

Introduction

In some families when a child's misbehavior passes a certain threshold, they give the child a time-out. Or they sit down and talk about why it is important to obey, or not to act out. In other families a parent might give a child a paddling on the rear end. My mother, a Holocaust survivor, wouldn't do any of those things. When I made a big mess or tried to flush the transistor radio down the toilet, my mother would work herself into a frenzy, erupt in tears, and start to scream at me. "I can't take it!" she'd shout. "I wish I were dead! Why did I survive? Why didn't Hitler kill me?"

Her rants made me feel bad. But the strange thing is, as a child, I thought my mother's reaction was normal. You learn many things growing up, but one of the strongest lessons—one that sometimes takes years of therapy to unlearn—is that whatever your parents say about you is correct and whatever happens in your household is the norm. And so I accepted my mother's rants. Sure, I knew that my friends' parents, who hadn't gone through the Holocaust, would not make the Hitler reference. But I imagined them spewing in some analogous manner. "Why did I survive? Why didn't that bus run me down?" "Why didn't that tornado carry me away?" "Why didn't I have a heart attack and drop dead?"

The idea that my mother was an outlier finally occurred to me

at dinner one evening when I was in high school. She spoke of a psychiatric appointment she had gone to earlier that day. The visit had been required as part of her application for Holocaust reparations from the German government. The Nazis had confiscated her family's considerable wealth when the war began and left her a pauper. But the payments were apparently based not just on financial considerations. They were based on evidence of emotional problems stemming from what she had endured. My mother had rolled her eyes at having to go to the appointment and was certain that due to her fine mental health she would be denied. But as my brother and I picked at the tasteless boiled chicken on our plates, she told us—indignantly—that the doctor concluded that she indeed had emotional issues.

“Can you believe that?” my mother asked. “He thinks I’m crazy! Obviously, he’s the crazy one, not me.” And then she raised her voice at me. “Finish your chicken!” she said. I resisted. It has no taste, I complained. “Eat it!” she said. “Someday you might wake up and find that your whole family was killed! And you, with nothing to eat, will have to crawl on your belly through the mud in order to drink stinking, filthy water from mud puddles! *Then* you’ll stop wasting food but it’ll be too late.”

Other kids’ mothers lectured them about not wasting food because there were people starving in impoverished faraway lands. My mother told me that *I* might soon be the one desperate to eat. It wasn’t the first time my mother had expressed such a sentiment, but this time, backed by my mental image of her wise psychiatrist, I began to question her sanity.

What I know now is that my mother was warning me about the future because she was tortured by her past, terrified that it would repeat. She was telling me that life might look good now, but that was just smoke and mirrors, and would be replaced by a nightmare sometime soon. Not recognizing that her expectation of future cataclysms was rooted in fear, not reality, she believed that her dire expectations were well-founded. As a result, anxiety and fear were never far from the surface.

My father, a former resistance fighter and Buchenwald death camp survivor, had gone through comparable trauma. He and my mother met as refugees soon after the war had ended and for the rest of their lives experienced most life events together. And yet they responded differently, he always being full of optimism and self-confidence. Why did my parents react to events in such varied ways? More generally, what *are* emotions? Why do we have them, and how do they arise in our brains? How do they affect our thoughts, judgments, motivation, and decisions, and how can we control them? These are the questions I will address in this book.

The human brain is often compared to a computer, but the information processing that this computer executes is inextricably intertwined with the deeply mysterious phenomenon we call feelings. We've all felt anxiety, fear, and anger. We've felt rage, despair, embarrassment, loneliness. We've felt joy, pride, excitement, contentment, lust, and love. When I was a child, scientists had little idea of how those emotions are formed, how one can manage them, what purpose they serve, or why two people—or the same individual at different times—may respond to the same triggers in quite disparate ways. Scientists back then believed that rational thought was the dominant influence on our behavior and that when emotions played a role they were likely to be counterproductive. Today we know better. We know that emotion is as important as reason in guiding our thoughts and decisions, though it operates in a different manner. While rational thought allows us to draw logical conclusions based on our goals and relevant data, emotion operates at a more abstract level—it affects the importance we assign to the goals and the weight we give to the data. It forms a framework for our assessments that is not only constructive but necessary. Rooted in both our knowledge and our past experience, emotion changes the way we think about our present circumstances and future prospects, often in subtle but consequential ways. Much of our understanding of how that works has come from advances in just the last decade or so, during which there has been an unparalleled explosion of research in the

field. This book is about that revolution in our understanding of human feelings.

THE EMOTION REVOLUTION

Before the current burst of research into emotion, most scientists understood our feelings within a framework that goes all the way back to the ideas of Charles Darwin. That traditional theory of emotion embraced a number of principles that seem intuitively plausible: that there is a small set of basic emotions—fear, anger, sadness, disgust, happiness, and surprise—that are universal among all cultures and have no functional overlap; that each emotion is triggered by specific stimuli in the external world; that each emotion causes fixed and specific behaviors; and that each emotion occurs in specific dedicated structures in the brain. This theory also encompassed a dichotomous view of the mind that goes back at least to the ancient Greeks: that the mind consists of two competing forces, one “cold,” logical, and rational and the other “hot,” passionate, and impulsive.

For millennia these ideas informed thinking in fields from theology to philosophy to the science of the mind. Freud incorporated the traditional theory into his work. John Mayer and Peter Salovey’s theory of “emotional intelligence,” popularized by the 1995 book of that name by Daniel Goleman, is in part based on it. And it is the framework for most of what we think about our feelings. But it is wrong.

Just as Newton’s laws of motion were superseded by quantum theory when science developed the tools that revealed the atomic world, so too is the old theory of emotion now giving way to a new view, thanks in large part to extraordinary advances in neuroimaging and other technologies that have allowed scientists to look into, and experiment upon, the brain.

One set of techniques developed in the past few years allows scientists to trace the connections among neurons, creating a kind of circuit diagram for the brain called the “connectome.” The

connectome map allows scientists to navigate the brain in a way that was never before possible. They can compare essential circuits, fly into specific regions of the brain to explore the cells that they comprise, and decipher the electrical signals that generate your thoughts, feelings, and behaviors. Another advance, optogenetics, lets scientists take *control* of individual neurons in an animal's brain. By selectively stimulating them, scientists have been able to uncover the micropatterns of brain activity that produce certain mental states, such as fear, anxiety, and depression. A third technology, transcranial stimulation, employs electromagnetic fields or currents to stimulate or inhibit neural activity in precise locations in the human brain with no permanent effects on the experimental subject, helping scientists to assess the function of those structures. These and other techniques and technologies have imparted so much insight, and given rise to so much new work, that a whole new field of psychology has emerged, called "affective neuroscience."

Founded on the application of modern tools to the age-old study of human feeling, affective neuroscience has reshaped the way scientists view emotion. They've found that while the old viewpoint offered what seemed like plausible answers to basic questions about feelings, it didn't accurately represent the way the human brain operates. For example, each "basic" emotion is not really a single emotion but actually a catchall term for a spectrum or category of feelings, and those categories are not necessarily distinct from one another. Fear, for instance, comes in different flavors and can in some instances be difficult to distinguish from anxiety.¹ What's more, the amygdala, long thought of as our "fear" center, actually plays a key role in several emotions and, conversely, is not necessary for all types of fear. Scientists today have also expanded their focus far beyond the "basic" five or six emotions to include dozens of others, such as embarrassment, pride, and other so-called social emotions, and even feelings that used to be thought of as drives, such as hunger and sexual desire.

In the domain of emotional health, affective neuroscience has taught us that depression is not a single disorder but rather a syn-

drome comprising four different subtypes, susceptible to different treatments and having different neural signatures. Researchers have used the new insights to develop a phone app that can help alleviate depression in a quarter of depressed patients.² In fact, scientists can now sometimes determine in advance, through a brain scan, whether a depressed person will benefit from psychotherapy rather than requiring drugs. Potential new treatments for emotion-related conditions from obesity to smoking addiction to anorexia are also being studied.

Fueled by such triumphs, affective neuroscience has come to be one of the hottest fields in academic research. It has become prominent in the National Institute of Mental Health's research agenda and in many institutions that are not commonly thought of as mind focused, such as the National Cancer Institute.³ Even institutions that have little to do with psychology and medicine, such as computer science centers, marketing organizations, business schools, and the Kennedy School of Government at Harvard, are now devoting resources and jobs to this new science.

Affective neuroscience has important implications for the place of feelings in our everyday lives and in the human experience. Said one leading scientist, "Our traditional 'knowledge' about emotion is being questioned at the most fundamental level."⁴ Said another leader in the field, "If you are like most people, you feel convinced that because you have emotions, you know a lot about what emotions are, and how they work . . . you are almost certainly wrong."⁵ According to a third, we are "in the midst of a revolution in our understanding of emotion, the mind, and the brain—a revolution that may compel us to rethink such central tenets of our society as our treatments for mental and physical illness, our understanding of personal relationships, our approaches to raising children, and ultimately our view of ourselves."⁶

Most important, where we once believed that emotion was detrimental to effective thought and decisions, we now know that we can't make decisions, or even think, without being influenced by our emotions. And though—in our modern societies that are so different from the surroundings in which we evolved—our emo-

tions are sometimes counterproductive, it is far more often the case that they lead us in the right direction. In fact, we'll see that without them we'd have difficulty moving in any direction at all.

WHAT'S AHEAD

Given their experiences in the Holocaust, my parents might not seem typical. But in a fundamental way we are all just like them. Deep within our brains, as in theirs, our shadowy unconscious mind is continuously applying the lessons of our past experience to predict the consequences of our current circumstances. In fact, one way to characterize a brain is as a prediction machine.

Hominids evolving on the African savanna faced constant decisions regarding food, water, and shelter. Is that rustling up ahead caused by an animal I can eat or one that wants to eat me? Animals that were better at analyzing their surroundings were more likely to survive and reproduce. Toward that end, given any circumstance, the job of their brains was to use their sensory input and past experience to decide on a set of possible actions and then, for each possible action, to forecast the likely outcomes. Which action is least probable to lead to death or injury, and most likely to provide nutrition, water, or some other contribution to their survival? In the pages that follow, we will look at how emotion influences those calculations. We'll look at how emotion arises, the role of our feelings in creating our thoughts and decisions, and how we can harness our feelings to thrive and be successful in the modern world.

In part I, I will describe our current knowledge of how emotions evolved and why. An understanding of the role of emotion in our basic blueprint for survival will reveal a lot about how we respond to situations; why we react with anxiety or anger, love or hate, happiness or sadness; and why we sometimes act inappropriately or lose control of our emotions.

We'll also explore the concept of "core affect," the mind-body state that subliminally informs all your emotional experience,

influencing not just the emotions you will feel in any given situation but also your decisions and reactions to events—one reason that on different occasions the same circumstance can create in you quite different emotional responses.

Part II will look into the central role of emotion in human pleasure, motivation, inspiration, and determination. Why, given two tasks of comparable interest, difficulty, and importance, might one of them seem so hard to achieve, the other easy? What factors affect the intensity of your desire to accomplish something? Why, in similar situations, do you sometimes press on with herculean effort and at other times immediately give up? And why are some individuals more prone to pressing on, others to dropping out?

Part III will explore emotional profile and emotion regulation. We each have tendencies to react with certain emotions and a disinclination to react with others. Scientists have developed questionnaires you can take to assess your own tendencies in several of those major dimensions, and I will present those in chapter 8. Chapter 9 will examine the burgeoning field called “emotion regulation,” time-tested strategies for emotion management that have recently been studied and corroborated through rigorous scientific research. Once you’ve understood where your feelings come from, how can you take charge of them? What makes that more difficult for some people than for others?

We all spend time deliberating about what restaurant to go to or what film to see, but we don’t necessarily devote time to pondering ourselves, to examining what we feel and why. Many of us were actually raised to do the opposite: we were taught to suppress emotion; we were taught not to feel. But though we can suppress emotion, we can’t “not feel.” Feelings are part of being human and of interacting with other humans. If we’re not in touch with them, we are not in touch with ourselves, and that will hamper us in our dealings with others and doom us to make judgments and decisions without a full understanding of the origin of our thinking.

As I write this, my mother is ninety-seven years old. She has mellowed, but at her core she never changed. Having studied the new theory of emotion, I’ve gained insight into her behavior. More

important, I've gained insight into mine, for to know yourself is a first step toward both acceptance and change, if you desire it. My hope is that this journey through the science of emotion will debunk the myth that emotions are counterproductive and offer a new understanding of the human mind that can help you navigate your world of feelings and gain control and power over them.

PART I

What Is Emotion?

Thought Versus Feeling

On the morning of Halloween 2014, a strange aircraft ascended high into the skies above the barren Mojave Desert. The custom-built carbon-fiber plane was essentially twin cargo jets flying side by side, joined at the wing. Suspended from that monstrous carrier vessel was a smaller plane dubbed the *Enterprise*—an homage to *Star Trek*. The aim was for the cargo jet to carry the *Enterprise* to an altitude of fifty thousand feet, from where it would be dropped, briefly fire its engines, and then glide to a landing.

The planes belonged to Virgin Galactic, the company created by Richard Branson to carry “space tourists” into suborbital flight. By 2014, more than seven hundred spaceship tickets had been sold, at \$200,000 to \$250,000 each. This was the thirty-fifth such test flight but only the fourth in which the *Enterprise* was meant to fire up its rocket, which had just been redesigned to make it more powerful.

The ascent went well. The pilot David Mackay launched the *Enterprise* from the underside of his carrier plane at the appointed moment. Then his eyes panned across the sky, searching for the plume of the *Enterprise*’s rocket engine. He couldn’t spot it. “I remember looking down and thinking, ‘Well that’s strange,’” recalled Mackay, experienced enough to be wary of anything unexpected.¹ But all was well. Out of his line of sight, the spaceship had indeed fired its rocket and in about ten seconds accelerated

through the sound barrier. The mission was unfolding without incident.

The *Enterprise* was captained by a test pilot named Peter Siebold, with almost thirty years of flying experience. His co-pilot, Michael Alsbury, had previously worked with eight different experimental aircraft. In some ways, the two men were quite different: while Siebold could strike co-workers as aloof, Alsbury was always friendly and known for his sense of humor. But strapped into their seats atop the rocket, they functioned as a unit, each of their lives dependent on the actions of the other.

Just before reaching the speed of sound, Alsbury unlocked the ship's air-braking device. The brake was crucial for controlling the spaceship's orientation and speed while dropping back to earth, but it wouldn't be needed for another fourteen seconds, and Alsbury had unlocked it before he should have. The National Transportation Safety Board would later criticize the Scaled Composites unit of Northrop Grumman, which designed the vehicle for Virgin, because it did not guard against such human slipups by providing a fail-safe system to prevent premature unlocking.

Unlike Virgin Galactic, government-sponsored space initiatives call for "two-failure tolerance." That means putting in place safeguards to protect against two separate and unrelated simultaneous problems—two human errors, two mechanical errors, or one of each. The Virgin team was confident that its extraordinarily well-trained test pilots wouldn't make such mistakes, and eliminating safeguards had certain advantages. "We don't have all the constraints a government organization like NASA would," one team member told me. "So we can get things done a lot faster."² But on that Halloween morning, the lock disengagement was no harmless mistake.

With the lock off prematurely, the force of the atmosphere caused the brake to deploy early, even though Alsbury never threw the second switch to deploy it. As the brake swung into position, the still-firing rocket placed tremendous stress on the plane's fuselage. Four seconds later, traveling at 920 miles per hour, the ship ripped apart. From the ground, it looked like a massive explosion.

Siebold, still attached to his ejection seat, was thrown from the plane. Traveling faster than sound, he was in an atmosphere where the temperature of the air around him was minus seventy degrees Fahrenheit, and there was just one-tenth the oxygen present at sea level. Still, he somehow managed to unbuckle himself, after which his parachute automatically opened. Upon rescue, he had no memory of the experience. Alsbury wasn't so lucky. He died instantly when the plane broke apart.

EMOTIONS AND THOUGHT

The long string of well-rehearsed procedures called for when a pilot tests a new plane are normally executed so smoothly that it's easy to think of them as rote and mechanical. But that view is profoundly misguided. When the *Enterprise* was dropped from its mother ship and started to fire its ferocious rocket engine—as planned—the physical circumstance of its pilots was suddenly disrupted. It's hard to imagine what that felt like, but a rocket is really a controlled exploding bomb, and a controlled explosion is still an explosion. It's a terribly violent event, and the *Enterprise* was relatively flimsy—a mere twenty thousand pounds, loaded, as compared with the space shuttle's four million. And so the ride is much different. If flying in the space shuttle is like racing down the highway in a Cadillac, piloting the *Enterprise* was like driving 150 miles per hour in a go-kart. The souped-up rocket's firing subjected the *Enterprise* pilots to a colossal roar, savage shaking and vibration, and fierce stresses of acceleration.

Why did Alsbury throw the switch when he did? The flight was proceeding as planned, so it's not likely he was panicking. We can't know what his reasoning was, nor perhaps did he. But in the anxious state that comes from a highly stressful physical environment, we process data in a manner that is hard to predict from practice runs in flight simulators. This was more or less the conclusion of the National Transportation Safety Board about the events on the *Enterprise*. Speculating that Alsbury, lacking recent

flight experience, might have been unusually stressed, the NTSB posited that he committed the misjudgment due to the anxiety caused by time pressure and the ship's strong vibration and forces of acceleration, which he hadn't experienced since his last test flight eighteen months earlier.

The story of the *Enterprise* illustrates how anxiety can lead to a bad decision, as it surely sometimes does. In our ancestral environment, there were many more life-threatening dangers than we typically face in civilized life, and so our fear and anxiety reactions, in particular, may at times seem overblown. Such cases, as exemplified by the *Enterprise* saga, are what, over the centuries, gave emotion a bad name.

But stories of emotions causing problems are often sensational, as this one was, while tales of emotions operating as they should tend to be mundane. It is the malfunctions that stand out in the telling, while a properly functioning system can easily go unheralded. There were, for example, thirty-four successful prior test flights of the *Enterprise*. In each of those, both the plane and its pilots operated as planned, controlled by a miraculous marriage of modern technology and the smooth interplay of the rational and emotional human brain, and none of them made the news.

A case that hit closer to home for me concerned a friend who lost his job, and therefore his health insurance. Knowing the cost of decent medical care, he became anxious about his health. What if he got sick? He could go broke. That anxiety affected his thinking—if he had a sore throat, he didn't ignore it or dismiss it as sniffles as he'd have previously done. Instead, he'd fear the worst: Was it throat cancer? As it turned out, his anxiety over his health saved his life. For one of the things he had never paid attention to, but now began to worry about, was a mole on his back. For the first time in his life, he went to a dermatologist and had it checked out. It was an early-stage cancer. He had it removed, and it never recurred—a man rescued by anxiety.

The moral of this pair of stories is not that emotions help or impede effective thinking but rather that *emotions affect thinking*: our emotional state influences our mental calculations as much