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 ass12;velyociation 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 rri221; (withfunnier than did 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 tc 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 exto 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 expefteelief. Trience 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.

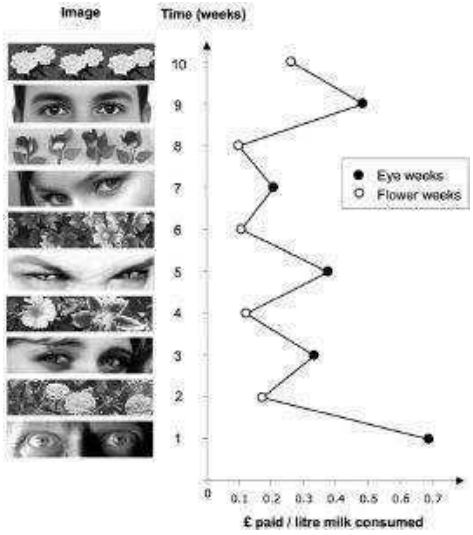

Figure 4

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 allel

"I made myself smile and I'm actually feeling better!"

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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.

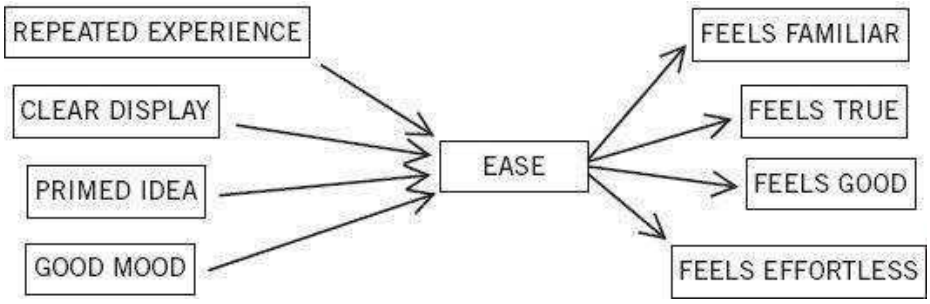

Figure 5. Causes and Consequences of Cognitive Ease

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 ispictana 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 chickenordblurred, 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 ton colleague Danny Oppenheimer refuted a myth prevalent a wo ton colmong 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. [*] 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 dmisorrectlo 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 sm 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 *iktitaf*. 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 hing icts 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 experimentershape tende computed 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 tri pr that aad 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."