

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,