4. RUNNING FOR YOUR LIFE: THE ANATOMY OF SURVIVAL

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CHAPTER 4
RUNNING FOR YOUR LIFE: THE
ANATOMY OF SURVIVAL
Prior to the advent of brain, there was no color and no sound in the universe, nor was there any flavor or aroma and probably little sense and no feeling or emotion. Before brains the universe was also free of pain and anxiety.
—Roger Sperry1
n September 11, 2001, five-year-old Noam Saul witnessed the first passenger plane slam into the World Trade Center from the windows of his first-grade classroom at PS 234, less than 1,500 feet away. He and his classmates ran with their teacher down the stairs to the lobby, where most of them were reunited with parents who had dropped them off at school just moments earlier. Noam, his older brother, and their dad were three of the tens of thousands of people who ran for their lives through the rubble, ash, and smoke of lower Manhattan that morning.
Ten days later I visited his family, who are friends of mine, and that evening his parents and I went for a walk in the eerie darkness through the still-smoking pit where Tower One once stood, making our way among the rescue crews who were working around the clock under the blazing klieg lights. When we returned home, Noam was still awake, and he showed me a picture that he had drawn at 9:00 a.m. on September 12. The drawing depicted what he had seen the day before: an airplane slamming into the tower, a ball of fire, firefighters, and people jumping from the tower's windows. But at the bottom of the picture he had drawn something else: a black circle at the foot of the buildings. I had no idea what it was, so I asked him. "A trampoline," he replied. What was a trampoline doing there? Noam explained, "So that the next time when people have to jump they will be safe." I was stunned: This five-year-old boy, a witness to unspeakable mayhem and disaster just twenty-four hours before he made that drawing, had used his imagination to process what he had seen and begin to go on with his life.
Noam was fortunate. His entire family was unharmed, he had grown up surrounded by love, and he was able to grasp that the tragedy they had witnessed had come to an end. During disasters young children usually take their cues from their parents. As long as their caregivers remain calm and responsive to their needs, they often survive terrible incidents without serious psychological scars.

Five-year-old Noam's drawing made after he witnessed the World Trade Center attack on 9/11. He reproduced the image that haunted so many survivors—people jumping to escape from the inferno—but with a life-saving addition: a trampoline at the bottom of the collapsing building.

But Noam's experience allows us to see in outline two critical aspects of the adaptive response to threat that is basic to human survival. At the time the disaster occurred, he was able to take an active role by running away from it, thus becoming an agent in his own rescue. And once he had reached the safety of home, the alarm bells in his brain and body quieted. This freed his mind to make some sense of what had happened and even to imagine a creative alternative to what he had seen—a lifesaving trampoline.

In contrast to Noam, traumatized people become stuck, stopped in their growth because they can't integrate new experiences into their lives. I was very moved when the veterans of Patton's army gave me a World War II army-issue watch for Christmas, but it was a sad memento of the year their lives had effectively stopped: 1944. Being traumatized means continuing to organize your life as if the trauma were still going on—unchanged and immutable—as every new encounter or event is contaminated by the past.

Trauma affects the entire human organism—body, mind, and brain. In PTSD the body continues to defend against a threat that belongs to the past. Healing from PTSD means being able to terminate this continued stress mobilization and restoring the entire organism to safety.

After trauma the world is experienced with a different nervous system. The survivor's energy now becomes focused on suppressing inner chaos, at the expense of spontaneous involvement in their lives. These attempts to maintain control over unbearable physiological reactions can result in a whole range of physical symptoms, including fibromyalgia, chronic fatigue, and other autoimmune diseases. This explains why it is critical for trauma treatment to engage the entire organism, body, mind, and brain.

ORGANIZED TO SURVIVE

This illustration on page 53 shows the whole-body response to threat.

When the brain's alarm system is turned on, it automatically triggers preprogrammed physical escape plans in the oldest parts of the brain. As in other animals, the nerves and chemicals that make up our basic brain structure have a direct connection with our body. When the old brain takes over, it partially shuts down the higher brain, our conscious mind, and propels the body to run, hide, fight, or, on occasion, freeze. By the time we are fully aware of our situation, our body may already be on the move. If the fight/flight/freeze response is successful and we escape the danger, we recover our internal equilibrium and gradually "regain our senses."

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Effective action versus immobilization. Effective action (the result of fight/flight) ends the threat. Immobilization keeps the body in a state of inescapable shock and learned helplessness. Faced with danger people automatically secrete stress hormones to fuel resistance and escape. Brain and body are programmed to run for home, where safety can be restored and stress hormones can come to rest. In these strapped-down men who are being evacuated far from home after Hurricane Katrina stress hormone levels remain elevated and are turned against the survivors, stimulating ongoing fear, depression, rage, and physical disease.

If for some reason the normal response is blocked—for example, when people are held down, trapped, or otherwise prevented from taking effective action, be it in a war zone, a car accident, domestic violence, or a rape—the brain keeps secreting stress chemicals, and the brain's electrical circuits continue to fire in vain.2 Long after the actual event has passed, the brain may keep sending signals to the body to escape a threat that no longer exists. Since at least 1889, when the French psychologist Pierre Janet published the first scientific account of traumatic stress,3 it has been recognized that trauma survivors are prone to “continue the action, or rather the (futile) attempt at action, which began when the thing happened.” Being able to move and do something to protect oneself is a critical factor in determining whether or not a horrible experience will leave long-lasting scars.

In this chapter I’m going to go deeper into the brain’s response to trauma. The more neuroscience discovers about the brain, the more we realize that it is a vast network of interconnected parts organized to help us survive and flourish. Knowing how these parts work together is essential to understanding how trauma affects every part of the human organism and can serve as an indispensable guide to resolving traumatic stress.

THE BRAIN FROM BOTTOM TO TOP

The most important job of the brain is to ensure our survival, even under the most miserable conditions. Everything else is secondary. In order to do that, brains need to: (1) generate internal signals that register what our bodies need, such as food, rest, protection, sex, and shelter; (2) create a map of the world to point us where to go to satisfy those needs; (3) generate the necessary energy and actions to get us there; (4) warn us of dangers and opportunities along the way; and (5) adjust our actions based on the requirements of the moment.4 And since we human beings are mammals, creatures that can only survive and thrive in groups, all of these imperatives require coordination and collaboration. Psychological problems occur when our internal signals don’t work, when our maps don’t lead us where we need to go, when we are too paralyzed to move, when our actions do not correspond to our needs, or when our relationships break down. Every brain structure that I discuss has a role to play in these essential functions, and as we will see, trauma can interfere with every one of them.

Our rational, cognitive brain is actually the youngest part of the brain and occupies only about 30 percent of the area inside our skull. The rational brain is primarily concerned with the world outside us: understanding how things and people work and figuring out how to accomplish our goals, manage our time, and sequence our actions. Beneath the rational brain lie two evolutionarily older, and to some degree separate, brains, which are in charge of everything else: the moment-by-moment registration and management of our body’s physiology and the identification of comfort, safety, threat, hunger, fatigue, desire, longing, excitement, pleasure, and pain.

The brain is built from the bottom up. It develops level by level within every child in the womb, just as it did in the course of evolution. The most primitive part, the part that is already online when we are born, is the ancient animal brain, often called the reptilian brain. It is located in the brain stem, just above the place where our spinal cord enters the skull. The reptilian brain is responsible for all the things that newborn babies can do: eat, sleep, wake, cry, breathe; feel temperature, hunger, wetness, and pain; and rid the body of toxins by urinating and defecating. The brain stem and the hypothalamus (which sits directly above it) together control the energy levels of the body. They coordinate the functioning of the heart and lungs and also the endocrine and immune systems, ensuring that these basic life-sustaining systems are maintained within the relatively stable internal balance known as homeostasis.

Breathing, eating, sleeping, pooping, and peeing are so fundamental that their significance is easily neglected when we're considering the complexities of mind and behavior. However, if your sleep is disturbed or your bowels don't work, or if you always feel hungry, or if being touched makes you want to scream (as is often the case with traumatized children and adults), the entire organism is thrown into disequilibrium. It is amazing how many psychological problems involve difficulties with sleep, appetite, touch, digestion, and arousal. Any effective treatment for trauma has to address these basic housekeeping functions of the body.

Right above the reptilian brain is the limbic system. It's also known as the mammalian brain, because all animals that live in groups and nurture their young possess one. Development of this part of the brain truly takes off after a baby is born. It is the seat of the emotions, the monitor of danger, the judge of what is pleasurable or scary, the arbiter of what is or is not important for survival purposes. It is also a central command post for coping with the challenges of living within our complex social networks.

The limbic system is shaped in response to experience, in partnership with the infant's own genetic makeup and inborn temperament. (As all parents of more than one child quickly notice, babies differ from birth in the intensity and nature of their reactions to similar events.) Whatever happens to a baby contributes to the emotional and perceptual map of the world that its developing brain creates. As my colleague Bruce Perry explains it, the brain is formed in a "use-dependent manner."5 This is another way of describing neuroplasticity, the relatively recent discovery that neurons that "fire together, wire together." When a circuit fires repeatedly, it can become a default setting—the response most likely to occur. If you feel safe and loved, your brain becomes specialized in exploration, play, and cooperation; if you are frightened and unwanted, it specializes in managing feelings of fear and abandonment.

As infants and toddlers we learn about the world by moving, grabbing, and crawling and by discovering what happens when we cry, smile, or protest. We are constantly experimenting with our surroundings—how do our interactions change the way our bodies feel? Attend any two-year-old's birthday party and notice how little Kimberly will engage you, play with you, flirt with you, without any need for language. These early explorations shape the limbic structures devoted to emotions and memory, but these structures can also be significantly modified by later experiences: for the better by a close friendship or a beautiful first love, for example, or for the worse by a violent assault, relentless bullying, or neglect.

Taken together the reptilian brain and limbic system make up what I'll call the "emotional brain" throughout this book.6 The emotional brain is at the heart of the central nervous system, and its key task is to look out for your welfare. If it detects danger or a special opportunity—such as a promising partner—it alerts you by releasing a squirt of hormones. The resulting visceral sensations (ranging from mild queasiness to the grip of panic in your chest) will interfere with whatever your mind is currently focused on and get you moving—physically and mentally—in a different direction. Even at their most subtle, these sensations have a huge influence on the small and large decisions we make throughout our lives: what we choose to eat, where we like to sleep and with whom, what music we prefer, whether we like to garden or sing in a choir, and whom we befriend and whom we detest.

The emotional brain's cellular organization and biochemistry are simpler than those of the neocortex, our rational brain, and it assesses incoming information in a more global way. As a result, it jumps to conclusions based on rough similarities, in contrast with the rational brain, which is organized to sort through a complex set of options. (The textbook example is leaping back in terror when you see a snake—only to realize that it's just a coiled rope.) The emotional brain initiates preprogrammed escape plans, like the fight-or-flight responses. These muscular and physiological reactions are automatic, set in motion without any thought or planning on our part, leaving our conscious, rational capacities to catch up later, often well after the threat is over.

Finally we reach the top layer of the brain, the neocortex. We share this outer layer with other mammals, but it is much thicker in us humans. In the second year of life the frontal lobes, which make up the bulk of our neocortex, begin to develop at a rapid pace. The ancient philosophers called seven years "the age of reason." For us first grade is the prelude of things to come, a life organized around frontal-lobe capacities: sitting still; keeping sphincters in check; being able to use words rather than acting out; understanding abstract and symbolic ideas; planning for tomorrow; and being in tune with teachers and classmates.

The frontal lobes are responsible for the qualities that make us unique within the animal kingdom.7 They enable us to use language and abstract thought. They give us our ability to absorb and integrate vast amounts of information and attach meaning to it. Despite our excitement about the linguistic feats of chimpanzees and rhesus monkeys, only human beings command the words and symbols necessary to create the communal, spiritual, and historical contexts that shape our lives.

The frontal lobes allow us to plan and reflect, to imagine and play out future scenarios. They help us to predict what will happen if we take one action (like applying for a new job) or neglect another (not paying the rent). They make choice possible and underlie our astonishing creativity. Generations of frontal lobes, working in close collaboration, have created culture, which got us from dug-out canoes, horse-drawn carriages, and letters to jet planes, hybrid cars, and e-mail. They also gave us Noam's lifesaving trampoline.

MIRRORING EACH OTHER: INTERPERSONAL NEUROBIOLOGY

Crucial for understanding trauma, the frontal lobes are also the seat of empathy—our ability to "feel into" someone else. One of the truly sensational discoveries of modern neuroscience took place in 1994, when in a lucky accident a group of Italian scientists identified specialized cells in the cortex that came to be known as mirror neurons.8 The researchers had attached electrodes to individual neurons in a monkey's premotor area, then set up a computer to monitor precisely which neurons fired when the monkey picked up a peanut or grasped a banana. At one point an experimenter was putting food pellets into a box when he looked up at the computer. The monkey's brain cells were firing at the exact location where the motor command neurons were located. But the monkey wasn't eating or moving. He was watching the researcher, and his brain was vicariously mirroring the researcher's actions.

Numerous other experiments followed around the world, and it soon became clear that mirror neurons explained many previously unexplainable aspects of the mind, such as empathy, imitation, synchrony, and even the development of language. One writer compared mirror neurons to "neural

WiFi"9—we pick up not only another person's movement but her emotional state and intentions as well. When people are in sync with each other, they tend to stand or sit similar ways, and their voices take on the same rhythms. But our mirror neurons also make us vulnerable to others' negativity, so that we respond to their anger with fury or are dragged down by their depression. I'll have more to say about mirror neurons later in this book, because trauma almost invariably involves not being seen, not being mirrored, and not being taken into account. Treatment needs to reactivate the capacity to safely mirror, and be mirrored, by others, but also to resist being hijacked by others' negative emotions.

The Triune (Three-part) Brain. The brain develops from the bottom up. The reptilian brain develops in the womb and organizes basic life sustaining functions. It is highly responsive to threat throughout our entire life span. The limbic system is organized mainly during the first six years of life but continues to evolve in a use-dependent manner. Trauma can have a major impact of its functioning throughout life. The prefrontal cortex develops last, and also is affected by trauma exposure, including being unable to filter out irrelevant information. Throughout life it is vulnerable to go off-line in response to threat.

As anybody who has worked with brain-damaged people or taken care of demented parents has learned the hard way, well-functioning frontal lobes are crucial for harmonious relationships with our fellow humans. Realizing that other people can think and feel differently from us is a huge developmental step for two- and three-year-olds. They learn to understand others' motives, so they can adapt and stay safe in groups that have different perceptions, expectations, and values. Without flexible, active frontal lobes people become creatures of habit, and their relationships become superficial and routine. Invention and innovation, discovery and wonder—all are lacking.

Our frontal lobes can also (sometimes, but not always) stop us from doing things that will embarrass us or hurt others. We don't have to eat every time we're hungry, kiss anybody who rouses our desires, or blow up every time we're angry. But it is exactly on that edge between impulse and acceptable behavior where most of our troubles begin. The more intense the visceral, sensory input from the emotional brain, the less capacity the rational brain has to put a damper on it.

IDENTIFYING DANGER: THE COOK AND THE SMOKE DETECTOR

Danger is a normal part of life, and the brain is in charge of detecting it and organizing our response. Sensory information about the outside world arrives through our eyes, nose, ears, and skin. These sensations converge in the thalamus, an area inside the limbic system that acts as the "cook" within the brain. The thalamus stirs all the input from our perceptions into a fully blended autobiographical soup, an integrated, coherent experience of "this is what is happening to me."10 The sensations are then passed on in two directions—down to the amygdala, two small almond-shaped structures that lie deeper in the limbic, unconscious brain, and up to the frontal lobes, where they reach our conscious awareness. The neuroscientist Joseph LeDoux calls the pathway to the amygdala "the low road," which is extremely fast, and that to the frontal cortex the "high road," which takes several milliseconds longer in the midst of an overwhelmingly threatening experience. However, processing by the thalamus can break down. Sights, sounds, smells, and touch are encoded as isolated, dissociated fragments, and normal memory processing disintegrates. Time freezes, so that the present danger feels like it will last forever.

The central function of the amygdala, which I call the brain's smoke detector, is to identify whether incoming input is relevant for our survival.11 It does so quickly and automatically, with the help of feedback from the hippocampus, a nearby structure that relates the new input to past experiences. If the amygdala senses a threat—a potential collision with an oncoming vehicle, a person on the street who looks threatening—it sends an instant message down to the hypothalamus and the brain stem, recruiting the stress-hormone system and the autonomic nervous system (ANS) to orchestrate a whole-body response. Because the amygdala processes the information it receives from the thalamus faster than the frontal lobes do, it decides whether incoming information is a threat to our survival even before we are consciously aware of the danger. By the time we realize what is happening, our body may already be on the move.

The emotional brain has first dibs on interpreting incoming information. Sensory Information about the environment and body state received by the eyes, ears, touch, kinesthetic sense, etc., converges on the thalamus, where it is processed, and then passed on to the amygdala to interpret its emotional significance. This occurs with lightning speed. If a threat is detected the amygdala sends messages to the hypothalamus to secrete stress hormones to defend against that threat. The neuroscientist Joseph LeDoux calls this the low road. The second neural pathway, the high road, runs from the thalamus, via the hippocampus and anterior cingulate, to the prefrontal cortex, the rational brain, for a conscious and much more refined interpretation. This takes several microseconds longer. If the interpretation of threat by the amygdala is too intense, and/or the filtering system from the higher areas of the brain are too weak, as often happens in PTSD, people lose control over automatic emergency responses, like prolonged startle or aggressive outbursts.

The amygdala's danger signals trigger the release of powerful stress hormones, including cortisol and adrenaline, which increase heart rate, blood pressure, and rate of breathing, preparing us to fight back or run away. Once the danger is past, the body returns to its normal state fairly quickly. But when recovery is blocked, the body is triggered to defend itself, which makes people feel agitated and aroused.

While the smoke detector is usually pretty good at picking up danger clues, trauma increases the risk of misinterpreting whether a particular situation is dangerous or safe. You can get along with other people only if you can accurately gauge whether their intentions are benign or dangerous. Even a slight misreading can lead to painful misunderstandings in relationships at home and at work. Functioning effectively in a complex work environment or a household filled with rambunctious kids requires the ability to quickly assess how people are feeling and continuously adjusting your behavior accordingly. Faulty alarm systems lead to blowups or shutdowns in response to innocuous comments or facial expressions.

CONTROLLING THE STRESS RESPONSE: THE WATCHTOWER

If the amygdala is the smoke detector in the brain, think of the frontal lobes —and specifically the medial prefrontal cortex (MPFC),12 located directly above our eyes—as the watchtower, offering a view of the scene from on high. Is that smoke you smell the sign that your house is on fire and you need to get out, fast—or is it coming from the steak you put over too high a flame? The amygdala doesn't make such judgments; it just gets you ready to fight back or escape, even before the frontal lobes get a chance to weigh in with their assessment. As long as you are not too upset, your frontal lobes can restore your balance by helping you realize that you are responding to a false alarm and abort the stress response.

Ordinarily the executive capacities of the prefrontal cortex enable people to observe what is going on, predict what will happen if they take a certain action, and make a conscious choice. Being able to hover calmly and objectively over our thoughts, feelings, and emotions (an ability I'll call mindfulness throughout this book) and then take our time to respond allows the executive brain to inhibit, organize, and modulate the hardwired automatic reactions preprogrammed into the emotional brain. This capacity is crucial for preserving our relationships with our fellow human beings. As long as our frontal lobes are working properly, we're unlikely to lose our temper every time a waiter is late with our order or an insurance company agent puts us on hold. (Our watchtower also tells us that other people's anger and threats are a function of their emotional state.) When that system breaks down, we become like conditioned animals: The moment we detect danger we automatically go into fight-or-flight mode.

Top down or bottom up. Structures in the emotional brain decide what we perceive as dangerous or safe. There are two ways of changing the threat detection system: from the top down, via modulating messages from the medial prefrontal cortex (not just prefrontal cortex), or from the bottom up, via the reptilian brain, through breathing, movement, and touch.

In PTSD the critical balance between the amygdala (smoke detector) and the MPFC (watchtower) shifts radically, which makes it much harder to control emotions and impulses. Neuroimaging studies of human beings in highly emotional states reveal that intense fear, sadness, and anger all increase the activation of subcortical brain regions involved in emotions and significantly reduce the activity in various areas in the frontal lobe, particularly the MPFC. When that occurs, the inhibitory capacities of the frontal lobe break down, and people "take leave of their senses": They may startle in response to any loud sound, become enraged by small frustrations, or freeze when somebody touches them.13

Effectively dealing with stress depends upon achieving a balance between the smoke detector and the watchtower. If you want to manage your emotions better, your brain gives you two options: You can learn to regulate them from the top down or from the bottom up.

Knowing the difference between top down and bottom up regulation is central for understanding and treating traumatic stress. Top-down regulation involves strengthening the capacity of the watchtower to monitor your body's sensations. Mindfulness meditation and yoga can help with this. Bottom-up regulation involves recalibrating the autonomic nervous system, (which, as we have seen, originates in the brain stem). We can access the ANS through breath, movement, or touch. Breathing is one of the few body functions under both conscious and autonomic control. In part 5 of this book we'll explore specific techniques for increasing both top-down and bottom-up regulation.

THE RIDER AND THE HORSE

For now I want to emphasize that emotion is not opposed to reason; our emotions assign value to experiences and thus are the foundation of reason. Our self-experience is the product of the balance between our rational and our emotional brains. When these two systems are in balance, we "feel like ourselves." However, when our survival is at stake, these systems can function relatively independently.

If, say, you are driving along, chatting with a friend, and a truck suddenly looms in the corner of your eye, you instantly stop talking, slam on the brakes, and turn your steering wheel to get out of harm's way. If your instinctive actions have saved you from a collision, you may resume where you left off. Whether you are able to do so depends largely on how quickly your visceral reactions subside to the threat.

The neuroscientist Paul MacLean, who developed the three-part description of the brain that I've used here, compared the relationship between the rational brain and the emotional brain to that between a more or less competent rider and his unruly horse.14 As long as the weather is calm and the path is smooth, the rider can feel in excellent control. But unexpected sounds or threats from other animals can make the horse bolt, forcing the rider to hold on for dear life. Likewise, when people feel that their survival is at stake or they are seized by rages, longings, fear, or sexual desires, they stop listening to the voice of reason, and it makes little sense to argue with them. Whenever the limbic system decides that something is a question of life or death, the pathways between the frontal lobes and the limbic system become extremely tenuous.

Psychologists usually try to help people use insight and understanding to manage their behavior. However, neuroscience research shows that very few psychological problems are the result of defects in understanding; most originate in pressures from deeper regions in the brain that drive our perception and attention. When the alarm bell of the emotional brain keeps signaling that you are in danger, no amount of insight will silence it. I am reminded of the comedy in which a seven-time recidivist in an anger-management program extols the virtue of the techniques he's learned: "They are great and work terrific—as long as you are not really angry."

When our emotional and rational brains are in conflict (as when we're enraged with someone we love, frightened by someone we depend on, or lust after someone who is off limits), a tug-of-war ensues. This war is largely played out in the theater of visceral experience—your gut, your heart, your lungs—and will lead to both physical discomfort and psychological misery. Chapter 6 will discuss how the brain and viscera interact in safety and danger, which is key to understanding the many physical manifestations of trauma.

I'd like to end this chapter by examining two more brain scans that illustrate some of the core features of traumatic stress: timeless reliving; reexperiencing images, sounds, and emotions; and dissociation.

STAN AND UTE'S BRAINS ON TRAUMA

On a fine September morning in 1999, Stan and Ute Lawrence, a professional couple in their forties, set out from their home in London, Ontario, to attend a business meeting in Detroit. Halfway through the journey they ran into a wall of dense fog that reduced visibility to zero in a split second. Stan immediately slammed on the brakes, coming to a standstill sideways on the highway, just missing a huge truck. An eighteen-wheeler went flying over the trunk of their car; vans and cars slammed into them and into each other. People who got out of their cars were hit as they ran for their lives. The ear-splitting crashes went on and on—with each jolt from behind they felt this would be the one that killed them. Stan and Ute were trapped in car number thirteen of an eighty-seven-car pileup, the worst road disaster in Canadian history.15

Then came the eerie silence. Stan struggled to open the doors and windows, but the eighteen-wheeler that had crushed their trunk was wedged against the car. Suddenly, someone was pounding on their roof. A girl was screaming, "Get me out of here—I'm on fire!" Helplessly, they saw her die as the car she'd been in was consumed by flames. The next thing they knew, a truck driver was standing on the hood of their car with a fire extinguisher. He smashed the windshield to free them, and Stan climbed through the opening. Turning around to help his wife, he saw Ute sitting frozen in her seat. Stan and the truck driver lifted her out and an ambulance took them to an emergency room. Aside from a few cuts, they were found to be physically unscathed.

At home that night, neither Stan nor Ute wanted to go to sleep. They felt that if they let go, they would die. They were irritable, jumpy, and on edge. That night, and for many to come, they drank copious quantities of wine to numb their fear. They could not stop the images that were haunting them or the questions that went on and on: What if they'd left earlier? What if they hadn't stopped for gas? After three months of this, they sought help from Dr. Ruth Lanius, a psychiatrist at the University of Western Ontario.

Dr. Lanius, who had been my student at the Trauma Center a few years earlier, told Stan and Ute she wanted to visualize their brains with an fMRI scan before beginning treatment. The fMRI measures neural activity by tracking changes in blood flow in the brain, and unlike the PET scan, it does not require exposure to radiation. Dr. Lanius used the same kind of script-driven imagery we had used at Harvard, capturing the images, sounds, smells, and other sensations Stan and Ute had experienced while they were trapped in the car.

Stan went first and immediately went into a flashback, just as Marsha had in our Harvard study. He came out of the scanner sweating, with his heart racing and his blood pressure sky high. "This was just the way I felt during the accident," he reported. "I was sure I was going to die, and there was nothing I could do to save myself." Instead of remembering the accident as something that had happened three months earlier, Stan was reliving it.

DISSOCIATION AND RELIVING

Dissociation is the essence of trauma. The overwhelming experience is split off and fragmented, so that the emotions, sounds, images, thoughts, and physical sensations related to the trauma take on a life of their own. The sensory fragments of memory intrude into the present, where they are literally relived. As long as the trauma is not resolved, the stress hormones that the body secretes to protect itself keep circulating, and the defensive movements and emotional responses keep getting replayed. Unlike Stan, however, many people may not be aware of the connection between their "crazy" feelings and reactions and the traumatic events that are being replayed. They have no idea why they respond to some minor irritation as if they were about to be annihilated.

Flashbacks and reliving are in some ways worse that the trauma itself.

A traumatic event has a beginning and an end—at some point it is over. But for people with PTSD a flashback can occur at any time, whether they are awake or asleep. There is no way of knowing when it's going to occur again or how long it will last. People who suffer from flashbacks often organize their lives around trying to protect against them. They may compulsively go to the gym to pump iron (but finding that they are never strong enough), numb themselves with drugs, or try to cultivate an illusory sense of control in highly dangerous situations (like motorcycle racing, bungee jumping, or working as an ambulance driver). Constantly fighting unseen dangers is exhausting and leaves them fatigued, depressed, and weary.

If elements of the trauma are replayed again and again, the accompanying stress hormones engrave those memories ever more deeply in the mind. Ordinary, day-to-day events become less and less compelling.

Not being able to deeply take in what is going on around them makes it impossible to feel fully alive. It becomes harder to feel the joys and aggravations of ordinary life, harder to concentrate on the tasks at hand. Not being fully alive in the present keeps them more firmly imprisoned in the past.

Triggered responses manifest in various ways. Veterans may react to the slightest cue—like hitting a bump in the road or a seeing a kid playing in the street—as if they were in a war zone. They startle easily and become enraged or numb. Victims of childhood sexual abuse may anesthetize their sexuality and then feel intensely ashamed if they become excited by sensations or images that recall their molestation, even when those sensations are the natural pleasures associated with particular body parts. If trauma survivors are forced to discuss their experiences, one person's blood pressure may increase while another responds with the beginnings of a migraine headache. Still others may shut down emotionally and not feel any obvious changes. However, in the lab we have no problem detecting their racing hearts and the stress hormones churning through their bodies.

These reactions are irrational and largely outside people's control. Intense and barely controllable urges and emotions make people feel crazy —and makes them feel they don't belong to the human race. Feeling numb during birthday parties for your kids or in response to the death of loved ones makes people feel like monsters. As a result, shame becomes the dominant emotion and hiding the truth the central preoccupation.

They are rarely in touch with the origins of their alienation. That is where therapy comes in—is the beginning of bringing the emotions that were generated by trauma being able to feel, the capacity to observe oneself online. However, the bottom line is that the threat-perception system of the brain has changed, and people's physical reactions are dictated by the imprint of the past.

The trauma that started "out there" is now played out on the battlefield of their own bodies, usually without a conscious connection between what happened back then and what is going on right now inside. The challenge is not so much learning to accept the terrible things that have happened but learning how to gain mastery over one's internal sensations and emotions. Sensing, naming, and identifying what is going on inside is the first step to recovery.

THE SMOKE DETECTOR GOES ON OVERDRIVE

Stan's brain scan shows his flashback in action. This is what reliving trauma looks like in the brain: the brightly lit area in the lower right-hand corner, the blanked-out lower left side, and the four symmetrical white holes around the center. (You may recognize the lit-up amygdala and the off-line left brain from the Harvard study discussed in chapter 3.) Stan's amygdala made no distinction between past and present. It activated just as if the car crash were happening in the scanner, triggering powerful stress hormones and nervous-system responses. These were responsible for his sweating and trembling, his racing heart and elevated blood pressure: entirely normal and potentially lifesaving responses if a truck has just smashed into your car.

Imaging a flashback with fMRI. Notice how much more activity appears on the right side than on the left.

It's important to have an efficient smoke detector: You don't want to get caught unawares by a raging fire. But if you go into a frenzy every time you smell smoke, it becomes intensely disruptive. Yes, you need to detect whether somebody is getting upset with you, but if your amygdala goes into overdrive, you may become chronically scared that people hate you, or you may feel like they are out to get you.

THE TIMEKEEPER COLLAPSES

Both Stan and Ute had become hypersensitive and irritable after the accident, suggesting that their prefrontal cortex was struggling to maintain control in the face of stress. Stan's flashback precipitated a more extreme reaction.

The two white areas in the front of the brain (on top in the picture) are the right and left dorsolateral prefrontal cortex. When those areas are deactivated, people lose their sense of time and become trapped in the moment, without a sense of past, present, or future.16

Two brain systems are relevant for the mental processing of trauma: those dealing with emotional intensity and context. Emotional intensity is defined by the smoke alarm, the amygdala, and its counterweight, the watchtower, the medial prefrontal cortex. The context and meaning of an experience are determined by the system that includes the dorsolateral prefrontal cortex (DLPFC) and the hippocampus. The DLPFC is located to the side in the front brain, while the MPFC is in the center. The structures along the midline of the brain are devoted to your inner experience of yourself, those on the side are more concerned with your relationship with your surroundings.

The DLPFC tells us how our present experience relates to the past and how it may affect the future—you can think of it as the timekeeper of the brain. Knowing that whatever is happening is finite and will sooner or later come to an end makes most experiences tolerable. The opposite is also true —situations become intolerable if they feel interminable. Most of us know from sad personal experience that terrible grief is typically accompanied by the sense that this wretched state will last forever, and that we will never get over our loss. Trauma is the ultimate experience of "this will last forever."

Stan's scan reveals why people can recover from trauma only when the brain structures that were knocked out during the original experience—which is why the event registered in the brain as trauma in the first place—are fully online. Visiting the past in therapy should be done while people are, biologically speaking, firmly rooted in the present and feeling as calm, safe, and grounded as possible. ("Grounded" means that you can feel your butt in your chair, see the light coming through the window, feel the tension in your calves, and hear the wind stirring the tree outside.) Being anchored in the present while revisiting the trauma opens the possibility of deeply knowing that the terrible events belong to the past. For that to happen, the brain's watchtower, cook, and timekeeper need to be online. Therapy won't work as long as people keep being pulled back into the past.

THE THALAMUS SHUTS DOWN

Look again at the scan of Stan's flashback, and you can see two more white holes in the lower half of the brain. These are his right and left thalamus—blanked out during the flashback as they were during the original trauma.

As I've said, the thalamus functions as a "cook"—a relay station that collects sensations from the ears, eyes, and skin and integrates them into the soup that is our autobiographical memory. Breakdown of the thalamus explains why trauma is primarily remembered not as a story, a narrative with a beginning middle and end, but as isolated sensory imprints: images, sounds, and physical sensations that are accompanied by intense emotions, usually terror and helplessness.17

In normal circumstances the thalamus also acts as a filter or gatekeeper.

This makes it a central component of attention, concentration, and new learning—all of which are compromised by trauma. As you sit here reading, you may hear music in the background or traffic rumbling by or feel a faint gnawing in your stomach telling you it's time for a snack. If you are able to stay focused on this page, your thalamus is helping you distinguish between sensory information that is relevant and information that you can safely ignore. In chapter 19, on neurofeedback, I'll discuss some of the tests we use to measure how well this gating system works, as well as ways to strengthen it.

People with PTSD have their floodgates wide open. Lacking a filter, they are on constant sensory overload. In order to cope, they try to shut themselves down and develop tunnel vision and hyperfocus. If they can't shut down naturally, they may enlist drugs or alcohol to block out the world. The tragedy is that the price of closing down includes filtering out sources of pleasure and joy, as well.

DEPERSONALIZATION: SPLIT OFF FROM THE SELF

Let's now look at Ute's experience in the scanner. Not all people react to trauma in exactly the same way, but in this case the difference is particularly dramatic, since Ute was sitting right next to Stan in the wrecked car. She responded to her trauma script by going numb: Her mind went blank, and nearly every area of her brain showed markedly decreased activity. Her heart rate and blood pressure didn't elevate. When asked how she'd felt during the scan, she replied: "I felt just like I felt at the time of the accident: I felt nothing."

Blanking out (dissociation) in response to being reminded of past trauma. In this case almost every area of the brain has decreased activation, interfering with thinking, focus, and orientation.

The medical term for Ute's response is depersonalization.18 Anyone who deals with traumatized men, women, or children is sooner or later confronted with blank stares and absent minds, the outward manifestation of the biological freeze reaction. Depersonalization is one symptom of the massive dissociation created by trauma. Stan's flashbacks came from his thwarted efforts to escape the crash—cued by the script, all his dissociated, fragmented sensations and emotions roared back into the present. But instead of struggling to escape, Ute had dissociated her fear and felt nothing.

I see depersonalization regularly in my office when patients tell me horrendous stories without any feeling. All the energy drains out of the room, and I have to make a valiant effort to keep paying attention. A lifeless patient forces you to work much harder to keep the therapy alive, and I often used to pray for the hour to be over quickly.

After seeing Ute's scan, I started to take a very different approach toward blanked-out patients. With nearly every part of their brains tuned out, they obviously cannot think, feel deeply, remember, or make sense out of what is going on. Conventional talk therapy, in those circumstances, is virtually useless.

In Ute's case it was possible to guess why she responded so differently from Stan. She was utilizing a survival strategy her brain had learned in childhood to cope with her mother's harsh treatment. Ute's father died when she was nine years old, and her mother subsequently was often nasty and demeaning to her. At some point Ute discovered that she could blank out her mind when her mother yelled at her. Thirty-five years later, when she was trapped in her demolished car, Ute's brain automatically went into the same survival mode—she made herself disappear.

The challenge for people like Ute is to become alert and engaged, a difficult but unavoidable task if they want to recapture their lives. (Ute herself did recover—she wrote a book about her experiences and started a successful journal called Mental Fitness.) This is where a bottom-up approach to therapy becomes essential. The aim is actually to change the patient's physiology, his or her relationship to bodily sensations. At the Trauma Center we work with such basic measures as heart rate and breathing patterns. We help patients evoke and notice bodily sensations by tapping acupressure19 points. Rhythmic interactions with other people are also effective—tossing a beach ball back and forth, bouncing on a Pilates ball, drumming, or dancing to music.

Numbing is the other side of the coin in PTSD. Many untreated trauma survivors start out like Stan, with explosive flashbacks, then numb out later in life. While reliving trauma is dramatic, frightening, and potentially self-destructive, over time a lack of presence can be even more damaging. This is a particular problem with traumatized children. The acting-out kids tend