The law asserts that if there are several ways of achieving the same goal, people will eventually gravitate to the least demanding course of action. In the economy of action, effort is a cost, and the acquisition of skill is driven by the balance of benefits and costs. Laziness is built deep into our nature.

The tasks that we studied varied considerably in their effects on the pupil. At baseline, our subjects were awake, aware, and ready to engage in a task—probably at a higher level of arousal and cognitive readiness than usual. Holding one or two digits in memory or learning to associate a word with a digit (3 = door) produced reliable effects on momentary arousal above that baseline, but the effects were minuscule, only 5% of the increase in pupil diameter associated with Add-3. A task that required discriminating between the pitch of two tones yielded significantly larger dilations. Recent research has shown that inhibiting the tendency to read distracting words (as in figure 2 of the preceding chapter) also induces moderate effort. Tests of short-term memory for six or seven digits were more effortful. As you can experience, the request to retrieve and say aloud your phone number or your spouse's birthday also requires a brief but significant effort, because the entire string must be held in memory as a response is organized. Mental multiplication of two-digit numbers and the Add-3 task are near the limit of what most people can do.

What makes some cognitive operations more demanding and effortful than others? What outcomes must we purchase in the currency of attention? What can System 2 do that System 1 cannot? We now have tentative answers to these questions.

Effort is required to maintain simultaneously in memory several ideas

that require separate actions, or that need to be combined according to a rule—rehearsing your shopping list as you enter the supermarket, choosing between the fish and the veal at a restaurant, or combining a surprising result from a survey with the information that the sample was small, for example. System 2 is the only one that can follow rules, compare objects on several attributes, and make deliberate choices between options. The automatic System 1 does not have these capabilities. System 1 detects simple relations (“they are all alike,” “the son is much taller than the father”) and excels at integrating information about one thing, but it does not deal with multiple distinct topics at once, nor is it adept at using purely statistical information. System 1 will detect that a person described as “a meek and tidy soul, with a need for order and structure, and a passion for detail” resembles a caricature librarian, but combining this intuition with knowledge about the small number of librarians is a task that only System 2 can perform—if System 2 knows how to do so, which is true of few people.

A crucial capability of System 2 is the adoption of “task sets”: it can program memory to obey an instruction that overrides habitual responses. Consider the following: Count all occurrences of the letter *f* in this page. This is not a task you have ever performed before and it will not come naturally to you, but your System 2 can take it on. It will be effortful to set yourself up for this exercise, and effortful to carry it out, though you will surely improve with practice. Psychologists speak of “executive control” to describe the adoption and termination of task sets, and neuroscientists have identified the main regions of the brain that serve the executive function. One of these regions is involved whenever a conflict must be resolved. Another is the prefrontal area of the brain, a region that is substantially more developed in humans than in other primates, and is involved in operations that we associate with intelligence.

Now suppose that at the end of the page you get another instruction: count all the commas in the next page. This will be harder, because you will have to overcome the newly acquired tendency to focus attention on the letter *f*. One of the significant discoveries of cognitive psychologists in recent decades is that switching from one task to another is effortful, especially under time pressure. The need for rapid switching is one of the reasons that Add-3 and mental multiplication are so difficult. To perform the Add-3 task, you must hold several digits in your working memory at the same time, associating each with a particular operation: some digits are in the queue to be transformed, one is in the process of transformation, and others, already transformed, are retained for reporting. Modern tests of working memory require the individual to switch repeatedly between two

demanding tasks, retaining the results of one operation while performing the other. People who do well on these tests tend to do well on tests of general intelligence. However, the ability to control attention is not simply a measure of intelligence; measures of efficiency in the control of attention predict performance of air traffic controllers and of Israeli Air Force pilots beyond the effects of intelligence.

Time pressure is another driver of effort. As you carried out the Add-3 exercise, the rush was imposed in part by the metronome and in part by the load on memory. Like a juggler with several balls in the air, you cannot afford to slow down; the rate at which material decays in memory forces the pace, driving you to refresh and rehearse information before it is lost. Any task that requires you to keep several ideas in mind at the same time has the same hurried character. Unless you have the good fortune of a capacious working memory, you may be forced to work uncomfortably hard. The most effortful forms of slow thinking are those that require you to think fast.

You surely observed as you performed Add-3 how unusual it is for your mind to work so hard. Even if you think for a living, few of the mental tasks in which you engage in the course of a working day are as demanding as Add-3, or even as demanding as storing six digits for immediate recall. We normally avoid mental overload by dividing our tasks into multiple easy steps, committing intermediate results to long-term memory or to paper rather than to an easily overloaded working memory. We cover long distances by taking our time and conduct our mental lives by the law of least effort.

## **Speaking of Attention and Effort**

"I won't try to solve this while driving. This is a pupil-dilating task. It requires mental effort!"

"The law of least effort is operating here. He will think as little as possible."

"She did not forget about the meeting. She was completely focused on something else when the meeting was set and she just didn't hear you."

“What came quickly to my mind was an intuition from System 1. I’ll have to start over and search my memory deliberately.”

# The Lazy Controller

I spend a few months each year in Berkeley, and one of my great pleasures there is a daily four-mile walk on a marked path in the hills, with a fine view of San Francisco Bay. I usually keep track of my time and have learned a fair amount about effort from doing so. I have found a speed, about 17 minutes for a mile, which I experience as a stroll. I certainly exert physical effort and burn more calories at that speed than if I sat in a recliner, but I experience no strain, no conflict, and no need to push myself. I am also able to think and work while walking at that rate. Indeed, I suspect that the mild physical arousal of the walk may spill over into greater mental alertness.

System 2 also has a natural speed. You expend some mental energy in random thoughts and in monitoring what goes on around you even when your mind does nothing in particular, but there is little strain. Unless you are in a situation that makes you unusually wary or self-conscious, monitoring what happens in the environment or inside your head demands little effort. You make many small decisions as you drive your car, absorb some information as you read the newspaper, and conduct routine exchanges of pleasantries with a spouse or a colleague, all with little effort and no strain. Just like a stroll.

It is normally easy and actually quite pleasant to walk and think at the same time, but at the extremes these activities appear to compete for the limited resources of System 2. You can confirm this claim by a simple experiment. While walking comfortably with a friend, ask him to compute  $23 \times 78$  in his head, and to do so immediately. He will almost certainly stop in his tracks. My experience is that I can think while strolling but cannot engage in mental work that imposes a heavy load on short-term memory. If I must construct an intricate argument under time pressure, I would rather be still, and I would prefer sitting to standing. Of course, not all slow thinking requires that form of intense concentration and effortful computation—I did the best thinking of my life on leisurely walks with Amos.

Accelerating beyond my strolling speed completely changes the experience of walking, because the transition to a faster walk brings about a sharp deterioration in my ability to think coherently. As I speed up, my attention is drawn with increasing frequency to the experience of walking and to the deliberate maintenance of the faster pace. My ability to bring a train of thought to a conclusion is impaired accordingly. At the highest speed I can sustain on the hills, about 14 minutes for a mile, I do not even try to think of anything else. In addition to the physical effort of moving my

body rapidly along the path, a mental effort of self-control is needed to resist the urge to slow down. Self-control and deliberate thought apparently draw on the same limited budget of effort.

For most of us, most of the time, the maintenance of a coherent train of thought and the occasional engagement in effortful thinking also require self-control. Although I have not conducted a systematic survey, I suspect that frequent switching of tasks and speeded-up mental work are not intrinsically pleasurable, and that people avoid them when possible. This is how the law of least effort comes to be a law. Even in the absence of time pressure, maintaining a coherent train of thought requires discipline. An observer of the number of times I look at e-mail or investigate the refrigerator during an hour of writing could reasonably infer an urge to escape and conclude that keeping at it requires more self-control than I can readily muster.

Fortunately, cognitive work is not always aversive, and people sometimes expend considerable effort for long periods of time without having to exert willpower. The psychologist Mihaly Csikszentmihalyi (pronounced six-cent-mihaly) has done more than anyone else to study this state of effortless attending, and the name he proposed for it, *flow*, has become part of the language. People who experience flow describe it as “a state of effortless concentration so deep that they lose their sense of time, of themselves, of their problems,” and their descriptions of the joy of that state are so compelling that Csikszentmihalyi has called it an “optimal experience.” Many activities can induce a sense of flow, from painting to racing motorcycles—and for some fortunate authors I know, even writing a book is often an optimal experience. Flow neatly separates the two forms of effort: concentration on the task and the deliberate control of attention. Riding a motorcycle at 150 miles an hour and playing a competitive game of chess are certainly very effortful. In a state of flow, however, maintaining focused attention on these absorbing activities requires no exertion of self-control, thereby freeing resources to be directed to the task at hand.

## **The Busy and Depleted System 2**

It is now a well-established proposition that both self-control and cognitive effort are forms of mental work. Several psychological studies have shown that people who are simultaneously challenged by a demanding cognitive task and by a temptation are more likely to yield to the temptation. Imagine that you are asked to retain a list of seven digits for a minute or two. You are told that remembering the digits is your top priority. While your attention is focused on the digits, you are offered a choice between two

desserts: a sinful chocolate cake and a virtuous fruit salad. The evidence suggests that you would be more likely to select the tempting chocolate cake when your mind is loaded with digits. System 1 has more influence on behavior when System 2 is busy, and it has a sweet tooth.

People who are *cognitively busy* are also more likely to make selfish choices, use sexist language, and make superficial judgments in social situations. Memorizing and repeating digits loosens the hold of System 2 on behavior, but of course cognitive load is not the only cause of weakened self-control. A few drinks have the same effect, as does a sleepless night. The self-control of morning people is impaired at night; the reverse is true of night people. Too much concern about how well one is doing in a task sometimes disrupts performance by loading short-term memory with pointless anxious thoughts. The conclusion is straightforward: self-control requires attention and effort. Another way of saying this is that controlling thoughts and behaviors is one of the tasks that System 2 performs.

A series of surprising experiments by the psychologist Roy Baumeister and his colleagues has shown conclusively that all variants of voluntary effort—cognitive, emotional, or physical—draw at least partly on a shared pool of mental energy. Their experiments involve successive rather than simultaneous tasks.

Baumeister's group has repeatedly found that an effort of will or self-control is tiring; if you have had to force yourself to do something, you are less willing or less able to exert self-control when the next challenge comes around. The phenomenon has been named *ego depletion*. In a typical demo thypical denstration, participants who are instructed to stifle their emotional reaction to an emotionally charged film will later perform poorly on a test of physical stamina—how long they can maintain a strong grip on a dynamometer in spite of increasing discomfort. The emotional effort in the first phase of the experiment reduces the ability to withstand the pain of sustained muscle contraction, and ego-depleted people therefore succumb more quickly to the urge to quit. In another experiment, people are first depleted by a task in which they eat virtuous foods such as radishes and celery while resisting the temptation to indulge in chocolate and rich cookies. Later, these people will give up earlier than normal when faced with a difficult cognitive task.

The list of situations and tasks that are now known to deplete self-control is long and varied. All involve conflict and the need to suppress a natural tendency. They include:

- avoiding the thought of white bears
- inhibiting the emotional response to a stirring film

- making a series of choices that involve conflict
- trying to impress others
- responding kindly to a partner's bad behavior
- interacting with a person of a different race (for prejudiced individuals)

The list of indications of depletion is also highly diverse:

- deviating from one's diet
- overspending on impulsive purchases
- reacting aggressively to provocation
- persisting less time in a handgrip task
- performing poorly in cognitive tasks and logical decision making

The evidence is persuasive: activities that impose high demands on System 2 require self-control, and the exertion of self-control is depleting and unpleasant. Unlike cognitive load, ego depletion is at least in part a loss of motivation. After exerting self-control in one task, you do not feel like making an effort in another, although you could do it if you really had to. In several experiments, people were able to resist the effects of ego depletion when given a strong incentive to do so. In contrast, increasing effort is not an option when you must keep six digits in short-term memory while performing a task. Ego depletion is not the same mental state as cognitive busyness.

The most surprising discovery made by Baumeister's group shows, as he puts it, that the idea of mental energy is more than a mere metaphor. The nervous system consumes more glucose than most other parts of the body, and effortful mental activity appears to be especially expensive in the currency of glucose. When you are actively involved in difficult cognitive reasoning or engaged in a task that requires self-control, your blood glucose level drops. The effect is analogous to a runner who draws down glucose stored in her muscles during a sprint. The bold implication of this idea is that the effects of ego depletion could be undone by ingesting glucose, and Baumeister and his colleagues have confirmed this hypothesis in several experiments.

Volunteers in one of their studies watched a short silent film of a woman being interviewed and were asked to interpret her body language. While they were performing the task, a series of words crossed the screen in slow succession. The participants were specifically instructed to ignore the words, and if they found their attention drawn away they had to refocus their concentration on the woman's behavior. This act of self-control was known to cause ego depletion. All the volunteers drank some lemonade before



participating in a second task. The lemonade was sweetened with glucose for half of them and with Splenda for the others. Then all participants were given a task in which they needed to overcome an intuitive response to get the correct answer. Intuitive errors are normally much more frequent among ego-depleted people, and the drinkers of Splenda showed the expected depletion effect. On the other hand, the glucose drinkers were not depleted. Restoring the level of available sugar in the brain had prevented the deterioration of performance. It will take some time and much further research to establish whether the tasks that cause glucose-depletion also cause the momentary arousal that is reflected in increases of pupil size and heart rate.

A disturbing demonstration of depletion effects in judgment was recently reported in the *Proceedings of the National Academy of Sciences*. The unwitting participants in the study were eight parole judges in Israel. They spend entire days reviewing applications for parole. The cases are presented in random order, and the judges spend little time on each one, an average of 6 minutes. (The default decision is denial of parole; only 35% of requests are approved. The exact time of each decision is recorded, and the times of the judges' three food breaks—morning break, lunch, and afternoon break—during the day are recorded as well.) The authors of the study plotted the proportion of approved requests against the time since the last food break. The proportion spikes after each meal, when about 65% of requests are granted. During the two hours or so until the judges' next feeding, the approval rate drops steadily, to about zero just before the meal. As you might expect, this is an unwelcome result and the authors carefully checked many alternative explanations. The best possible account of the data provides bad news: tired and hungry judges tend to fall back on the easier default position of denying requests for parole. Both fatigue and hunger probably play a role.

## The Lazy System 2

One of the main functions of System 2 is to monitor and control thoughts and actions “suggested” by System 1, allowing some to be expressed directly in behavior and suppressing or modifying others.

For an example, here is a simple puzzle. Do not try to solve it but listen to your intuition:

A bat and ball cost \$1.10.

The bat costs one dollar more than the ball.

How much does the ball cost?

A number came to your mind. The number, of course, is 10: 10¢. The distinctive mark of this easy puzzle is that it evokes an answer that is intuitive, appealing, and wrong. Do the math, and you will see. If the ball costs 10¢, then the total cost will be \$1.20 (10¢ for the ball and \$1.10 for the bat), not \$1.10. The correct answer is 5¢. It's safe to assume that the intuitive answer also came to the mind of those who ended up with the correct number—they somehow managed to resist the intuition.

Shane Frederick and I worked together on a theory of judgment based on two systems, and he used the bat-and-ball puzzle to study a central question: How closely does System 2 monitor the suggestions of System 1? His reasoning was that we know a significant fact about anyone who says that the ball costs 10¢: that person did not actively check whether the answer was correct, and her System 2 endorsed an intuitive answer that it could have rejected with a small investment of effort. Furthermore, we also know that the people who give the intuitive answer have missed an obvious social cue; they should have wondered why anyone would include in a questionnaire a puzzle with such an obvious answer. A failure to check is remarkable because the cost of checking is so low: a few seconds of mental work (the problem is moderately difficult), with slightly tensed muscles and dilated pupils, could avoid an embarrassing mistake. People who say 10¢ appear to be ardent followers of the law of least effort. People who avoid that answer appear to have more active minds.

Many thousands of university students have answered the bat-and-ball puzzle, and the results are shocking. More than 50% of students at Harvard, MIT, and Princeton gave the intuitive—incorrect—answer. At less selective universities, the rate of demonstrable failure to check was in excess of 80%. The bat-and-ball problem is our first encounter with an observation that will be a recurrent theme of this book: many people are overconfident, prone to place too much faith in their intuitions. They apparently find cognitive effort at least mildly unpleasant and avoid it as much as possible.

Now I will show you a logical argument—two premises and a conclusion. Try to determine, as quickly as you can, if the argument is logically valid. Does the conclusion follow from the premises?

All roses are flowers.

Some flowers fade quickly.

Therefore some roses fade quickly.

A large majority of college students endorse this syllogism as valid. In fact the argument is flawed, because it is possible that there are no roses among the flowers that fade quickly. Just as in the bat-and-ball problem, a

plausible answer comes to mind immediately. Overriding it requires hard work—the insistent idea that “it’s true, it’s true!” makes it difficult to check the logic, and most people do not take the trouble to think through the problem.

This experiment has discouraging implications for reasoning in everyday life. It suggests that when people believe a conclusion is true, they are also very likely to believe arguments that appear to support it, even when these arguments are unsound. If System 1 is involved, the conclusion comes first and the arguments follow.

Next, consider the following question and answer it quickly before reading on:

How many murders occur in the state of Michigan in one year?

The question, which was also devised by Shane Frederick, is again a challenge to System 2. The “trick” is whether the respondent will remember that Detroit, a high-crime city, is in Michigan. College students in the United States know this fact and will correctly identify Detroit as the largest city in Michigan. But knowledge of a fact is not all-or-none. Facts that we know do not always come to mind when we need them. People who remember that Detroit is in Michigan give higher estimates of the murder rate in the state than people who do not, but a majority of Frederick’s respondents did not think of the city when questioned about the state. Indeed, the average guess by people who were asked about Michigan is *lower* than the guesses of a similar group who were asked about the murder rate in Detroit.

Blame for a failure to think of Detroit can be laid on both System 1 and System 2. Whether the city comes to mind when the state is mentioned depends in part on the automatic function of memory. People differ in this respect. The representation of the state of Michigan is very detailed in some people’s minds: residents of the state are more likely to retrieve many facts about it than people who live elsewhere; geography buffs will retrieve more than others who specialize in baseball statistics; more intelligent individuals are more likely than others to have rich representations of most things. Intelligence is not only the ability to reason; it is also the ability to find relevant material in memory and to deploy attention when needed. Memory function is an attribute of System 1. However, everyone has the option of slowing down to conduct an active search of memory for all possibly relevant facts—just as they could slow down to check the intuitive answer in the bat-and-ball problem. The extent of deliberate checking and search is a characteristic of System 2, which varies among individuals.

The bat-and-ball problem, the flowers syllogism, and the Michigan/Detroit problem have something in common. Failing these minitests appears to be, at least to some extent, a matter of insufficient motivation, not trying hard enough. Anyone who can be admitted to a good university is certainly able to reason through the first two questions and to reflect about Michigan long enough to remember the major city in that state and its crime problem. These students can solve much more difficult problems when they are not tempted to accept a superficially plausible answer that comes readily to mind. The ease with which they are satisfied enough to stop thinking is rather troubling. "Lazy" is a harsh judgment about the self-monitoring of these young people and their System 2, but it does not seem to be unfair. Those who avoid the sin of intellectual sloth could be called "engaged." They are more alert, more intellectually active, less willing to be satisfied with superficially attractive answers, more skeptical about their intuitions. The psychologist Keith Stanovich would call them more rational.

## **Intelligence, Control, Rationality**

Researchers have applied diverse methods to examine the connection between thinking and self-control. Some have addressed it by asking the correlation question: If people were ranked by their self-control and by their cognitive aptitude, would individuals have similar positions in the two rankings?

In one of the most famous experiments in the history of psychology, Walter Mischel and his students exposed four-year-old children to a cruel dilemma. They were given a choice between a small reward (one Oreo), which they could have at any time, or a larger reward (two cookies) for which they had to wait 15 minutes under difficult conditions. They were to remain alone in a room, facing a desk with two objects: a single cookie and a bell that the child could ring at any time to call in the experimenter and receive one and receive the one cookie. As the experiment was described: "There were no toys, books, pictures, or other potentially distracting items in the room. The experimenter left the room and did not return until 15 min had passed or the child had rung the bell, eaten the rewards, stood up, or shown any signs of distress."

The children were watched through a one-way mirror, and the film that shows their behavior during the waiting time always has the audience roaring in laughter. About half the children managed the feat of waiting for 15 minutes, mainly by keeping their attention away from the tempting reward. Ten or fifteen years later, a large gap had opened between those

who had resisted temptation and those who had not. The resisters had higher measures of executive control in cognitive tasks, and especially the ability to reallocate their attention effectively. As young adults, they were less likely to take drugs. A significant difference in intellectual aptitude emerged: the children who had shown more self-control as four-year-olds had substantially higher scores on tests of intelligence.

A team of researchers at the University of Oregon explored the link between cognitive control and intelligence in several ways, including an attempt to raise intelligence by improving the control of attention. During five 40-minute sessions, they exposed children aged four to six to various computer games especially designed to demand attention and control. In one of the exercises, the children used a joystick to track a cartoon cat and move it to a grassy area while avoiding a muddy area. The grassy areas gradually shrank and the muddy area expanded, requiring progressively more precise control. The testers found that training attention not only improved executive control; scores on nonverbal tests of intelligence also improved and the improvement was maintained for several months. Other research by the same group identified specific genes that are involved in the control of attention, showed that parenting techniques also affected this ability, and demonstrated a close connection between the children's ability to control their attention and their ability to control their emotions.

Shane Frederick constructed a Cognitive Reflection Test, which consists of the bat-and-ball problem and two other questions, chosen because they also invite an intuitive answer that is both compelling and wrong ([the questions are shown here](#)). He went on to study the characteristics of students who score very low on this test—the supervisory function of System 2 is weak in these people—and found that they are prone to answer questions with the first idea that comes to mind and unwilling to invest the effort needed to check their intuitions. Individuals who uncritically follow their intuitions about puzzles are also prone to accept other suggestions from System 1. In particular, they are impulsive, impatient, and keen to receive immediate gratification. For example, 63% of the intuitive respondents say they would prefer to get \$3,400 this month rather than \$3,800 next month. Only 37% of those who solve all three puzzles correctly have the same shortsighted preference for receiving a smaller amount immediately. When asked how much they will pay to get overnight delivery of a book they have ordered, the low scorers on the Cognitive Reflection Test are willing to pay twice as much as the high scorers. Frederick's findings suggest that the characters of our psychodrama have different "personalities." System 1 is impulsive and intuitive; System 2 is capable of reasoning, and it is cautious, but at least for some people it is also lazy. We recognize related differences among

individuals: some people are more like their System 2; others are closer to their System 1. This simple test has emerged as one of the better predictors of laziness or of lazy thinking.

Keith Stanovich and his longtime collaborator Richard West originally introduced the terms System 1 and System 2 (they now prefer to speak of Type 1 and Type 2 processes). Stanovich and his colleagues have spent decades studying differences among individuals in the kinds of problems with which this book is concerned. They have asked one basic question in many different ways: What makes some people more susceptible than others to biases of judgment? Stanovich published his conclusions in a book titled *Rationality and the Reflective Mind*, which offers a bold and distinctive approach to the topic of this chapter. He draws a sharp distinction between two parts of System 2—indeed, the distinction is so sharp that he calls them separate “minds.” One of these minds (he calls it algorithmic) deals with slow thinking and demanding computation. Some people are better than others in these tasks of brain power—they are the individuals who excel in intelligence tests and are able to switch from one task to another quickly and efficiently. However, Stanovich argues that high intelligence does not make people immune to biases. Another ability is involved, which he labels rationality. Stanovich’s concept of a rational person is similar to what I earlier labeled “engaged.” The core of his argument is that *rationality* should be distinguished from *intelligence*. In his view, superficial or “lazy” thinking is a flaw in the reflective mind, a failure of rationality. This is an attractive and thought-provoking idea. In support of it, Stanovich and his colleagues have found that the bat-and-ball question and others like it are somewhat better indicators of our susceptibility to cognitive errors than are conventional measures of intelligence, such as IQ tests. Time will tell whether the distinction between intelligence and rationality can lead to new discoveries.

## Speaking of Control

“She did not have to struggle to stay on task for hours. She was in a state of *flow*.”

“His ego was depleted after a long day of meetings. So he just turned to standard operating procedures instead of thinking through the problem.”

“He didn’t bother to check whether what he said made sense. Does he usually have a lazy System 2 or was he unusually tired?”

“Unfortunately, she tends to say the first thing that comes into her mind. She probably also has trouble delaying gratification. Weak System 2.”

# The Associative Machine

To begin your exploration of the surprising workings of System 1, look at the following words:

Bananas Vomit

A lot happened to you during the last second or two. You experienced some unpleasant images and memories. Your face twisted slightly in an expression of disgust, and you may have pushed this book imperceptibly farther away. Your heart rate increased, the hair on your arms rose a little, and your sweat glands were activated. In short, you responded to the disgusting word with an attenuated version of how you would react to the actual event. All of this was completely automatic, beyond your control.

There was no particular reason to do so, but your mind automatically assumed a temporal sequence and a causal connection between the words *bananas* and *vomit*, forming a sketchy scenario in which bananas caused the sickness. As a result, you are experiencing a temporary aversion to bananas (don't worry, it will pass). The state of your memory has changed in other ways: you are now unusually ready to recognize and respond to objects and concepts associated with "vomit," such as sick, stink, or nausea, and words associated with "bananas," such as yellow and fruit, and perhaps apple and berries.

Vomiting normally occurs in specific contexts, such as hangovers and indigestion. You would also be unusually ready to recognize words associated with other causes of the same unfortunate outcome. Furthermore, your System 1 noticed the fact that the juxtaposition of the two words is uncommon; you probably never encountered it before. You experienced mild surprise.

This complex constellation of responses occurred quickly, automatically, and effortlessly. You did not will it and you could not stop it. It was an operation of System 1. The events that took place as a result of your seeing the words happened by a process called associative activation: ideas that have been evoked trigger many other ideas, in a spreading cascade of activity in your brain. The essential feature of this complex set of mental events is its coherence. Each element is connected, and each supports and strengthens the others. The word evokes memories, which evoke emotions, which in turn evoke facial expressions and other reactions, such as a general tensing up and an avoidance tendency. The



facial expression and the avoidance motion intensify the feelings to which they are linked, and the feelings in turn reinforce compatible ideas. All this happens quickly and all at once, yielding a self-reinforcing pattern of cognitive, emotional, and physical responses that is both diverse and integrated—it has been called *associatively coherent*.

In a second or so you accomplished, automatically and unconsciously, a remarkable feat. Starting from a completely unexpected event, your System 1 made as much sense as possible of the situation—two simple words, oddly juxtaposed—by linking the words in a causal story; it evaluated the possible threat (mild to moderate) and created a context for future developments by preparing you for events that had just become more likely; it also created a context for the current event by evaluating how surprising it was. You ended up as informed about the past and as prepared for the future as you could be.

An odd feature of what happened is that your System 1 treated the mere conjunction of two words as representations of reality. Your body reacted in an attenuated replica of a reaction to the real thing, and the emotional response and physical recoil were part of the interpretation of the event. As cognitive scientists have emphasized in recent years, cognition is embodied; you think with your body, not only with your brain.

The mechanism that causes these mental events has been known for a long time: it is the association of ideas. We all understand from experience that ideas follow each other in our conscious mind in a fairly orderly way. The British philosophers of the seventeenth and eighteenth centuries searched for the rules that explain such sequences. In *An Enquiry Concerning Human Understanding*, published in 1748, the Scottish philosopher David Hume reduced the principles of association to three: resemblance, contiguity in time and place, and causality. Our concept of association has changed radically since Hume's days, but his three principles still provide a good start.

I will adopt an expansive view of what an idea is. It can be concrete or abstract, and it can be expressed in many ways: as a verb, as a noun, as an adjective, or as a clenched fist. Psychologists think of ideas as nodes in a vast network, called associative memory, in which each idea is linked to many others. There are different types of links: causes are linked to their effects (virus → cold); things to their properties (lime → green); things to the categories to which they belong (banana → fruit). One way we have advanced beyond Hume is that we no longer think of the mind as going through a sequence of conscious ideas, one at a time. In the current view of how associative memory works, a great deal happens at once. An idea that has been activated does not merely evoke one other idea. It activates

many ideas, which in turn activate others. Furthermore, only a few of the activated ideas will register in consciousness; most of the work of associative thinking is silent, hidden from our conscious selves. The notion that we have limited access to the workings of our minds is difficult to accept because, naturally, it is alien to our experience, but it is true: you know far less about yourself than you feel you do.

## The Marvels of Priming

As is common in science, the first big breakthrough in our understanding of the mechanism of association was an improvement in a method of measurement. Until a few decades ago, the only way to study associations was to ask many people questions such as, "What is the first word that comes to your mind when you hear the word DAY?" The researchers tallied the frequency of responses, such as "night," "sunny," or "long." In the 1980s, psychologists discovered that exposure to a word causes immediate and measurable changes in the ease with which many related words can be evoked. If you have recently seen or heard the word EAT, you are temporarily more likely to complete the word fragment SO\_P as SOUP than as SOAP. The opposite would happen, of course, if you had just seen WASH. We call this a *priming effect* and say that the idea of EAT primes the idea of SOUP, and that WASH primes SOAP.

Priming effects take many forms. If the idea of EAT is currently on your mind (whether or not you are conscious of it), you will be quicker than usual to recognize the word SOUP when it is spoken in a whisper or presented in a blurry font. And of course you are primed not only for the idea of soup but also for a multitude of food-related ideas, including fork, hungry, fat, diet, and cookie. If for your most recent meal you sat at a wobbly restaurant table, you will be primed for wobbly as well. Furthermore, the primed ideas have some ability to prime other ideas, although more weakly. Like ripples on a pond, activation spreads through a small part of the vast network of associated ideas. The mapping of these ripples is now one of the most exciting pursuits in psychological research.

Another major advance in our understanding of memory was the discovery that priming is not restricted to concepts and words. You cannot know this from conscious experience, of course, but you must accept the alien idea that your actions and your emotions can be primed by events of which you are not even aware. In an experiment that became an instant classic, the psychologist John Bargh and his collaborators asked students at New York University—most aged eighteen to twenty-two—to assemble four-word sentences from a set of five words (for example, "finds he it

yellow instantly"). For one group of students, half the scrambled sentences contained words associated with the elderly, such as *Florida*, *forgetful*, *bald*, *gray*, or *wrinkle*. When they had completed that task, the young participants were sent out to do another experiment in an office down the hall. That short walk was what the experiment was about. The researchers unobtrusively measured the time it took people to get from one end of the corridor to the other. As Bargh had predicted, the young people who had fashioned a sentence from words with an elderly theme walked down the hallway significantly more slowly than the others.

The "Florida effect" involves two stages of priming. First, the set of words primes thoughts of old age, though the word *old* is never mentioned; second, these thoughts prime a behavior, walking slowly, which is associated with old age. All this happens without any awareness. When they were questioned afterward, none of the students reported noticing that the words had had a common theme, and they all insisted that nothing they did after the first experiment could have been influenced by the words they had encountered. The idea of old age had not come to their conscious awareness, but their actions had changed nevertheless. This remarkable priming phenomenon—the influencing of an action by the idea—is known as the ideomotor effect. Although you surely were not aware of it, reading this paragraph primed you as well. If you had needed to stand up to get a glass of water, you would have been slightly slower than usual to rise from your chair—unless you happen to dislike the elderly, in which case research suggests that you might have been slightly faster than usual!

The ideomotor link also works in reverse. A study conducted in a German university was the mirror image of the early experiment that Bargh and his colleagues had carried out in New York. Students were asked to walk around a room for 5 minutes at a rate of 30 steps per minute, which was about one-third their normal pace. After this brief experience, the participants were much quicker to recognize words related to old age, such as *forgetful*, *old*, and *lonely*. Reciprocal priming effects tend to produce a coherent reaction: if you were primed to think of old age, you would tend to act old, and acting old would reinforce the thought of old age.

Reciprocal links are common in the associative network. For example, being amused tends to make you smile, and smiling tends to make you feel amused. Go ahead and take a pencil, and hold it between your teeth for a few seconds with the eraser pointing to your right and the point to your left. Now hold the pencil so the point is aimed straight in front of you, by pursing your lips around the eraser end. You were probably unaware that one of these actions forced your face into a frown and the other into a smile. College students were asked to rate the humor of cartoons from

Gary Larson's *The Far Side* while holding a pencil in their mouth. Those who were "smiling" (without any awareness of doing so) found the cartoons funnier; those who were "frowning." In another experiment, people whose face was shaped into a frown (by squeezing their eyebrows together) reported an enhanced emotional response to upsetting pictures—starving children, people arguing, maimed accident victims.

Simple, common gestures can also unconsciously influence our thoughts and feelings. In one demonstration, people were asked to listen to messages through new headphones. They were told that the purpose of the experiment was to test the quality of the audio equipment and were instructed to move their heads repeatedly to check for any distortions of sound. Half the participants were told to nod their head up and down while others were told to shake it side to side. The messages they heard were radio editorials. Those who nodded (a yes gesture) tended to accept the message they heard, but those who shook their head tended to reject it. Again, there was no awareness, just a habitual connection between an attitude of rejection or acceptance and its common physical expression. You can see why the common admonition to "act calm and kind regardless of how you feel" is very good advice: you are likely to be rewarded by actually feeling calm and kind.

## **Primes That Guide Us**

Studies of priming effects have yielded discoveries that threaten our self-image as conscious and autonomous authors of our judgments and our choices. For instance, most of us think of voting as a deliberate act that reflects our values and our assessments of policies and is not influenced by irrelevancies. Our vote should not be affected by the location of the polling station, for example, but it is. A study of voting patterns in precincts of Arizona in 2000 showed that the support for propositions to increase the funding of schools was significantly greater when the polling station was in a school than when it was in a nearby location. A separate experiment showed that exposing people to images of classrooms and school lockers also increased the tendency of participants to support a school initiative. The effect of the images was larger than the difference between parents and other voters! The study of priming has come some way from the initial demonstrations that reminding people of old age makes them walk more slowly. We now know that the effects of priming can reach into every corner of our lives.

Reminders of money produce some troubling effects. Participants in one

experiment were shown a list of five words from which they were required to construct a four-word phrase that had a money theme ("high a salary desk paying" became "a high-paying salary"). Other primes were much more subtle, including the presence of an irrelevant money-related object in the background, such as a stack of Monopoly money on a table, or a computer with a screen saver of dollar bills floating in water.

Money-primed people become more independent than they would be without the associative trigger. They persevered almost twice as long in trying to solve a very difficult problem before they asked the experimenter for help, a crisp demonstration of increased self-reliance. Money-primed people are also more selfish: they were much less willing to spend time helping another student who pretended to be confused about an experimental task. When an experimenter clumsily dropped a bunch of pencils on the floor, the participants with money (unconsciously) on their mind picked up fewer pencils. In another experiment in the series, participants were told that they would shortly have a get-acquainted conversation with another person and were asked to set up two chairs while the experimenter left to retrieve that person. Participants primed by money chose in the end to stay much farther apart than their nonprimed peers (118 vs. 80 centimeters). Money-primed undergraduates also showed a greater preference for being alone.

The general theme of these findings is that the idea of money primes individualism: a reluctance to be involved with others, to depend on others, or to accept demands from others. The psychologist who has done this remarkable research, Kathleen Vohs, has been laudably restrained in discussing the implications of her findings, leaving the task to her readers. Her experiments are profound—her findings suggest that living in a culture that surrounds us with reminders of money may shape our behavior and our attitudes in ways that we do not know about and of which we may not be proud. Some cultures provide frequent reminders of respect, others constantly remind their members of God, and some societies prime obedience by large images of the Dear Leader. Can there be any doubt that the ubiquitous portraits of the national leader in dictatorial societies not only convey the feeling that "Big Brother Is Watching" but also lead to an actual reduction in spontaneous thought and independent action?

The evidence of priming studies suggests that reminding people of their mortality increases the appeal of authoritarian ideas, which may become reassuring in the context of the terror of death. Other experiments have confirmed Freudian insights about the role of symbols and metaphors in unconscious associations. For example, consider the ambiguous word fragments W \_ \_ H and S \_ \_ P. People who were recently asked to think of an action of which they are ashamed are more likely to complete those

fragments as WASH and SOAP and less likely to see WISH and SOUP. Furthermore, merely thinking about stabbing a coworker in the back leaves people more inclined to buy soap, disinfectant, or detergent than batteries, juice, or candy bars. Feeling that one's soul is stained appears to trigger a desire to cleanse one's body, an impulse that has been dubbed the "Lady Macbeth effect."

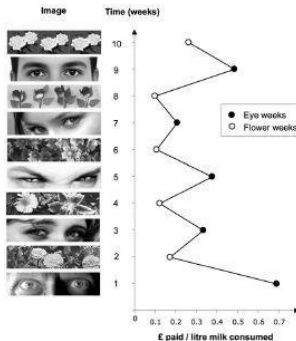
The cleansing is highly specific to the body parts involved in a sin. Participants in an experiment were induced to "lie" to an imaginary person, either on the phone or in e-mail. In a subsequent test of the desirability of various products, people who had lied on the phone preferred mouthwash over soap, and those who had lied in e-mail preferred soap to mouthwash.

When I describe priming studies to audiences, the reaction is often disbelief. This is not a surprise: System 2 believes that it is in charge and that it knows the reasons for its choices. Questions are probably cropping up in your mind as well: How is it possible for such trivial manipulations of the context to have such large effects? Do these experiments demonstrate that we are completely at the mercy of whatever primes the environment provides at any moment? Of course not. The effects of the primes are robust but not necessarily large. Among a hundred voters, only a few whose initial preferences were uncertain will vote differently about a school issue if their precinct is located in a school rather than in a church—but a few percent could tip an election.

The idea you should focus on, however, is that disbelief is not an option. The results are not made up, nor are they statistical flukes. You have no choice but to accept that the major conclusions of these studies are true. More important, you must accept that they are true about *you*. If you had been exposed to a screen saver of floating dollar bills, you too would likely have picked up fewer pencils to help a clumsy stranger. You do not believe that these results apply to you because they correspond to nothing in your subjective experience. But your subjective experience consists largely of the story that your System 2 tells itself about what is going on. Priming phenomena arise in System 1, and you have no conscious access to them.

I conclude with a perfect demonstration of a priming effect, which was conducted in an office kitchen at a British university. For many years members of that office had paid for the tea or coffee to which they helped themselves during the day by dropping money into an "honesty box." A list of suggested prices was posted. One day a banner poster was displayed just above the price list, with no warning or explanation. For a period of ten weeks a new image was presented each week, either flowers or eyes that appeared to be looking directly at the observer. No one commented on the

new decorations, but the contributions to the honesty box changed significantly. The posters and the amounts that people put into the cash box (relative to the amount they consumed) are shown in figure 4. They deserve a close look.



**Figure 4**

On the first week of the experiment (which you can see at the bottom of the figure), two wide-open eyes stare at the coffee or tea drinkers, whose average contribution was 70 pence per liter of milk. On week 2, the poster shows flowers and average contributions drop to about 15 pence. The trend continues. On average, the users of the kitchen contributed almost three times as much in “eye weeks” as they did in “flower weeks.” Evidently, a purely symbolic reminder of being watched prodded people into improved behavior. As we expect at this point, the effect occurs without any awareness. Do you now believe that you would also fall into the same pattern?

Some years ago, the psychologist Timothy Wilson wrote a book with the evocative title *Strangers to Ourselves*. You have now been introduced to that stranger in you, which may be in control of much of what you do, although you rarely have a glimpse of it. System 1 provides the impressions that often turn into your beliefs, and is the source of the impulses that often become your choices and your actions. It offers a tacit interpretation of what happens to you and around you, linking the present

with the recent past and with expectations about the near future. It contains the model of the world that instantly evaluates events as normal or surprising. It is the source of your rapid and often precise intuitive judgments. And it does most of this without your conscious awareness of its activities. System 1 is also, as we will see in the following chapters, the origin of many of the systematic errors in your intuitions.

## **Speaking of Priming**

“The sight of all these people in uniforms does not prime creativity.”

“The world makes much less sense than you think. The coherence comes mostly from the way your mind works.”

“They were primed to find flaws, and this is exactly what they found.”

“His System 1 constructed a story, and his System 2 believed it. It happens to all of us.”

“I made myself smile and I’m actually feeling better!”

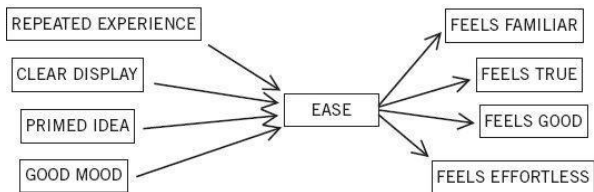


# Cognitive Ease

Whenever you are conscious, and perhaps even when you are not, multiple computations are going on in your brain, which maintain and update current answers to some key questions: Is anything new going on? Is there a threat? Are things going well? Should my attention be redirected? Is more effort needed for this task? You can think of a cockpit, with a set of dials that indicate the current values of each of these essential variables. The assessments are carried out automatically by System 1, and one of their functions is to determine whether extra effort is required from System 2.

One of the dials measures *cognitive ease*, and its range is between “Easy” and “Strained.” Easy is a sign that things are going well—no threats, no major news, no need to redirect attention or mobilize effort. Strained indicates that a problem exists, which will require increased mobilization of System 2. Conversely, you experience *cognitive strain*. Cognitive strain is affected by both the current level of effort and the presence of unmet demands. The surprise is that a single dial of cognitive ease is connected to a large network of diverse inputs and outputs. [Figure 5](#) tells the story.

The figure suggests that a sentence that is printed in a clear font, or has been repeated, or has been primed, will be fluently processed with cognitive ease. Hearing a speaker when you are in a good mood, or even when you have a pencil stuck crosswise in your mouth to make you “smile,” also induces cognitive ease. Conversely, you experience cognitive strain when you read instructions in a poor font, or in faint colors, or worded in complicated language, or when you are in a bad mood, and even when you frown.



**Figure 5. Causes and Consequences of Cognitive Ease**

The various causes of ease or strain have interchangeable effects. When you are in a state of cognitive ease, you are probably in a good mood, like what you see, believe what you hear, trust your intuitions, and feel that the current situation is comfortably familiar. You are also likely to be relatively casual and superficial in your thinking. When you feel strained, you are more likely to be vigilant and suspicious, invest more effort in what you are doing, feel less comfortable, and make fewer errors, but you also are less intuitive and less creative than usual.

## Illusions of Remembering

The word *illusion* brings visual illusions to mind, because we are all familiar with pictures that mislead. But vision is not the only domain of illusions; memory is also susceptible to them, as is thinking more generally.

David Stenbill, Monica Bigoutski, Sh"imight=s is pictana Tirana. I just made up these names. If you encounter any of them within the next few minutes you are likely to remember where you saw them. You know, and will know for a while, that these are not the names of minor celebrities. But suppose that a few days from now you are shown a long list of names, including some minor celebrities and "new" names of people that you have never heard of; your task will be to check every name of a celebrity in the list. There is a substantial probability that you will identify David Stenbill as a well-known person, although you will not (of course) know whether you encountered his name in the context of movies, sports, or politics. Larry Jacoby, the psychologist who first demonstrated this memory illusion in the laboratory, titled his article "Becoming Famous Overnight." How does this happen? Start by asking yourself how you know whether or not someone is famous. In some cases of truly famous people (or of celebrities in an area you follow), you have a mental file with rich information about a person—think Albert Einstein, Bono, Hillary Clinton. But you will have no file of information about David Stenbill if you encounter his name in a few days. All you will have is a sense of familiarity—you have seen this name somewhere.

Jacoby nicely stated the problem: "The experience of familiarity has a simple but powerful quality of 'pastness' that seems to indicate that it is a direct reflection of prior experience." This quality of pastness is an illusion. The truth is, as Jacoby and many followers have shown, that the name David Stenbill will look familiar when you see it *because you will see it more clearly*. Words that you have seen before become easier to see

again—you can identify them better than other words when they are shown very briefly or masked by noise, and you will be quicker (by a few hundredths of a second) to read them than to read other words. In short, you experience greater cognitive ease in perceiving a word you have seen earlier, and it is this sense of ease that gives you the impression of familiarity.

Figure 5 suggests a way to test this. Choose a completely new word, make it easier to see, and it will be more likely to have the quality of pastness. Indeed, a new word is more likely to be recognized as familiar if it is unconsciously primed by showing it for a few milliseconds just before the test, or if it is shown in sharper contrast than some other words in the list. The link also operates in the other direction. Imagine you are shown a list of words that are more or less out of focus. Some of the words are severely blurred, others less so, and your task is to identify the words that are shown more clearly. A word that you have seen recently will appear to be clearer than unfamiliar words. As figure 5 indicates, the various ways of inducing cognitive ease or strain are interchangeable; you may not know precisely what it is that makes things cognitively easy or strained. This is how the illusion of familiarity comes about.

## Illusions of Truth

“New York is a large city in the United States.” “The moon revolves around Earth.” “A chicken has four legs.” In all these cases, you quickly retrieved a great deal of related information, almost all pointing one way or another. You knew soon after reading them that the first two statements are true and the last one is false. Note, however, that the statement “A chicken has three legs” is more obviously false than “A chicken has four legs.” Your associative machinery slows the judgment of the latter sentence by delivering the fact that many animals have four legs, and perhaps also that supermarkets often sell chicken or blurred, legs in packages of four. System 2 was involved in sifting that information, perhaps raising the issue of whether the question about New York was too easy, or checking the meaning of *revolves*.

Think of the last time you took a driving test. Is it true that you need a special license to drive a vehicle that weighs more than three tons? Perhaps you studied seriously and can remember the side of the page on which the answer appeared, as well as the logic behind it. This is certainly not how I passed driving tests when I moved to a new state. My practice was to read the booklet of rules quickly once and hope for the best. I knew some of the answers from the experience of driving for a long time. But

there were questions where no good answer came to mind, where all I had to go by was cognitive ease. If the answer felt familiar, I assumed that it was probably true. If it looked new (or improbably extreme), I rejected it. The impression of familiarity is produced by System 1, and System 2 relies on that impression for a true/false judgment.

The lesson of figure 5 is that predictable illusions inevitably occur if a judgment is based on an impression of cognitive ease or strain. Anything that makes it easier for the associative machine to run smoothly will also bias beliefs. A reliable way to make people believe in falsehoods is frequent repetition, because familiarity is not easily distinguished from truth. Authoritarian institutions and marketers have always known this fact. But it was psychologists who discovered that you do not have to repeat the entire statement of a fact or idea to make it appear true. People who were repeatedly exposed to the phrase “the body temperature of a chicken” were more likely to accept as true the statement that “the body temperature of a chicken is 144°” (or any other arbitrary number). The familiarity of one phrase in the statement sufficed to make the whole statement feel familiar, and therefore true. If you cannot remember the source of a statement, and have no way to relate it to other things you know, you have no option but to go with the sense of cognitive ease.

## How to Write a Persuasive Message

Suppose you must write a message that you want the recipients to believe. Of course, your message will be true, but that is not necessarily enough for people to believe that it is true. It is entirely legitimate for you to enlist cognitive ease to work in your favor, and studies of *truth illusions* provide specific suggestions that may help you achieve this goal.

The general principle is that anything you can do to reduce cognitive strain will help, so you should first maximize legibility. Compare these two statements:

**Adolf Hitler was born in 1892.**

Adolf Hitler was born in 1887.

Both are false (Hitler was born in 1889), but experiments have shown that the first is more likely to be believed. More advice: if your message is to be printed, use high-quality paper to maximize the contrast between characters and their background. If you use color, you are more likely to be believed if your text is printed in bright blue or red than in middling shades of green, yellow, or pale blue.

If you care about being thought credible and intelligent, do not use complex language where simpler language will do. My Princeton colleague Danny Oppenheimer refuted a myth prevalent among undergraduates about the vocabulary that professors find most impressive. In an article titled "Consequences of Erudite Vernacular Utilized Irrespective of Necessity: Problems with Using Long Words Needlessly," he showed that couching familiar ideas in pretentious language is taken as a sign of poor intelligence and low credibility.

In addition to making your message simple, try to make it memorable. Put your ideas in verse if you can; they will be more likely to be taken as truth. Participants in a much cited experiment read dozens of unfamiliar aphorisms, such as:

Woes unite foes.  
Little strokes will tumble great oaks.  
A fault confessed is half redressed.

Other students read some of the same proverbs transformed into nonrhyming versions:

Woes unite enemies.  
Little strokes will tumble great trees.  
A fault admitted is half redressed.

The aphorisms were judged more insightful when they rhymed than when they did not.

Finally, if you quote a source, choose one with a name that is easy to pronounce. Participants in an experiment were asked to evaluate the prospects of fictitious Turkish companies on the basis of reports from two brokerage firms. For each stock, one of the reports came from an easily pronounced name (e.g., Artan) and the other report came from a firm with an unfortunate name (e.g., Taahhut). The reports sometimes disagreed. The best procedure for the observers would have been to average the two reports, but this is not what they did. They gave much more weight to the report from Artan than to the report from Taahhut. Remember that System 2 is lazy and that mental effort is aversive. If possible, the recipients of your message want to stay away from anything that reminds them of effort, including a source with a complicated name.

All this is very good advice, but we should not get carried away. High-quality paper, bright colors, and rhyming or simple language will not be much help if your message is obviously nonsensical, or if it contradicts facts that your audience knows to be true. The psychologists who do these

experiments do not believe that people are stupid or infinitely gullible. What psychologists do believe is that all of us live much of our life guided by the impressions of System 1—and we often do not know the source of these impressions. How do you know that a statement is true? If it is strongly linked by logic or association to other beliefs or preferences you hold, or comes from a source you trust and like, you will feel a sense of cognitive ease. The trouble is that there may be other causes for your feeling of ease—including the quality of the font and the appealing rhythm of the prose—and you have no simple way of tracing your feelings to their source. This is the message of figure 5: the sense of ease or strain has multiple causes, and it is difficult to tease them apart. Difficult, but not impossible. People can overcome some of the superficial factors that produce illusions of truth when strongly motivated to do so. On most occasions, however, the lazy System 2 will adopt the suggestions of System 1 and march on.

## **Strain and Effort**

The symmetry of many associative connections was a dominant theme in the discussion of associative coherence. As we saw earlier, people who are made to “smile” or “frown” by sticking a pencil in their mouth or holding a ball between their furrowed brows are prone to experience the emotions that frowning and smiling normally express. The same self-reinforcing reciprocity is found in studies of cognitive ease. On the one hand, cognitive strain is experienced when the effortful operations of System 2 are engaged. On the other hand, the experience of cognitive strain, whatever its source, tends to mobilize System 2, shifting people’s approach to problems from a casual intuitive mode to a more engaged and analytic mode.

The bat-and-ball problem was mentioned earlier as a test of people’s tendency to answer questions with the first idea that comes to their mind, without checking it. Shane Frederick’s Cognitive Reflection Test consists of the bat-and-ball problem and two others, all chosen because they evoke an immediate intuitive answer that is incorrect. The other two items in the CRT are:

If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

100 minutes OR 5 minutes

In a lake, there is a patch of lily pads. Every day, the patch doubles in size.

If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

24 days OR 47 days

The correct answers to both problems are in a footnote at the bottom of the page.<sup>4</sup> The experimenters recruited 40 Princeton students to take the CRT. Half of them saw the puzzles in a small font in washed-out gray print. The puzzles were legible, but the font induced cognitive strain. The results tell a clear story: 90% of the students who saw the CRT in normal font made at least one mistake in the test, but the proportion dropped to 35% when the font was barely legible. You read this correctly: performance was better with the bad font. Cognitive strain, whatever its source, mobilizes System 2, which is more likely to reject the intuitive answer suggested by System 1.

## The Pleasure of Cognitive Ease

An article titled “Mind at Ease Puts a Smile on the Face” describes an experiment in which participants were briefly shown pictures of objects. Some of these pictures were made easier to recognize by showing the outline of the object just before the complete image was shown, so briefly that the contours were never noticed. Emotional reactions were measured by recording electrical impulses from facial muscles, registering changes of expression that are too slight and too brief to be detectable by observers. As expected, people showed a faint smile and relaxed brows when the pictures were easier to see. It appears to be a feature of System 1 that cognitive ease is associated with good feelings.

As expected, easily pronounced words evoke a favorable attitude. Companies with pronounceable names perform better than others for the first week after the stock is issued, though the effect disappears over time. Stocks with pronounceable trading symbols (like KAR or LUNMOO) outperform those with tongue-twisting tickers like PXG or RDO—and they appear to retain a small advantage over some time. A study conducted in Switzerland found that investors believe that stocks with fluent names like Emmi, Swissfirst, and Comet will earn higher returns than those with clunky labels like Geberit and Ypsomed.

As we saw in figure 5, repetition induces cognitive ease and a comforting feeling of familiarity. The famed psychologist Robert Zajonc dedicated much of his career to the study of the link between the repetition of an arbitrary stimulus and the mild affection that people eventually have for it. Zajonc called it the *mere exposure effect*. A demonstration

conducted in the student newspapers of the University of Michigan and of Michigan State University is one of my favorite experiments. For a period of some weeks, an ad-like box appeared on the front page of the paper, which contained one of the following Turkish (or Turkish-sounding) words: *kadirga*, *saricik*, *biwonjni*, *nansoma*, and *iktita*. The frequency with which the words were repeated varied: one of the words was shown only once, the others appeared on two, five, ten, or twenty-five separate occasions. (The words that were presented most often in one of the university papers were the least frequent in the other.) No explanation was offered, and readers' queries were answered by the statement that "the purchaser of the display wished for anonymity."

When the mysterious series of ads ended, the investigators sent questionnaires to the university communities, asking for impressions of whether each of the words "means something 'good' or something 'bad.'" The results were spectacular: the words that were presented more frequently were rated much more favorably than the words that had been shown only once or twice. The finding has been confirmed in many experiments, using Chinese ideographs, faces, and randomly shaped polygons.

The mere exposure effect does not depend on the conscious experience of familiarity. In fact, the effect does not depend on consciousness at all: it occurs even when the repeated words or pictures are shown so quickly that the observers never become aware of having seen them. They still end up liking the words or pictures that were presented more frequently. As should be clear by now, System 1 can respond to impressions of events of which System 2 is unaware. Indeed, the mere exposure effect is actually stronger for stimuli that the individual never consciously sees.

Zajonc argued that the effect of repetition on liking is a profoundly important biological fact, and that it extends to all animals. To survive in a frequently dangerous world, an organism should react cautiously to a novel stimulus, with withdrawal and fear. Survival prospects are poor for an animal that is not suspicious of novelty. However, it is also adaptive for the initial caution to fade if the stimulus is actually safe. The mere exposure effect occurs, Zajonc claimed, because the repeated exposure of a stimulus is followed by nothing bad. Such a stimulus will eventually become a safety signal, and safety is good. Obviously, this argument is not restricted to humans. To make that point, one of Zajonc's associates exposed two sets of fertile chicken eggs to different tones. After they hatched, the chicks consistently emitted fewer distress calls when exposed to the tone they had heard while inhabiting the shell.

Zajonc offered an eloquent summary of his entire program of research:



The consequences of repeated exposures benefit the organism in its relations to the immediate animate and inanimate environment. They allow the organism to distinguish objects and habitats that are safe from those that are not, and they are the most primitive basis of social attachments. Therefore, they form the basis for social organization and cohesion—the basic sources of psychological and social stability.

The link between positive emotion and cognitive ease in System 1 has a long evolutionary history.

## **Ease, Mood, and Intuition**

Around 1960, a young psychologist named Sarnoff Mednick thought he had identified the essence of creativity. His idea was as simple as it was powerful: creativity is associative memory that works exceptionally well. He made up a test, called the Remote Association Test (RAT), which is still often used in studies of creativity.

For an easy example, consider the following three words:

cottage Swiss cake

Can you think of a word that is associated with all three? You probably worked out that the answer is *cheese*. Now try this:

dive light rocket

This problem is much harder, but it has a unique correct answer, which every speaker of English recognizes, although less than 20% of a sample of students found it within 15 seconds. The answer is *sky*. Of course, not every triad of words has a solution. For example, the words *dream*, *ball*, *book* do not have a shared association that everyone will recognize as valid.

Several teams of German psychologists that have studied the RAT in recent years have come up with remarkable discoveries about cognitive ease. One of the teams raised two questions: Can people feel that a triad of words has a solution before they know what the solution is? How does mood influence performance in this task? To find out, they first made some of their subjects happy and others sad, by asking them to think for several minutes about happy or sad episodes in their lives. Then they presented these subjects with a series of triads, half of them linked (such as *dive*, *light*, *rocket*) and half unlinked (such as *dream*, *ball*, *book*), and instructed them to press one of two keys very quickly to indicate their guess about whether the triad was linked. The time allowed for this guess, 2 seconds,

was much too short for the actual solution to come to anyone's mind.

The first surprise is that people's guesses are much more accurate than they would be by chance. I find this astonishing. A sense of cognitive ease is apparently generated by a very faint signal from the associative machine, which "knows" that the three words are coherent (share an association) long before the association is retrieved. The role of cognitive ease in the judgment was confirmed experimentally by another German team: manipulations that increase cognitive ease (priming, a clear font, pre-exposing words) all increase the tendency to see the words as linked.

Another remarkable discovery is the powerful effect of mood on this intuitive performance. The experimenters had participants compute an "intuition index" to measure accuracy. They found that putting the participants in a good mood before the test by having them think happy thoughts more than doubled accuracy. An even more striking result is that unhappy subjects were completely incapable of performing the intuitive task accurately; their guesses were no better than random. Mood evidently affects the operation of System 1: when we are uncomfortable and unhappy, we lose touch with our intuition.

These findings add to the growing evidence that good mood, intuition, creativity, gullibility, and increased reliance on System 1 form a cluster. At the other pole, sadness, vigilance, suspicion, an analytic approach, and increased effort also go together. A happy mood loosens the control of System 2 over performance: when in a good mood, people become more intuitive and more creative but also less vigilant and more prone to logical errors. Here again, as in the mere exposure effect, the connection makes biological sense. A good mood is a signal that things are generally going well, the environment is safe, and it is all right to let one's guard down. A bad mood indicates that things are not going very well, there may be a threat, and vigilance is required. Cognitive ease is both a cause and a consequence of a pleasant feeling.

The Remote Association Test has more to tell us about the link between cognitive ease and positive affect. Briefly consider two triads of words:

sleep mail switch

salt deep foam

You could not know it, of course, but measurements of electrical activity in the muscles of your face would probably have shown a slight smile when you read the second triad, which is coherent (sea is the solution). This smiling reaction to coherence appears in subjects who are told nothing about common associates; they are merely shown a vertically arranged triad of words and instructed to press the space bar after they have read it. The impression of cognitive ease that comes with the presentation of a coherent triad appears to be mildly pleasurable in itself.

The evidence that we have about good feelings, cognitive ease, and the intuition of coherence is, as scientists say, correlational but not necessarily causal. Cognitive ease and smiling occur together, but do the good feelings actually lead to intuitions of coherence? Yes, they do. The proof comes from a clever experimental approach that has become increasingly popular. Some participants were given a cover story that provided an alternative interpretation for their good feeling: they were told about music played in their earphones that “previous research showed that this music influences the emotional reactions of individuals.” This story completely eliminates the intuition of coherence. The finding shows that the brief emotional response that follows the presentation of a triad of words (pleasant if the triad is coherent, unpleasant otherwise) is actually the basis of judgments of coherence. There is nothing here that System 1 cannot do. Emotional changes are now expected, and because they are unsurprising they are not linked causally to the words.

This is as good as psychological research ever gets, in its combination of experimental techniques and in its results, which are both robust and extremely surprising. We have learned a great deal about the automatic workings of System 1 in the last decades. Much of what we now know would have sounded like science fiction thirty or forty years ago. It was beyond imagining that bad font influences judgments of truth and improves cognitive performance, or that an emotional response to the cognitive ease of a triad of words mediates impressions of coherence. Psychology has come a long way.

## **Speaking of Cognitive Ease**

“Let’s not dismiss their business plan just because the font makes it hard to read.”

“We must be inclined to believe it because it has been repeated so often, but let’s think it through again.”

“Familiarity breeds liking. This is a mere exposure effect.”

“I’m in a very good mood today, and my System 2 is weaker than usual. I should be extra careful.”